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Apache Aviator Visual Experiences with the IHADSS Helmet-Mounted Display in Operation Iraqi Freedom

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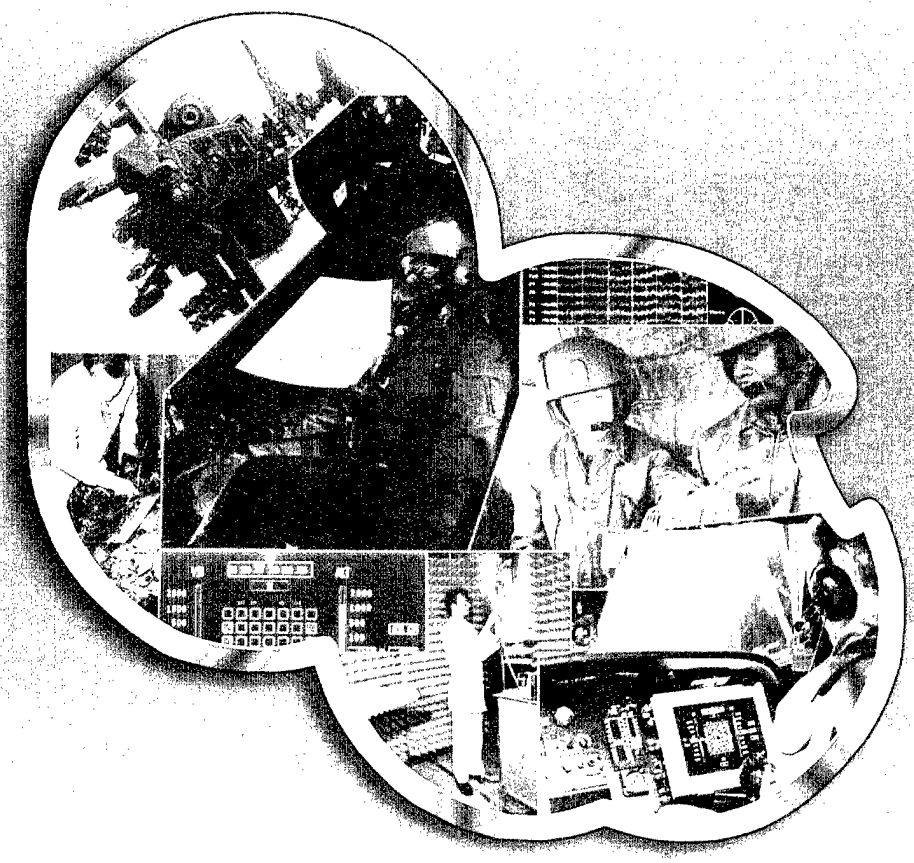

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Forty AH-64 Apache aviators representing a total of 8,564 flight hours and 2,260 combat hours during Operation Iraqi Freedom and its aftermath were surveyed for their visual experiences with the AH-64's monocular integrated helmet and display sighting system (IHADSS) helmet-mounted display in a combat environment. A major objective of this study was to determine if the frequencies of reports of visual complaints and illusions reported in previous studies, addressing mostly benign training environments, differ in the more stressful combat environment. The most frequently reported visual complaints, both *while* and *after* flying, were visual discomfort and headache, which is consistent with previous studies. Frequencies of complaints *after* flying in the current study were numerically lower for all complaint types, but differences from previous studies are statistically significant only for visual discomfort and disorientation (vertigo). With the exception of "brownout/whiteout," reports of degraded visual cues in the current study were numerically lower for all types, but statistically significant only for impaired depth perception, decreased field of view, and inadvertent instrument meteorological conditions. This study also found statistically lower reports of all static and dynamic illusions (with one exception, disorientation). This important finding is attributed to the generally flat and featureless geography present in a large portion of the Iraqi theatre and to the shift in the way that aviators use the two disparate visual inputs presented by the IHADSS monocular design (i.e., greater use of both eyes as opposed to concentrating primarily on display imagery).

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Table of contents

List of tables

Table of contents (Continued)
List of tables (Continued)

Page

List of figures

Introduction

The US Army's AH-64 Apache attack helicopter has been fielded since the early 1980's (Figure 1). There are currently two models (A & D) of the Apache. The latter D-model differs primarily from the A-model in cockpit design and the addition of a mast-mounted millimeter radar system. The AH-64 is a tandem-seated aircraft with the pilot occupying the rear seat and the copilot/gunner occupying the front seat. Both pilots fly and perform fire-control procedures using a monocular helmet-mounted display (HMD) known as the Integrated Helmet and Display Sighting System (IHADSS) (Figure 2). The IHADSS provides pilotage and fire-control imagery from separate forward-looking infrared (FLIR) sensors mounted on the nose of the aircraft. Flight symbology is integrated (embedded) into the HMD imagery. The FLIR sensor that provides the pilotage imagery is known as the Pilot's Night Vision System (PNVS); the FLIR sensor that provides the fire-control imagery is known as the Target Acquisition and Designation System (TADS).

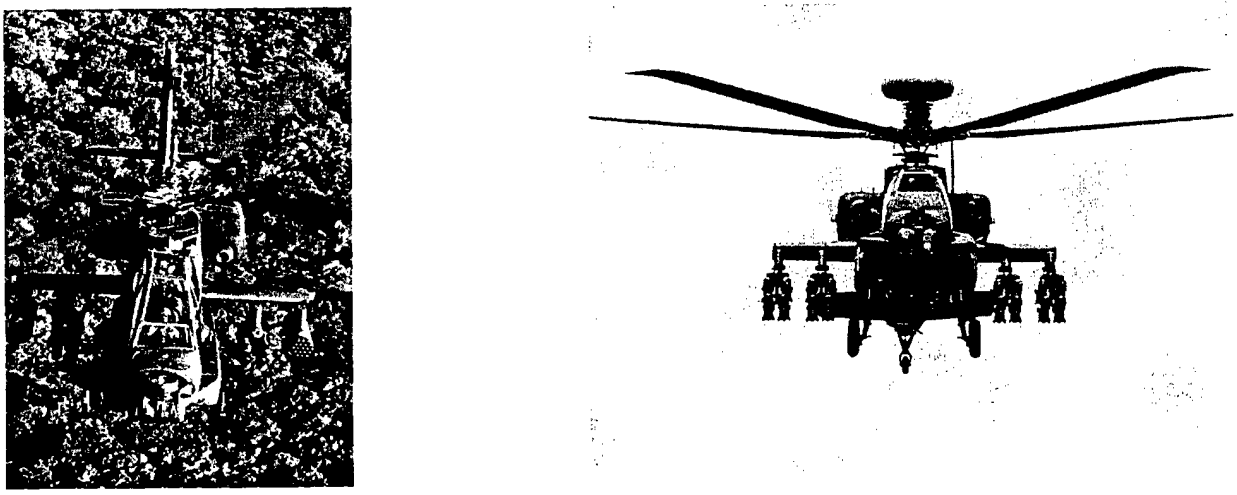

Figure 1. The AH-64A (left) and AH-64D (right) Apache helicopters.

Figure 2. The AH-64 Integrated Helmet and Display Sighting System (IHADSS).

A number of studies (Hale and Piccione, 1989; Behar et al., 1990; Crowley, Rash and Stephens, 1992; Rash et al., 2001) have documented pilot reports of degraded visual cues, visual symptoms, and visual illusions while flying using the IHADSS HMD. All of these studies were conducted in relatively benign environments (e.g. training and non-combat missions). The study reported herein is the first to investigate the presence of visual complaints and artifacts in an operational combat environment; i.e., in Operation Iraqi Freedom (OIF).

Background

Following the fielding of the AH-64 (A-model), as pilots gained experience with the use of the novel monocular IHADSS HMD, complaints of visual problems began to manifest themselves. In 1989, Hale and Piccione (1989) conducted the first, although limited, survey of AH-64 Apache aviator experience with the IHADSS HMD. The study documented aviator complaints of physical fatigue and headaches. The aviators attributed these symptoms to binocular rivalry, poor FLIR image quality, narrow field-of-view (FOV), poor depth perception, and inadequate eye relief.

The design of the IHADSS as a monocular HMD was based somewhat on cost but primarily on head-supported weight considerations. At the time of development, helmet and display technologies could not provide a binocular (two-eyed) HMD system at the level of head-supported weight needed to address safety issues during crashes. There are two major visual concerns associated with the IHADSS's monocular design: binocular rivalry and eye dominance. Binocular rivalry is a phenomenon that occurs when the eyes receive dissimilar input. The brain resolves this visual conflict by suppressing one of the input images (Bishop, 1981). The IHADSS presents the eyes with two separate inputs. The right eye views the FLIR imagery, and the left eye views the external world (to include the interior cockpit). These two views differ in color, resolution, FOV, motion content, and brightness. While in practice, the aviator must possess the capability to intentionally switch attention between the two visual inputs, binocular rivalry can produce unintentional alternation between the two inputs.

Eye, or "sighting", dominance refers to a tendency for an individual to use or prefer one eye over the other for monocular tasks. Again for weight considerations, a decision was made to provide mounting of the HMD only for the right eye. While serious questions were raised during early system development as to whether a left-eye dominant aviator could learn to use a right-eye display, there has been no conclusive evidence linking sighting dominance with various facets of cognitive ability, including tracking ability and marksmanship performance (Crowley, 1989).

Crowley's 1989 study requested aviators to report illusions or other visual effects experienced while flying image intensification devices (i.e. night vision goggles) or the AH-64 IHADSS HMD. Due to the limited number of AH-64 aircraft fielded at that time, the majority of reports were associated with image intensification devices; only 21 reports were associated with the use of the IHADSS. The reports were classified as either relating to degraded visual cues, static illusions, dynamic illusions, or miscellaneous. The most common degraded visual cue reported was impaired acuity (14%); the most common static illusion was faulty height judgment (19%);

and the most common dynamic illusions were undetected aircraft drift (24%) and illusory aircraft drift (25%). Table 1 summarizes these reports.

Table 1.
Reports of degraded visual cues (n = 21).
(Crowley, 1991)

Degraded visual cues	%	n
Degraded resolution/insufficient detail	14	3
Loss of visual contact with horizon	10	2
Impaired depth perception	10	2
Decreased field-of-view	10	2
Inadvertent instrument meteorological conditions (IMC)	5	1
Static Illusions		
Faulty height judgment	19	4
Trouble with lights	5	1
Dynamic Illusions		
Undetected aircraft drift	24	5
Illusory aircraft drift	24	5
Disorientation ("vertigo")	14	3
Faulty closure judgment	10	2
Miscellaneous		
Hardware-related problems distracting symbology	14	3
Crew coordination problems mixing FLIR and image intensification	5	1
Physiological effects (dark adaptation effects)	5	1

The 1990 Visual Issues Survey of Apache Aviators (VISAA) (Behar et al., 1990) study was designed specifically to address visual medical concerns raised by Apache unit flight surgeons. It consisted of three parts that addressed separate aspects of Apache aviator vision. The first part was an epidemiological assessment that documented visual problems being reported by the Ft. Rucker, AL, Apache instructor pilot (IP) community. The second part was a clinical and laboratory evaluation of the refractive and visual status of a sample of the IP community. The third part measured the Apache aviators' adjustment of the IHADSS focus setting.

For the epidemiological vision survey, a questionnaire was distributed to the Ft. Rucker, AL, Apache IP community. Fifty-eight questionnaires were completed and returned. The sample had a mean age of 35.8 years, mean total flight hours of 3330, and mean AH-64 flight hours of 664. More than 80% of the aviators reported at least one visual complaint associated with periods of flying or directly following flight in the AH-64. From respondent comments, the authors concluded that most visual symptoms occurred during long flights and/or while flying with poor quality FLIR imagery. The most common visual symptom reported *while* flying was that of visual discomfort (51%); the most common visual symptom reported *after* flying was headache (34%).

The second part of the study was a clinical visual assessment of 10 IPs. Subjects ranged in age from 32 to 44 with a mean of 38.6 years. Average total flight hours were 4560; average AH-64 flight hours was 895. The clinical assessment consisted of a comprehensive visual function test battery that included assessment of visual acuity, contrast sensitivity, color vision, depth perception, sighting preference, binocular rivalry, and clinical optometric tests of manifest and cycloplegic refractions, accommodated function, and oculomotor status. No significant variation from expected normal values were found.

The third and final part of the study assessed focus setting. Twenty AH-64 aviators were approached on the flight line during actual preflight activities (9 night launches and 11 day launches) and were requested to perform normal adjustment of the IHADSS, to include focus setting. At this point, a mini-dioptometer was used to measure the focus dioptric setting. The range of measured settings was 0 to –5.25 diopters with a mean of –2.28 diopters. The study concluded that the required positive accommodation by the eye to offset these inappropriate negative focus settings was very likely a source of reported headaches and visual discomfort during and after long flights.

The year 2000 study (Rash et al., 2001) was a near duplication of the 1990 VISAA survey and the Crowley 1989 visual illusion questionnaire, combined. The study was repeated for two reasons. First, there had been renewed interest in the incidence of visual complaints with use of the monocular IHADSS, fueled by expanded fielding of the AH-64 Apache helicopter in the United Kingdom and other countries; and second, during the intervening period, the flight track for AH-64 aviators had changed. During the early years of the AH-64 fielding, all AH-64 aviators were experienced aviators who had transitioned from other aircraft (primarily the AH-1 Cobra). Since 1986, AH-64 aviators had begun transitioning directly from initial entry rotary-wing (IERW) training into flying the AH-64 Apache. In addition to this change, the respondents in the 1990 study were all experienced IPs. The year 2000 study included aviators with as few as 20 AH-64 flight hours.

The survey was conducted exclusively via the Internet. The questionnaire was developed and placed at a dedicated Internet address, reachable only by knowing the direct Internet address. This address was advertised in *Flightfax*, a U.S. Army Safety Center, Fort Rucker, Alabama, publication that is distributed to all U.S. Army aviation units. The Internet survey was advertised further via emails to commanders of all AH-64 units worldwide. The questionnaire consisted of six sections: (1) demographics, (2) visual history, (3) helmet fit, (4) aviation vision, (5) acoustical issues, and (6) an open-ended comment section. The most important section, aviation vision, repeated the previous studies' questions about visual complaints, symptoms and illusions experienced either *during* or *after* flight using the IHADSS HMD.

A total of 216 questionnaires were evaluated, which represented approximately 12 percent of the AH-64 active-duty and National Guard AH-64 aviator population. Respondents had a mean age of 36.5 years, mean total flight hours of 2131, and mean AH-64 flight hours of 1116. The study concluded that 92% of respondents reported at least one visual complaint/symptom either *during* or *after* flight; the frequency of complaints did not correlate to age or flight experience; the data did not support any association between eye preference (dominant eye) and the number of visual complaints; the two most reported static illusions were faulty slope estimation (80.1%)

and faulty height judgment (73.6%); and the two most reported dynamic illusions were undetected drift (78.2%) and illusory drift (71.3%). Table 2 summarizes the types and frequency of reported visual symptoms.

Table 2.
Percentage of aviators reporting visual symptoms *during* and *after* Apache flight (n=216). (Rash et al., 2001)

	During flight				After flight			
	Never	Sometimes	Always	NR	Never	Sometimes	Always	NR
Visual discomfort	18.5	76.4	5.1	0.0	25.5	66.2	7.9	0.5
Headache	38.9	59.7	0.9	0.5	36.1	61.1	1.4	1.4
Double vision	93.5	6.0	0.5	0.0	93.1	4.6	0.5	1.9
Blurred vision	66.2	33.3	0.5	0.0	63.0	36.6	0.5	0.0
Disorientation	57.4	42.1	0.0	0.5	88.4	9.7	0.0	1.9
Afterimages	70.4	27.3	1.9	0.5	51.9	41.7	5.1	1.4

Methodology

Operation Iraqi Freedom AH-64 Apache aviator survey

The survey in the current study was conducted in northern Iraq over a 3-day period, 25-27 November 2003. The survey consisted of a written questionnaire and an oral interview (both administered by a U.S. Army flight surgeon assigned to the 101st Airborne Division, deployed in northern Iraq, who also is a co-investigator in this study). The questionnaire (Appendix A) consisted of five sections: (1) demographics, (2) visual history, (3) helmet fit, (4) aviation vision, and (5) combat effectiveness. The demographics section addressed age, gender, total flight hours, total AH-64 flight hours, total combat hours flown in OIF, and information about number and duration of flown sorties. The visual history section documented the use of vision correction (i.e., spectacles and contact lenses) and eye preference. In the helmet fit section, aviators were requested to provide information regarding history, quality and satisfaction of the fit of their IHADSS helmet, an important factor in maintaining HMD optical alignment. Of primary interest were questions in the aviation vision section regarding visual complaints, symptoms, and illusions experienced either *while* or *after* flying with the IHADSS. Respondents were asked to rate the effectiveness of their IHADSS during OIF (using a Likert scale of 1 to 5). Finally, respondents were asked if they had participated in the 2000 Internet survey conducted by the U.S. Army Aeromedical research Laboratory (USAARL) (Rash et al., 2001).

Immediately following completion of the questionnaire, each respondent was asked to participate in a short oral interview conducted by the flight surgeon. The interview consisted of 11 structured questions and 1 unstructured question. Structured questions addressed previously identified potential problem areas, e.g., maintaining full FOV, combiner breakage, and sensor slew rate. Additional questions requested respondent opinion on the best and worst features of the IHADSS, day versus night use of the IHADSS, and the acceptance of a hypothetical

binocular IHADSS design. The final, unstructured, question provided respondents with the opportunity to identify previously unaddressed IHADSS issues.

Subjects

A total of 41 AH-64 aviators participated in the study. One respondent was eliminated when it was determined he was newly assigned and had not logged any flight hours within the theatre of operations. It is estimated that the 40 valid respondents represented approximately 20% of the targeted population of AH-64 aviators conducting day-to-day flights in OIF. All respondents were assigned to units of the 101st Aviation Brigade, 101st Airborne Division (Air Assault), participating in OIF throughout the theatre of operations in northern Iraq. Note: Due to ongoing hostile conditions, subject selection was not fully randomized, but was based on availability. However, subject demographics (Table 3) depict a diverse range of age and flight experience.

Demographics

Demographic data for the 40 valid respondents are presented in Table 3. This table is a summary of age, overall flight hours, and flight experience in OIF. All 40 respondents were male. Forty-eight percent (19) of respondents identified their primary flight role as pilot; 53% (21) indicated copilot/gunner.

Table 3.
Respondent demographics.
(n = 40)

	Mean	Median	Range	Stand. Dev.
Age (years)	32	32	24-43	5.4
Total flight hours	1110	800	200-3600	824.1
Total AH-64 flight hours	774	578	52-3400	701.0
AH-64 flight hours in area of operation	214	200	27-400	102.5
Combat hours	59	50	0-300	66.3
	Male		Female	
Gender	40 (100%)		0 (0%)	

Respondents reported a mean number of sorties flown of 82 (ranging from 4 to 200). A sortie is defined as an operational flight by a single aircraft. The mean "average sortie length" was approximately 2.7 hours (ranging from 1 to 5 hours); the mean "longest sortie length" was approximately 7.2 hours.

Vision history

To establish knowledge of certain vision characteristics of respondents that could impact IHADSS use, respondents were asked to indicate use of vision correction devices (i.e., spectacles or contact lenses) and sighting eye preference.

Three (7.5%) respondents indicated the use of vision correction devices. Two reported requiring such correction both when flying and when not flying. The third reported using correction only when flying. All three reported using single vision correction only (i.e., no bifocals, trifocals, etc.). Of the two respondents using correction when flying, one reported using contact lenses only and one reported alternating between spectacles and contact lenses.

Eye dominance was documented by asking respondents to identify their preferred sighting eye and the eye used for viewing through a telescope (Figure 3). Twenty-seven (67.5%) respondents reported the right eye for both questions; 5 (12.5%) reported the left eye. Two (5%) respondents reported their right eye as the preferred sighting eye but use of the left eye for telescope viewing. Five (12.5%) did not respond to either question.

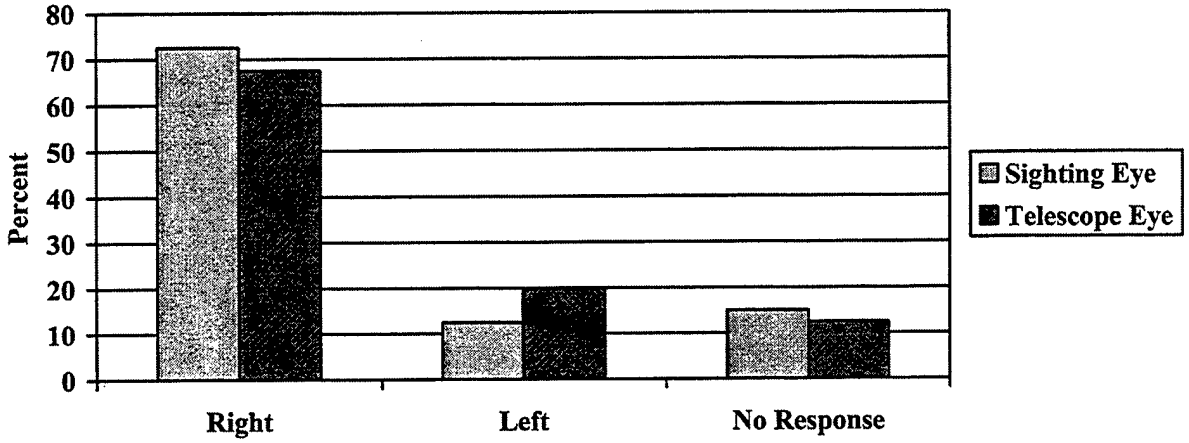

Figure 3. Preferred eye and eye used for viewing through telescope.

The percentages of respondents requiring (7.5%) and using (5%) vision correction in this study are relatively low. In the 2000 study (Rash et al., 2001), these values were 29.6% and 24.1%, respectively. These latter percentages are more consistent with data reported from the U.S. Army Epidemiology Data Register (Schrimsher and Lattimore, 1991). The lower percentage of vision correction use found in the present study is most likely explained by the higher ratio of active duty (typically younger) to National Guard (typically older) participants serving in Iraq. The 2000 study respondents were a mix of active duty and National Guard aviators; all 40 respondents of the current study were active duty aviators. This explanation is supported by the decreased sample age statistics of the current study (mean and median of 32 years) as compared to the 2000 study (mean 36.5 years; median 36 years). The onset of presbyopia (a reduction in ability to change focus) first manifests itself in the late 30s or early 40s, necessitating an increased use of optical correction devices.

The IHADSS is a monocular HMD with flight imagery being delivered to the right eye only (Figure 2). The left eye can view interior cockpit displays or the external scene. The decision to provide right-eye-only capability was based on the need to constrain head-supported-weight (Rash, Verona and Crowley, 1990). Beginning with the early design phases of the IHADSS, there was concern over the potential problems associated with aviators who were not right-eye

dominant. Eye dominance generally refers to which visual input (left or right eye) is preferentially attended to by the visual system. It correlates well with an individual's choice of "preferred eye." However, eye dominance may be more strictly defined by the visual task at hand. Coarsely, an individual can determine eye dominance by using both eyes to view a finger held at full extension that overlays some distant object and then, by alternatively closing one eye, identify the eye for which the covered object does not appear to move.

In the current study, respondents predominately indicated a right-eye sighting preference (72.5%) and a right-eye telescope viewing (67.5%); these percentages increased to 85% and 77%, respectively, when "No response" answers were eliminated. These percentages agree well with the 84% values obtained for both "preferred sighting eye" and "telescope viewing eye" in the 2000 study.

Sample validity

The purpose of this study was to investigate the presence of visual complaints, illusions, and other visual artifacts associated with the use of the IHADSS HMD in the AH-64 in the operational combat environment, as compared to all previous studies that captured experiences in non-combat mission and benign training environments. The validity of the study hinged on surveying aviators with sufficient flight experience in the combat environment. The respondents in this study represented a total of 8564 (mean of 214) AH-64 flight hours and 2260 (mean of 59) combat hours in the Iraqi theater. Eighty percent of respondents flew combat missions.

Discussions with Army pilots indicated that between 15-40 flight hours were required at a new deployment location in order to become "comfortable" with the new flight environment. All 40 respondents exceeded this threshold requirement. The 40 respondents represented approximately 20% of the target population, defined as AH-64 aviators.

As a comparison, the demographics of the 2000 study (Rash et al., 2001) reported mean and median ages of 36.5 and 36 years, respectively. These higher age statistics reflect a higher participation of National Guard aviators in the 2000 study.

Analysis

Survey responses were tabulated and presented as percentages. Where appropriate, data were presented in bar chart format. To answer the research question of comparing HMD visual complaints and problems in the current combat environment study to findings of the previous 2000 study, a chi-squared analysis was used to compare frequencies of response between the two studies. For Likert scale data, the Mann-Whitney U-test was used to compare response distributions (patterns).

Questionnaire data and discussion

The following sections report major data findings for each questionnaire topic. These findings are discussed within the context of helmet-mounted displays and human visual performance. Complete questionnaire data are provided in Appendix B.

Eye change

When asked if their better eye was the same now as it was prior to their AH-64 flight experience, 55% (22) of respondents reported "Yes," and 30% (12) reported "No." Six (15%) failed to answer the question.

Although placed in the "Visual history" section of the questionnaire, the question, "Is your better eye the same now (after AH-64 training and experience) as it was prior to your AH-64 experience?" goes to the core of visual performance and etiology issues associated with the monocular IHADSS. While studies to date have documented reports of multiple visual symptoms and illusions by aviators (Hale and Piccione, 1989; Behar et al., 1990; Crowley, Rash and Stephens, 1992; Rash et al., 2001), no studies have established physiological changes in vision due to the use of the monocular IHADSS system. The first systematic study to investigate this question is currently underway in the United Kingdom (Hiatt et al., 2001). The study (initiated in 2001) follows a cohort of British Apache AH Mk1 aviators (exposed group) and British Army helicopter aviators who do not fly the Apache AH Mk1 (control group) over a 10-year period. Each participant, at his annual flight physical, undergoes an expanded battery of vision tests designed to detect any changes in visual physiological state or symptomatology.

In the current study, 30% of all respondents reported a change in their better eye. This value increases to 35% if the six "No response" answers are ignored. In the 2000 study, approximately one-third (35.6%) of respondents asked the identical question reported a change in their better eye. While these percentages appear to track well across the two studies, an interpretation of the data may be confounded by erroneous ambiguity in the question. The intention of the question was to inquire if any changes in vision had been experienced as a result of AH-64 flight exposure to the monocular IHADSS. Unfortunately, the question was open to two interpretations. The first possible interpretation was whether the "better eye" now (after AH-64 experience) is the same eye as was your "better eye" before the AH-64 experience. The second possible interpretation was whether the better eye has changed in performance. This ambiguity was present in both studies. However, in the 2000 study, comments provided by aviators seemed to imply that the latter interpretation was used, with several aviators reporting a perceived worsening in the right (IHADSS monocular) eye. This implication was not present in the current study.

Helmet fit

The helmet fit section of the questionnaire requested data regarding how much time had elapsed since last helmet fitting (critical to maintaining optical alignment of the HMD's exit pupil [the volume of space where the eye must be placed in order to achieve the full FOV]),

satisfaction with current helmet fit, experience with wearing the nuclear/biological/chemical (NBC) mask with the IHADSS, and ability to achieve the full 30- by 40-degree FOV.

Achieving a satisfactory helmet fit is critical for the AH-64 aviator. At night, the AH-64 is flown primarily using the FLIR pilotage and symbology imagery provided through the IHADSS. The IHADSS has a relatively small 10-millimeter exit pupil, which must be centered at the eye in order to achieve a full FOV. To maintain this exit pupil in the presence of the high-vibration environment of rotary-wing aircraft, it is necessary to achieve a good, stable fit. In addition, the quality of the fit strongly influences aviator comfort (e.g., hot spots, slippage, chafing, etc.).

The mean and median time periods since last helmet fitting were approximately 13 and 12 months, respectively. Sixty-five percent (26) of respondents had received a refitting within the year (12 months) preceding participation in the study. One respondent had not received a refitting in the past 56 months (in excess of 4-1/2 years).

The IHADSS presents a 30-degree vertical by 40-degree horizontal image. Symbology is embedded into the pilotage imagery and is located in the periphery. When asked about ability to achieve the full FOV, respondents overwhelmingly (33, 82.5%) answered "Yes;" it should be noted that 17.5% (7) reported they were not able to achieve a full FOV.

Approximately two-thirds (62.5%) of respondents were somewhat or completely satisfied with the quality of their helmet fit; one-fourth (25%) of respondents were somewhat or completely dissatisfied with their helmet fit. The most common impact of a poor fit was an inability to achieve a full FOV of the IHADSS imagery. Forty percent (16) of respondents reported fit-related degradations in FOV. Representative comments included "helmet slides with head movement, causing me to lose symbology," "improper fit makes it hard to view image after a sustained amount of time," and "I have to tilt my helmet back through [out] flight to maintain visibility."

While a majority (25, 62.5%) of respondents reported being somewhat or completely satisfied with their current IHADSS fit, one out of four (10, 25%) rated satisfaction with their current fit as somewhat or completely dissatisfied. In addition, 40% of respondents reported their ability to view IHADSS imagery was impacted by their helmet fit. In the 2000 study, a comparable 68.1% of respondents reported being somewhat or completely satisfied with the fit of their IHADSS helmet; a slightly smaller percentage (17.1% vs. 25%) reported being somewhat or completely dissatisfied. A statistical comparison between the distributions of the Likert scale responses for helmet satisfaction for the current and 2000 studies, using a two-tailed Mann-Whitney U-test, produced a p-value of 0.11, indicating there was no statistically significant difference between the two helmet fit satisfaction distributions. (NOTE: The Mann-Whitney test is a nonparametric statistical procedure for judging the statistical significance of differences between patterns of responses.)

Only 16 (40%) respondents had received a helmet fitting that included the NBC mask. Even fewer respondents, (3, 7.5%), reported flying with the NBC mask during OIF. Two of these three reported 1 hour of flight with the NBC mask; one reported 20 hours of NBC mask flight.

Although only three respondents reported flying with the NBC mask in OIF, 12 respondents provided comments on the issue of incompatibility between the NBC mask and the IHADSS optics (i.e., the Helmet Display Unit [HDU]). Of the three respondents who flew with the NBC mask, two provided comments about incompatibility. One comment addressed the known fact that the helmet design did not anticipate a requirement for use with an under-the-helmet NBC mask. The second comment stated the respondent was unable to place the HDU sufficiently close to the eye when wearing the NBC mask. The additional comments provided by respondents who had not flown the mask in the Iraqi theatre of operation were based on previously acquired experience. These comments focused on poor fit, reduced FOV, basic design incompatibility between mask and HDU, and loss of symbology (associated with reduced FOV). Two representative comments were "lost all symbology in lower right [corner] and unable to move full left and right" and "helmet was not designed to incorporate a mask."

During the development of the AH-64 and the accompanying IHADSS HMD, the intent was to address the issue of NBC protection through aircraft overpressure. Later in the design phase, a decision was made to provide NBC protection through an under-the-helmet mask design. As a result, there is an inherent design incompatibility between the mask and the HDU. Consequently, it is not surprising that the ability of aviators to view IHADSS imagery is compromised when wearing the NBC mask. This degradation was borne out by respondent comments about reduced FOV and loss of symbology information. The reduction in available IHADSS FOV while wearing the NBC mask has been previously documented (Rash and Martin, 1987; Crosley, Rash, and Levine, 1991). These studies reported an average reduced FOV of 29 degrees vertical by 32 degrees horizontal, as compared to the full 30- by 40-degree FOV. The anticipated effect of this reduction is that aviators can expect to encounter losses in some portions of symbology information when wearing the NBC mask.

Aviation vision

Previous studies have documented a number of visual symptoms, complaints, degraded visual cues, and illusions associated with Apache AH-64 flight using the IHADSS monocular HMD. The major goal of this study was to compare the types and frequencies of these reports for the previous studies, and their generally benign flight environments, to the more demanding and stressful combat environment encountered in the initial conflict period of OIF and its aftermath.

Visual complaints and symptoms

Reported visual complaints and symptoms for both *while* and *after* flying with the IHADSS HMD are presented in Table 4 and Figures 4 and 5. The most common visual complaint reported *while* flying was visual discomfort (e.g., eyestrain, fatigue) (30, 75%), followed by headache (27, 67.5%). Other complaints such as blurred vision (18, 45%) and afterimages (16, 40%) were reported by over one-third of the respondents. These were followed by disorientation (11, 27.5%) and double vision (4, 10%). Respondents reported a typical onset period of 2 hours into flight for the symptoms.

The most common complaints reported *after* flight, likewise, were visual discomfort (23, 57.5%) and headache (23, 57.5%). These were followed by afterimages (16, 40%), blurred vision (11, 27.5%), and double vision (2, 5%).

Table 4.
Visual complaints.
(expressed in percent)

	During flight				After flight			
	Never	Sometimes	Always	NR	Never	Sometimes	Always	NR
Visual discomfort	25.0	70.0	5.0	0.0	42.5	57.5	0.0	0.0
Headache	32.5	67.5	0.0	0.0	42.5	57.5	0.0	0.0
Double vision	90.0	10.0	0.0	0.0	95.0	5.0	0.0	0.0
Blurred vision	55.0	42.5	2.5	0.0	72.5	22.5	5.0	0.0
Disorientation	72.5	27.5	0.0	0.0	100.0	0.0	0.0	0.0
Afterimages	60.0	37.5	2.5	0.0	62.5	30.0	5.0	2.5

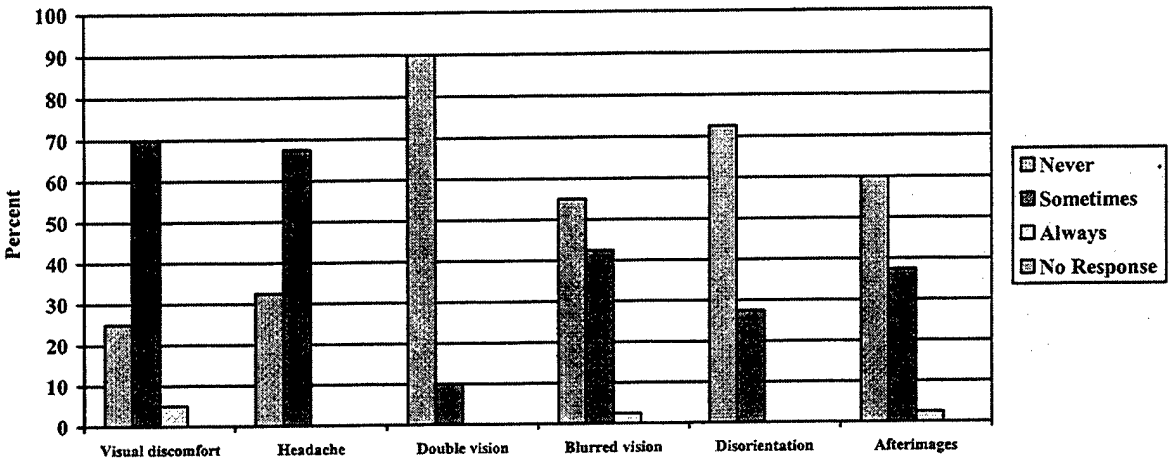

Figure 4. Visual complaints and symptoms *while* flying.

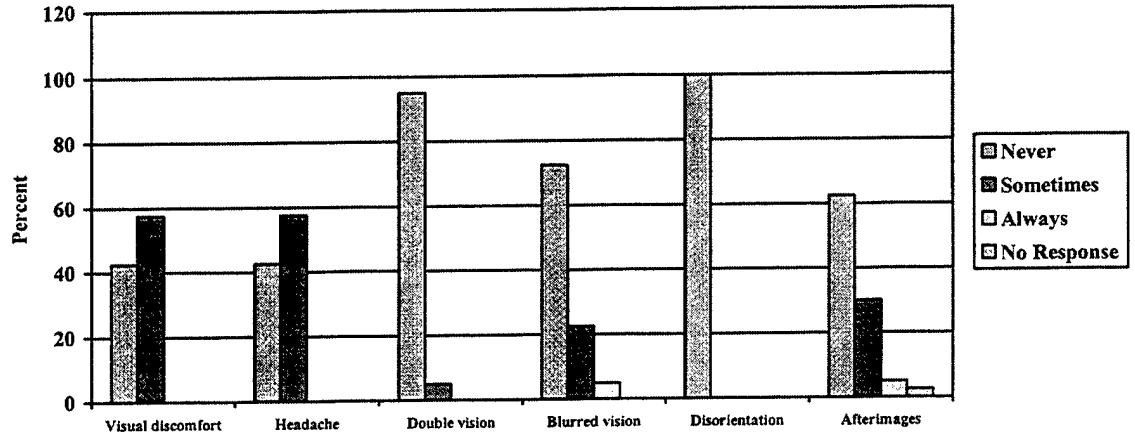

Figure 5. Visual complaints and symptoms *after* flying.

A comparison between the frequencies of visual complaints *while* flying for the 2000 study and the current study is provided in Table 5. While the percentage of occurrence increased for four of the six complaints, none of the differences between the two studies were found to be statistically significant to the .05-level, based on a chi-squared test for proportions.

Table 5.
Comparison of *while* flying visual complaints for current and 2000 studies.

	2000 Survey (n = 216)	Iraqi Freedom Study (n = 40)	p value
Visual discomfort	**82%**	75%	0.3050
Headache	61%	**67.5%**	0.4444
Double vision	7%	**10%**	0.4981
Blurred vision	34%	**45%**	0.1739
Disorientation (vertigo)	**42%**	27.5%	0.0825
Afterimages	29%	**40%**	0.1731

Note: Percentages are rounded to the nearest integer. **Bold** values indicate the higher of the compared values and differences that were statistically significant to the .05-level.

A comparison between the frequencies of visual complaints *after* flying for the 2000 study and the current study is provided in Table 6. While the percentage of occurrence decreased for all of the complaints except double vision, only two of the differences between the two studies were found to be statistically significant to the .05-level based on a chi-squared test for proportions. The two significant reductions occur for visual discomfort and disorientation. Two possible explanations are offered for the reduced incidence of visual discomfort. The first is that the living conditions in the field (in Iraq) for the pilots are difficult; i.e., heat, sand, insects, etc. It is very likely that a complaint of visual discomfort, in comparison to other stressors, ranks very low. Another possible explanation is that between flights pilots have little demand on their time, and as a result have increased levels of crew rest.

Table 6.
Comparison of *after* flying visual complaints for current and 2000 studies.

	2000 Survey (n = 216)	Iraqi Freedom Study (n = 40)	p value
Visual discomfort	**74.0%**	57.5%	**0.0330**
Headache	**63.0%**	57.5%	0.5130
Double vision	5.0%	5.0%	0.9748
Blurred vision	**37.0%**	27.5%	0.2470
Disorientation (vertigo)	**10.0%**	0.0%	**0.0348**
Afterimages	**47.0%**	35.0%	0.1537

Note: Percentages are rounded to the nearest integer. **Bold** values indicate the higher of the compared values and differences that were statistically significant to the .05-level.

Degraded visual cues

Reports of degraded visual cues are summarized in Figure 6. The most frequently reported degraded visual cue was whiteout/brownout (35, 87.5%); this was closely followed by degraded resolution/insufficient detail (34, 85%). Virtually all of the different types of degraded cues (except inadvertent IMC) were reported by approximately half of all respondents. Comments provided by respondents primarily blamed the degraded cues on poor FLIR performance. A representative comment was, "Rarely use FLIR without some degraded visual cues."

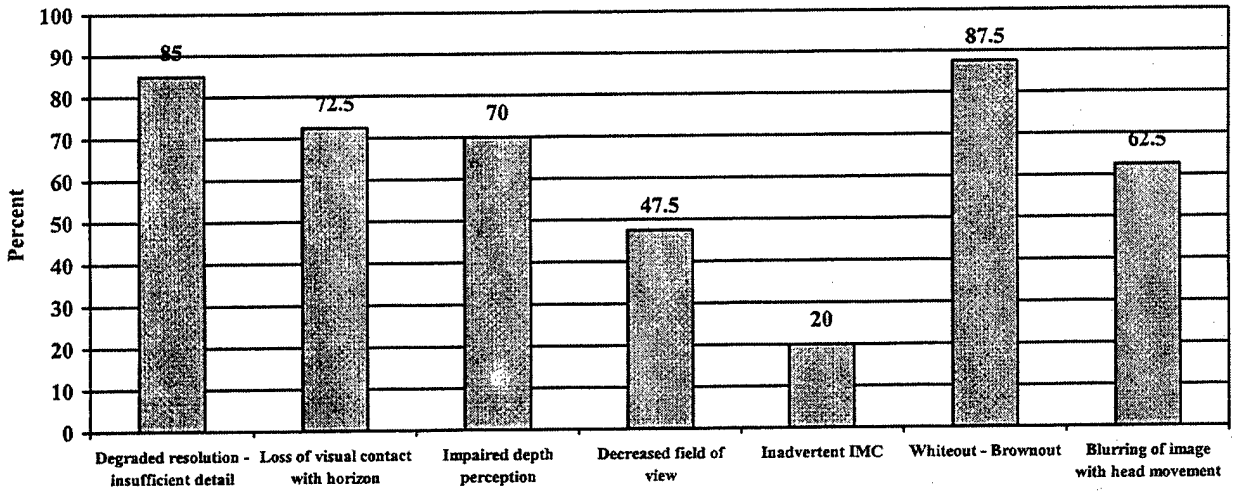

Figure 6. Degraded visual cues experienced *while* flying.

The FLIR thermal sensors (both pilotage and targeting) are 1970s technology and have been a major source of complaints in previous studies (Rash et al., 2001). Therefore, the high reported frequency of degraded visual cues is not surprising. The two most cited degraded cues were whiteout-brownout (35, 87.5%) and degraded resolution-insufficient detail (34, 85%). Table 7 provides a comparison of frequencies of reported degraded cues for the 2000 and current studies.

Consistently, the frequency of reports of degraded visual cues was lower in the current study than in the 2000 study (with the one exception of whiteout/brownout, most likely due to sandy environment). However, these lower frequencies were found to be statistically significant only for illusions of impaired depth perception, decreased FOV, and inadvertent IMC (which is consistent with the lack of foggy and rainy weather in Iraq). The lower frequencies for impaired depth perception and decreased FOV may be explained by the uniqueness of the Iraqi geography; the geography of Iraq generally is defined as featureless desert terrain. However, this is not universally true. OIF started out in Southwestern Iraq. There, the terrain varies from flat desert with little elevation variation, to areas with 50' variations (wadi systems). The terrain around the lakes near Karbala is hilly (including some small cliffs) near the lakes and flattened out farther away from the lakes. As you approach Baghdad from the Southwest towards the two river ystems, vegetation increases proportionately, but the terrain remains fairly flat. As you approach Qayyarah, the terrain again is fairly flat and used predominately for growing wheat. However, the further north you go, the greater the terrain variation. East of Qayyarah is Kirkuk,

Table 7.
Comparison of reports of degraded visual cues for current and 2000 studies.

	2000 Survey (n = 216)	Iraqi Freedom Study (n = 40)	p value
Degraded resolution/insufficient detail	**90.3%**	85.0%	0.3183
Loss of visual contact with horizon	**75.9%**	72.5%	0.6437
Impaired depth perception	**84.7%**	70.0%	**0.0246**
Decreased FOV	**81.0%**	47.5%	**0.0000**
Inadvertent IMC	**38.9%**	20.0%	**0.0222**
Whiteout/brownout	75.5%	**87.5%**	0.0948
Blurring of image with head movement	**75.5%**	62.5%	0.0882

Note: Percentages are rounded to the nearest integer. **Bold** values indicate the higher of the compared values and differences that were statistically significant to the .05-level.

between which, there are several ridgelines with elevation variations of up to 750 feet. East and southeast of Kirkuk, the terrain becomes mountainous continuing to the border with Iran; elevation changes of up to 5000 feet are common in this area. Hence, while many areas of operation were over flat geography, "Iraq is not just a flat featureless desert," at least in the northeastern third of the country (Marston, 2004). However, a large portion of the country is generally flat, which serves as a reasonable explanation of the reduced frequency of reports of impaired depth perception and decreased FOV.

Static and dynamic illusions

Reports of static and dynamic illusions experienced during flight with the IHADSS are reported in Figures 7 and 8, respectively. The most frequently reported static illusion was faulty slope estimation (23, 57.5%), followed by faulty height judgment (18, 45%). The least reported static illusion was the perception of the bending of straight lines (2, 5%). Respondent comments regarding the presence of static illusions cited the influence of the IHADSS monocular design. A representative comment was, "The monocular nature of the system causes these problems for me."

The most frequently reported dynamic illusions were undetected aircraft drift (22, 55%) and faulty closure judgment (21, 52.5%). Respondent comments were diverse and failed to identify any specific causes or factors associated with the onset of dynamic illusions.

The 1989 night vision devices visual illusions study (Crowley, Rash, and Stephens, 1992) was very limited in its reports by AH-64 Apache pilots (only 21 of the 243 respondents reported illusions associated with IHADSS flight). The most reported static illusion was faulty height judgment; the most reported dynamic illusions were undetected aircraft drift and illusory aircraft

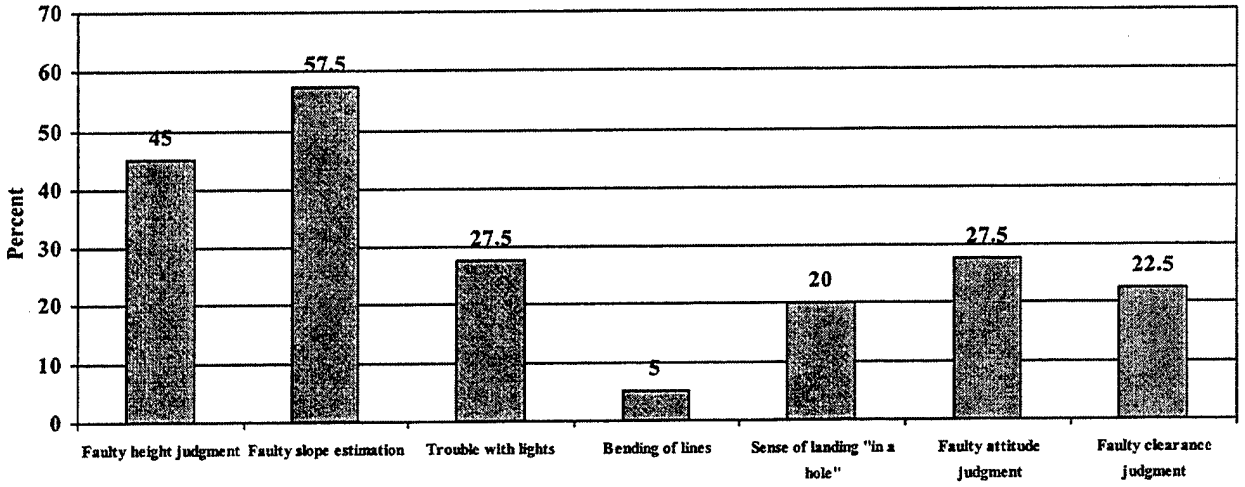

Figure 7. Static illusions experienced *while* flying.

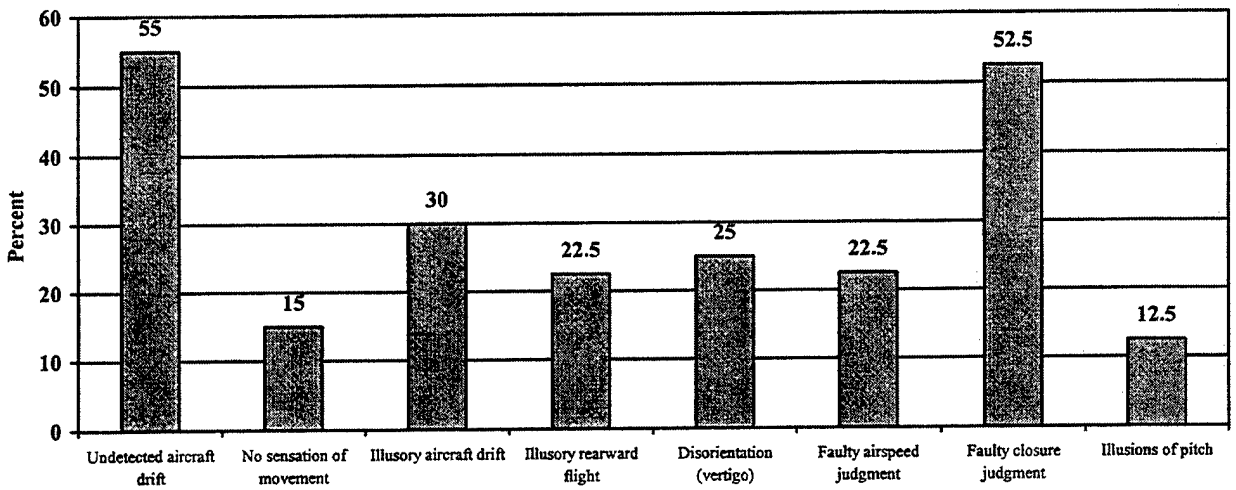

Figure 8. Dynamic illusions experienced *while* flying.

drift, both at 24%. In the 2000 study, a much higher reporting frequency of illusions was found, with approximately 92% and 95% of respondents reporting at least one static or dynamic illusion, respectively. The two most frequently cited static illusions were faulty slope estimation (80.1%) and faulty height judgment (73.6%). Dynamic illusions were even more pronounced with approximately three-fourths of respondents reporting experiencing undetected drift (78.2%), faulty closure judgment (75.5%), and illusory drift (71.3%).

The findings of the current study for both static and dynamic illusions compare exceptionally well with the ranking of illusion frequencies found in the two past studies. The two most frequently reported static illusions for the current study were faulty slope estimation (23, 57.5%) and faulty height judgment (18, 45%), the same rank order reported in the 2000 study. The three most frequently reported dynamic illusions for the current study were undetected aircraft drift (22, 55%), faulty closure judgment (21, 52.5%), and illusory aircraft drift (12, 30%), also which

present the same rank order reported in the 2000 study. In addition, Crowley, Rash, and Stephens (1992) also reported undetected drift and illusory drift as the most frequent dynamic illusions (although at much lower frequencies, 24% for each).

Table 8 presents a comparison of individual static illusions for the current and 2000 studies. For each static illusion type, the current study reports lower frequency of incidence values. All of these differences are of statistical significance to the .05-level. One proposed explanation for these lower values lies again in the featureless desert terrain that makes up the geography of Iraq. This terrain contraindicates conditions that generally give rise to most types of static illusions.

Table 8.
Comparison of reports of static illusions for current and 2000 studies.

	2000 Survey (n = 216)	Iraqi Freedom Study (n = 40)	p value
Faulty height judgment	**73.6%**	45.0%	**0.0003**
Trouble with lights	**60.2%**	27.5%	**0.0001**
Sense of "Landing in a hole"	**41.2%**	20.0%	**0.0111**
Faulty clearance judgment	**60.2%**	22.5%	**0.0000**
Faulty slope estimation	**80.1%**	57.5%	**0.0019**
Bending of straight lines	**20.4%**	5.0%	**0.0200**
Faulty altitude judgment	**68.1%**	27.5%	**0.0000**

Note: Percentages are rounded to the nearest integer. **Bold** values indicate the higher of the compared values and differences that were statistically significant to the .05-level.

Table 9 presents a comparison of individual dynamic illusions for the current and 2000 studies. As found with static illusions, for each dynamic illusion type (except disorientation [vertigo]), the current study reports lower values of statistical significance to the .05-level.

Table 9.
Comparison of reports of dynamic illusions for current and 2000 studies.

	2000 Survey (n = 216)	Iraqi Freedom Study (n = 40)	p value
Undetected drift	**78.2%**	55.0%	**0.0019**
Illusory drift	**71.3%**	30.0%	**0.0000**
Disorientation (Vertigo)	**38.0%**	25.0%	0.1166
Faulty closure judgment	**75.5%**	52.5%	**0.0030**
No sensation of movement	**55.6%**	15.0%	**0.0000**
Faulty airspeed judgment	**64.8%**	22.5%	**0.0000**
Illusory rearward flight	**55.6%**	22.5%	**0.0001**
Illusions of pitch	**44.9%**	12.5%	**0.0001**

Note: Percentages are rounded to the nearest integer. **Bold** values indicate the higher of the compared values and differences that were statistically significant to the .05-level.

In order to understand the significantly lower reported frequencies of dynamic illusions (along with the same finding for static illusions), the authors solicited comments from Apache aviators who had recently (early 2004) returned from their deployment in Iraq. (The aviators involved in these post hoc discussions did not identify any participation or lack thereof in the current study.) These aviators raised an interesting point may explain the lower incidence of problems during OIF. This point is as follows: In peacetime, flight hours are very limited. Hence, when the opportunity to fly is available, aviators make a conscious effort to "fly the system," i.e., fly relying almost entirely on the imagery on the HDU. This effort is an attempt to maximize proficiency with the IHADSS HMD for each and every flight hour available. In contrast, aviators said that during OIF, flight time was very high. And, of greater impact on this discussion, during these flights, aviators used both visual inputs, making use of all visual information available, expressed by aviators as being responsible for reduced frequency of complaints and illusions.

It was further suggested that dynamic illusions associated with drift (undetected or illusory) would be less for aviators flying the D-model because hover-control on the D-model is more advanced. This prompted a comparison of static and dynamic illusions between the two AH-64 models. Table 10 presents a comparison of mean number of illusions by aircraft model. No statistically significant differences were found for the two aircraft models.

Table 10.
Comparison of mean number of illusions by aircraft model.

	A-model	D-model	p value
Static Illusions	2.47	1.62	0.111
Dynamic Illusions	2.74	1.95	0.172

Viewing symbology

The FLIR imagery is overlaid with sets of symbols and graphics (collectively known as symbology). This symbology provides aircraft status information (e.g., heading, altitude, engine torque, weapons load, etc.). Two questions addressed the visibility and usability of this symbology. The first question asked respondents if they had noted any change in their ability to see and interpret symbology during any phase of flight. Only 9 (22.5%) respondents reported having experienced such a change. While respondent comments generally indicated a degradation in ability to see symbology over extended flights and the need for greater concentration during such flights, one respondent said, "My HMD perception gets better the longer I fly." However, it is not clear as to whether the statement was directed only to symbology or referred to the overall imagery, which included FLIR and symbology presentation.

When asked if both the external scene (pilotage) image and the symbology could be focused simultaneously when viewing the full IHADSS imagery, over one-third (14, 35%) reported an inability to perform this task under daytime conditions, and almost half (18, 45%) reported this inability under nighttime conditions. When asked to comment on this issue, some respondents indicated that if the IHADSS is properly, and carefully, adjusted (e.g., focus, exit pupil alignment, etc.), they experienced no problems. Of respondents who reported having a problem,

one stated his ability was affected by the presence of binocular rivalry (a phenomenon where attention involuntarily switches back and forth between the two different visual inputs to the two eyes).

This imagery consists of pilotage or targeting FLIR imagery electronically mixed with symbology. As a result of embedded rather than overlaid symbology, all of the presented information is in the same focal plane. Studies have shown there is a natural tendency to perceive the symbology as being in the foreground. This is believed to be partly due to the pilot having knowledge that the symbology is physically located at close-distance to the eye (Kotulak, Morse, and Wiley, 1994). This perception is believed to lead to accommodative (focus) problems when viewing IHADSS imagery.

There is no statistically significant difference ($p = 0.3614$) between the proportions of respondents reporting this problem for daytime versus nighttime flight. As compared to the 2000 study, the percentages of respondents reporting a change in their ability to view symbology (22.5%) and difficulty in focusing clearly on the FLIR image and symbology simultaneously (35%) are lower, but these differences are significant only for having experienced a change in symbology viewing ability ($p = 0.0427$).

Visual input alternation

In the IHADSS's monocular design, display imagery is provided to the right eye only, with the left eye being free to view the external scene or cockpit displays. This requires the Apache aviator to switch his visual input between the two eyes, depending on the required task. In the survey, respondents were asked about their ability to purposefully alternate between the two eyes and whether such alternation ever occurred unintentionally (involuntarily).

Only two (5%) respondents reported having great difficulty in purposefully alternating between the two different visual inputs provided to the two eyes. The overwhelming majority (33, 82.5%) of respondents reported being able to easily perform this task. Five (12.5%) respondents reported having some difficulty. Over half (21, 52.5%) of respondents reported using some specialized technique as an aid to switching inputs. Examples of such techniques, provided in respondent comments, included closing one eye, blinking, and squinting. Several respondents commented that the ability to alternate "is achieved with time and experience" and "keeping the HDU [imagery] at a low-brightness level..."

Respondents were fairly even in their reported experience with unintentional alternation. Twenty-one (52.5%) reported episodes of unintentional alternation. Representative comments suggested that such alternation was attributed to extended flight periods and the presence of bright light sources either external to or within the cockpit.

The monocular design of the IHADSS raised two visual issues that, without doubt, drive the alternation problem and may very well have been contributing factors to the presence and frequency of visual complaints and illusions. These issues were eye dominance and binocular rivalry. Eye dominance refers to the preference an individual exhibits to accepting the visual input in one eye over the other. Most individuals demonstrated a preference of one eye over the

other for various vision tasks (Miles, 1930). In the general population, estimates of right-eye dominance range from 50-90% (Crider, 1944). This range no doubt is due to the dependence of dominance on task. In the current study, eye dominance was surveyed by asking the respondents to report their preferred sighting eye and their choice of telescope viewing eye.

During the first years of fielding of the Apache, the training dropout rate was relatively high (~10%), and eye dominance was suggested as a probable cause (Rash et. al., 2000). McLean (1990) correlated data on 16 Apache pilots for multiple eye dominance tests. Results showed little correlation between tests. This was explained by the rationale that eye dominance itself is not a singularly defined concept but is task dependent.

In binocular rivalry, two different images are present in the two different eyes. In such a case, the two visual inputs compete for awareness. This can result in each eye alternating in suppressing the input of the other eye. This phenomenon was responsible for the reports of unintentional alternation.

In order to investigate a possible relationship between the eye dominance responses and reported visual complaints, illusions and alternation problems in the current study, the mean numbers of complaints and illusions per respondent were calculated and presented in Table 11.

Table 11.
Relationship between eye preference, mean number of visual complaints and illusions, and unintentional alternation.

	Preferred sighting eye			Telescope viewing eye		
	Right	Left	p value	Right	Left	p value
Mean number of complaints *while* flying	2.9	2.0	0.169	2.8	1.7	**0.048**
Mean number of complaints *after* flying	1.9	1.4	0.433	2.1	0.6	**0.009**
Proportion reporting problem with unintentional alternation	52%	80%	0.2396	52%	57%	0.803
Mean number of static illusions	2.2	2.6	0.605	2.3	1.9	0.588
Mean number of dynamic illusions	2.6	2.4	0.800	2.5	2.1	0.623

Note: **Bold** values indicate a statistical significant to the .05-level.

When eye preference was compared to the frequency of visual complaints (visual discomfort, headache, etc.), respondents reporting a right-eye sighting preference averaged 2.9 types of complaints *while* flying; left-eye sighting preference respondents averaged 2.0 types of complaints. This difference was not statistically significant ($p = 0.169$). Similarly, no statistically significant differences were reported for right versus left preferred sighting eye for other statistics of complaints, illusions, etc. This tends to lead to the conclusion that the choice of preferred eye was not a major factor in using the right-eye only IHADSS HMD.

For eye-dominance based on reported telescope viewing eye, the mean number of complaints for right-eye responses as compared to left-eye responses were found to be statistically significant for both *while* flying ($p = 0.048$) and *after* flying ($p = 0.009$). The remaining illusion and switching statistics were not statistically significant.

Based on reported preferred eye, there was no evidence of a difference between the mean number of complaints, problems and illusions, for the left and right eyes, even though aviators were forced to use the right-eye monocular design of the IHADSS. However, based on telescope viewing eye, there was evidence that the mean number of complaints for *while* flying and *after* flying does differ; but not for illusions or the problem of unintentional alternation.

At first glance, this finding for telescope viewing seemed somewhat logical. After all, an eye predilection for a practical application like telescope viewing was more closely related to the viewing task of looking at the monocular IHADDS display than just a general eye preference. However, what might be expected was that respondents who use their right eye telescope viewing would have fewer problems viewing the right-eye IHADSS than respondents who use their left eye for telescope viewing. However, this was not the case. Instead, respondents favoring the left eye had a lower mean number of complaints, both *while* and *after* flying. The authors can offer no explanation for this apparent contradiction.

IHADSS effectiveness in OIF

Effectiveness ratings provided by respondents are presented in Figure 9. Almost two-thirds (25, 62.5%) of respondents rated the IHADSS as fairly or very effective in OIF; five (12.5) of respondents provided a rating of fairly or very ineffective. Based on the provided Likert scale (1, Very ineffective – 5, Very effective), the mean rating was 3.6, between neutral and fairly effective.

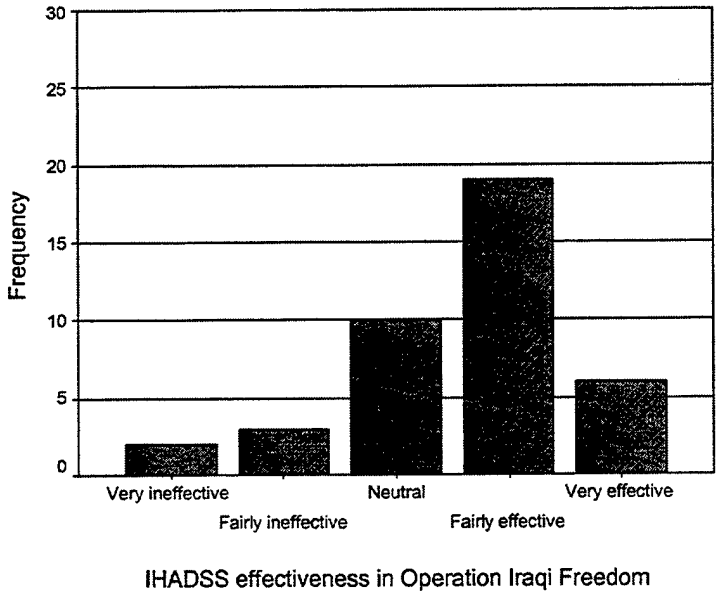

Figure 9. Effectiveness rating for IHADSS in OIF.

To test for correlation between effectiveness on the battlefield and the number of complaints or illusions, Pearson product-moment coefficients were calculated. None of the correlations were significant (i.e., complaints *while* flying, $r(38) = -0.228$, $p = 0.157$; complaints *after* flying, $r(38) = -0.190$, $p = 0.239$; static illusions, $r(38) = 0.060$, $p = 0.684$; and dynamic illusions, $r(38) = 0.102$, $p = 0.533$). These findings may be interpreted as pilots judging the effectiveness of the system based on operational mission performance rather than on the frequency of visual complaints and illusions. A second correlation between effectiveness rating and combat flight hours also was not statistically significant ($r(38) = -0.054$, $p = 0.746$).

The final question asked respondents if they had participated in the 2000 Internet survey. Only four (10%) respondents indicated that they had done so. Because these respondents represent such a small proportion of the sample, no comparison between this subsample and the 2000 sample is warranted.

Interview data and discussion

After completing the written questionnaire, each study participant was asked to respond to a series of oral questions presented in an interview format. There were 12 questions that addressed specific IHADSS characteristics. Occasionally, the interviewer interjected a follow-up question for the purpose of clarity. All 40 respondents participated in the interview. Full interview comments are provided in Appendix C. Occasionally, respondent comments were edited slightly to improve fragmentary responses or verbal lacunae.

The first question asked participants to specify problems encountered with using the IHADSS in the desert environment presented in OIF. Of the 39 participants who responded to this question, 10 (25%) respondents cited specific problems. These problems included reduction in FOV due to helmet slippage and center of mass effects, incompatibility issues with M48 NBC mask and body armor, and equipment failures with the infrared harness.

Respondents were asked to comment on problems in maintaining the full FOV. Forty percent (16) of respondents reported at least some difficulty in maintaining full FOV. Reasons for a reduction in FOV included poor helmet fit (including one respondent who had an improperly sized helmet), interference with NBC mask and body armor, having to move HDU away from face in order to prevent irritation from aircraft vibration (knot-hole effect on FOV), and due to torque applied to the helmet during head motion resulting from cables. Of real concern is the reporting by two respondents of adjusting the Display Adjust Panel (DAP) to minimize the image on the HDU. This minimization is strongly discouraged but is, based on anecdotal information, common among the Apache community to achieve the full FOV. This minimization can negatively impact visual perception (Hale and Piccione, 1989; Rash et al., 2001).

When asked about problems with the combiner (the beamsplitter mounted on the end of the HDU), 30% (12) of respondents cited combiner problems. The two most frequently mentioned problems were combiner failure due to spring mounts and damage to the combiner coating due to dirt and handling (oils from fingers).

A majority of respondents (35, 87.5%) reported using the IHADSS system during the day. However this usage was primarily for symbology rather than for pilotage FLIR imagery.

Respondents were asked if the slew rates of the pilotage (PNVS) and targeting (TADS) FLIRs were too slow and, if so, how did respondents compensate. The PNVS slew rate is 120 degrees per second; the TADS slew rate is 60 degrees per second. While only 15% (6) of respondents reported dissatisfaction with the PNVS slew rate, a vast majority (34, 85%) of respondents reported dissatisfaction with the much slower TADS sensor. While a few respondents implied that their training and experience taught them to "adjust," approximately half of respondents reported purposefully reducing normal head movement rates in order to compensate for the sensor slew rates.

When asked if the IHADSS 30- by 40-degree FOV was sufficient, respondents were generally divided; 55% (22) reported it as sufficient, and 45% (18) reported it as insufficient. Respondent comments, not surprisingly, expressed a desire for larger FOV values, both horizontal and vertical.

Eighty percent (32) of respondents reported situations in which the IHADSS HDU is rotated out of the way. Reasons cited for doing this include when using I^2 (Night Vision Goggles), observing TADS panel-mounted display, when on the ground and working in the cockpit, or refueling, when taxiing, during gunnery, when flying over where there are a lot of bright lights, to relieve hotspots or eye strain, and during maintenance flights.

Respondents were asked if they would like a binocular HMD design, assuming that weight and center-of-gravity were not an issue. Responses were somewhat evenly divided, with just under (45%) of respondents indicating wanting such a design. For respondents preferring the current monocular design, the predominant reason was a desire to maintain one "unaided" eye. Only two respondents indicated a clear preference of a binocular over monocular design.

When asked to cite the best and worst features of the IHADSS, the presence of symbology was overwhelmingly the most liked feature; the least liked features ware FLIR quality and slew rate.

In a similar interview question, respondents were asked to identify the single one change they would suggest to improve IHADSS effectiveness. Not surprisingly, the overwhelming suggestion correlated with the least liked feature cited in the previous question, the FLIR sensor quality. The current FLIR is referred to as GEN 1 (1970's) to indicate first generation technology. This system incorporates a mercury-cadmium-telluride (HgCdTe) detector operating in the 8-12 micron range (Rash et al., 2001). The combination AH-64 PNVS/IHADSS system provides an equivalent Snellen visual acuity of 20/60 (Green, 1988). Complaints regarding FLIR quality have been consistently present in previous surveys. According to the Apache Program Manager, advanced generation FLIR upgrades are programmed for the near future.

The final question in the interview offered respondents the opportunity to raise additional issues not previously addressed either in the survey questionnaire or interview. In general,

respondents reiterated problems areas such as FLIR quality and helmet fit. The only previously unaddressed topic was an expression of optimism that continuous upgrades to the operational capability of the IHADSS will be forthcoming.

Summary

Subject demographics

A major objective of this study is to determine if the frequencies of reports of visual complaints and illusions reported in previous studies, addressing mostly benign training environments, differ in the more stressful combat environment.

Forty AH-64 male Apache aviators were surveyed for their visual experiences with the AH-64's monocular IHADSS HMD in a combat environment. The aviators range in age from 24 to 43 years; represent a total of 8564 flight hours and 2260 combat hours during OIF and its aftermath; and are experienced aviators with a mean of 1110 total flight hours across all Army aircraft and a mean of 774 total flight hours in the AH-64.

The most frequently reported visual complaints, both *while* and *after* flying, continue to be visual discomfort and headache. Frequencies of complaints *after* flying in the current study are numerically lower than reported in the 2000 study for all complaint types, but differences are statistically significant only for visual discomfort and disorientation (vertigo).

With the exception of brownout/whiteout, reports of degraded visual cues are numerically lower (current vs. 2000 study) for all types, but statistically significant only for impaired depth perception, decreased FOV, and inadvertent IMC.

The current study produces statistically lower reports of all static and dynamic illusions (with one exception, disorientation). This important finding is possibly attributed to the generally flat and featureless geography present in a large portion of the Iraqi theater and to the shift in the way that aviators use the two disparate visual inputs presented by the IHADSS monocular design (i.e., greater use of both eyes as opposed to concentrating primarily on display imagery).

When the findings of the current study are compared to a similar study conducted in 2000, considerable similarities are present. These include aviator satisfaction ratings for helmet fit (important for maintaining FOV and reducing reports of headaches), types and frequencies of visual complaints both *while* and *after* AH-64 flight, and the most prevalent types of static and dynamic illusions.

Responses to interview questions correlate well with those provided via the survey questionnaire. Respondents express a desire for a larger FOV; they emphasize the impact of poor helmet fit on ability to achieve and maintain a full FOV; decry the overall performance of the current FLIR sensors; and they report that the current slew rates for the PNVS and TADS are slower than desired (worse for TADS), necessitating compensation in normal head movement rates.

Conclusions

The current study does not indicate an increase in visual complaints and artifacts resulting from use of the IHADSS HMD in the more stressed and demanding combat environment of OIF. In fact, for the most part, the frequencies of complaints *after* flying, and presence of degraded visual cues, and reports of both static and dynamic illusions are found to be statistically lower. However, these findings are very likely attributed to the geography of the flying environment and different visual input strategies when flying in combat versus when flying in flight hour-limited training flights.

Recommendations

If future combat situations involve urban scenarios, it is recommended that visual experiences with the IHADSS be surveyed. Once the Iraqi war is concluded and Apache aviators return to their normal training environment, flight time needs to be increased. This increased number of flight hours must be sufficient enough that aviators do not feel pressured to concentrate on maintaining proficiency with the IHADSS HMD but will instead conduct such flights using a full vision complement that includes both visual inputs of the unaided and IHADSS viewing eyes. Only then can Apache aviators "Train as we fight."

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Appendix A.

Integrated Helmet Display Sighting System (IHADSS) survey Apache (AH-64) vision questionnaire.

DATE _____ **SUBJECT #**_____

Integrated Helmet and Display Sighting System (IHADSS) Survey

Apache (AH-64) Vision Questionnaire

For AH-64 Apache Aviators Only

Purpose: To identify and assess visual performance issues and problems relating to use of the monocular IHADSS helmet-mounted display in Operation Iraqi Freedom.

Accuracy of your responses: It is important that you answer the questions as accurately and fully as possible. Your response will assist in the design and improvement of future and current HMDs.

Anonymity: Your responses are anonymous. Your name will not be associated with any of your responses. The data provided by you will be used for research purposes only.

1. Demographics and flight experience:

a. Age: ____ b. Sex: M____ F____

c. Total flight hours across all Army aircraft____ d. Total flight hours in AH-64_____

e. AH-64 flight hours in Iraq or surrounding areas: _____

f. Combat hours during initial portion of conflict: _____

g. Estimated number of sorties since arriving in Iraq: _____ Average length (hours) _____

Longest length (hours): _____

h. While flying in Operation Iraqi Freedom, have you been primarily:

Pilot____ Copilot/gunner____

2. Visual history:

a. Do you wear any type of vision correction when not flying? Yes___ No____

If "Yes" check all that apply:

(1) Glasses: Single vision____ -Bifocals____ - Trifocals____ - Progressive (No line)____

(2) Contacts: Single (mono)vision____ -Bifocal____

b. Do you wear any type of vision correction when flying? Yes___ No____

If "Yes" check all that apply:

1) Glasses- Single vision____ -Bifocals____ - Trifocals____ - Progressive (No line)____

2) Contacts -Single (mono)vision____ -Bifocal____

c. Which is your preferred sighting eye? Right___ Left____

d. Which eye would you use with a telescope? Right____ Left____

e. Is your better eye the same now (after AH-64 training and experience) as it was prior to your AH-64 experience? Yes___ No_____

3. Helmet fit:

a. How long since last helmet fit: ____months

b. Was your helmet fitted with the NBC mask? (Circle one) Yes No

c. Did you fly with the NBC mask during Iraqi Freedom? (Circle one) Yes No

If **YES,** approximate number of hours: _____.

Did you experience incompatibility with the HDU and the mask? (Circle one) Yes No

If **YES,** please explain: _____

_____

d. Rate satisfaction with current fit: (circle one)

1	2	3	4	5
Completely Satisfied	Somewhat satisfied	Neutral	Somewhat dissatisfied	Completely dissatisfied

e. Is your ability to view IHADSS imagery impacted by your helmet fit (e.g., helmet slippage impacts ability to maintain field of view)?

Yes____ No____ If "yes," explain_____

_____

f. Do you achieve a full field of view? Yes ___ No _____

4. Aviation vision:

a. ***While*** flying the Apache, have you experienced?

Visual discomfort (e.g., eyestrain, fatigue):	Never___	Sometimes___	Always___
Headache:	Never___	Sometimes___	Always___
Double vision:	Never___	Sometimes___	Always___
Blurred vision:	Never___	Sometimes___	Always___
Disorientation:	Never___	Sometimes___	Always___
After-images:	Never___	Sometimes___	Always___

b. If symptoms were reported in (a) above, please comment on length of time IHADSS was in use before symptoms occurred: _____

_____

c. ***After*** flying the Apache, have you experienced?

Visual discomfort (e.g., eyestrain, fatigue):	Never___	Sometimes___	Always___
Headache:	Never___	Sometimes___	Always___
Double vision:	Never___	Sometimes___	Always___
Blurred vision:	Never___	Sometimes___	Always___
Disorientation:	Never___	Sometimes___	Always___
After-images:	Never___	Sometimes___	Always___

d. During Apache flight, have you experienced any of the following degraded visual cues? (Check all that apply)

Degraded resolution/insufficient detail____

Loss of visual contact with horizon____

Impaired depth perception____

Decreased field of view___

Inadvertent IMC____

Whiteout/brownout____

Blurring of image with head movement____

Comments: _____

e. **During** Apache flight, have you experienced any of the following illusions? (Check all that apply)

Static illusions:

Faulty height judgement____	Faulty slope estimation____
Trouble with lights____	Bending of straight lines____
Sense of landing "in a hole"____	Faulty attitude judgement____
Faulty clearance judgement____	

Comments: _____

Dynamic illusions:

Undetected aircraft drift____	No sensation of movement____
Illusory aircraft drift____	Illusory rearward flight____
Disorientation (vertigo)____	Faulty airspeed judgement____
Faulty closure judgment____	Illusions of pitch____

Comments: _____

f. Have you noted any change in your ability to see or interpret HMD symbology during any phase of flight? Yes____ No____ If "**Yes,**" explain (e.g., description, duration, reason, etc.)

_____

g. When viewing through the HMD, can you focus clearly on the external scene and the symbology simultaneously?

Daytime: Yes____ No____ If "Yes",explain_____

_____

Nighttime: Yes____ No____ If "Yes",explain_____

_____

h. During flight, does your vision sometimes <u>unintentionally</u> alternate between the two eyes?

Yes____ No____ If "**Yes,**"comment_____

i. To what degree can you purposely alternate between your two eyes?

Easily___ With **some** difficulty___ With **great** difficulty____

Do you have any special methods to assist in switching?

Yes____ No____ If "**Yes**,"comment_____

_____

5. How effective has the IHADSS system been in Operation Iraqi Freedom (circle one)?

1	2	3	4	5
Very ineffective	Fairly ineffective	Neutral	Fairly effective	Very effective

6. In 2000, a web-based questionnaire similar to this one was conducted by USAARL, Fort Rucker. It was advertised in FlightFax and offered over the Internet. Did you participate?

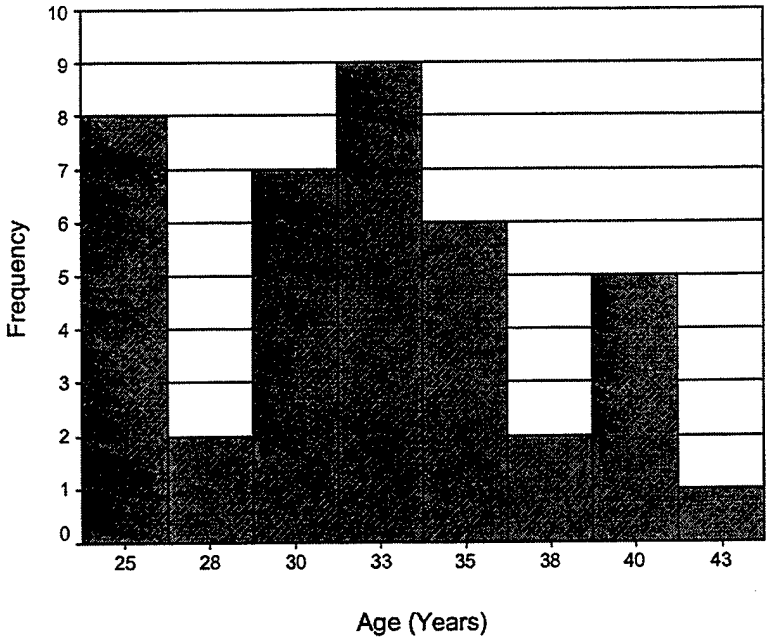
Yes ____ No _____

Appendix B.

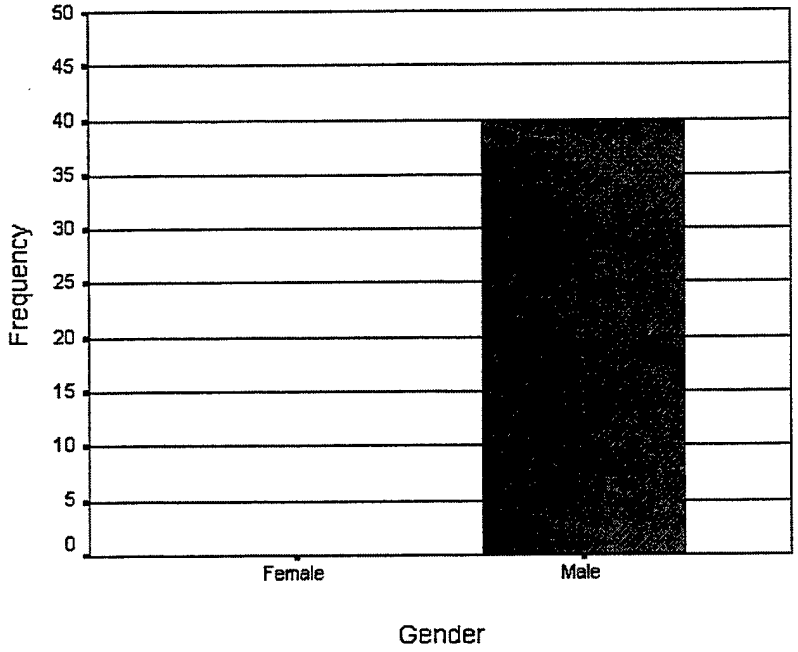
AH-64 aviator questionnaire responses.

1. **Demographics and flight experience:**

a. Age (Years): Mean (32) Median (32) Std. Dev. (5.4) Min. (24) Max. (43)

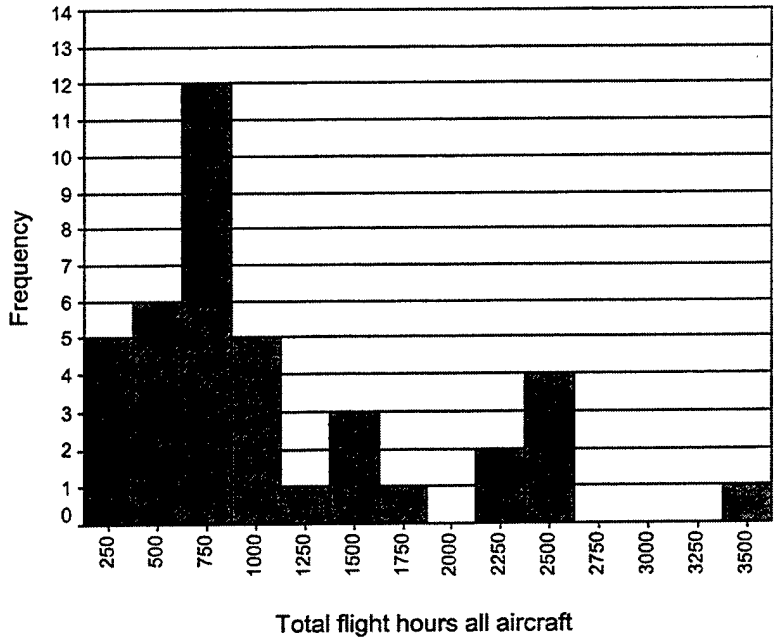


b. Sex: M (40, 100%)



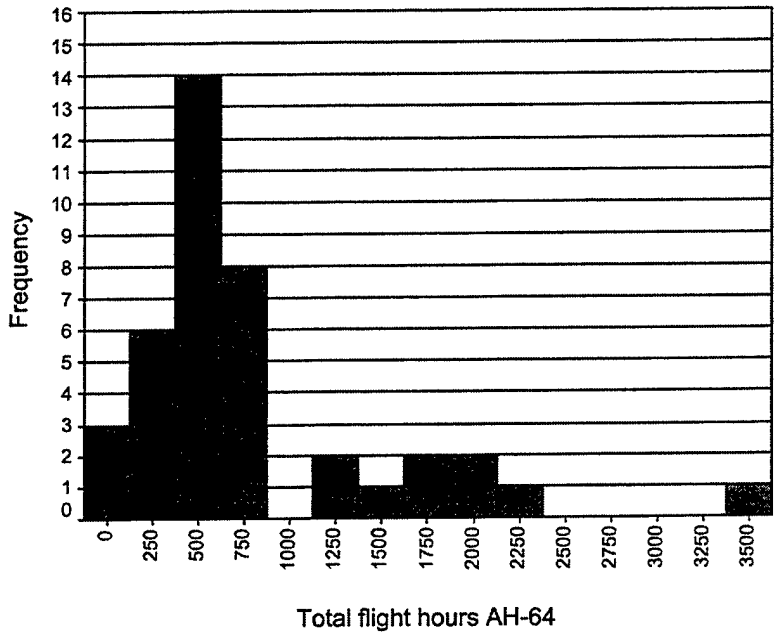
c. Total flight hours across all Army aircraft:

Mean 1110 Median 800 Std. Dev. 824.1 Min. 200 Max. 3600



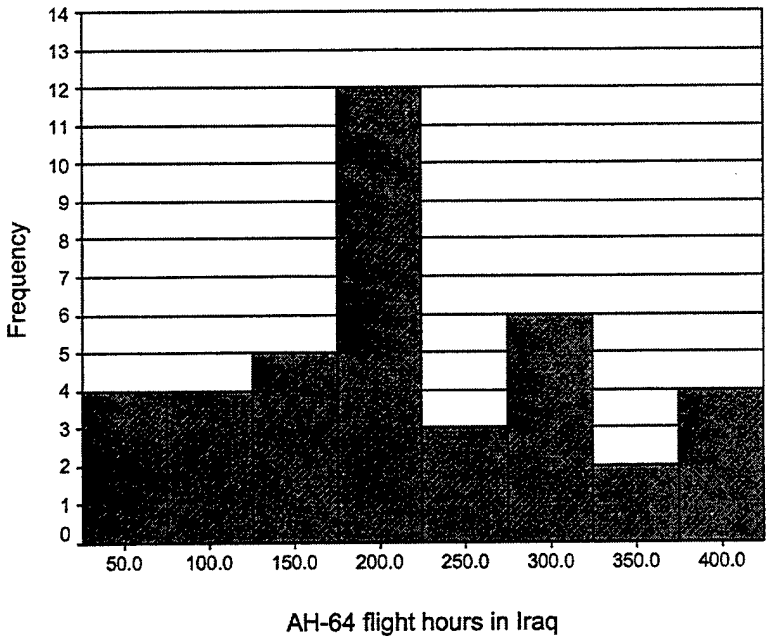
d. Total flight hours in AH-64:

Mean 774 Median 578 Std. Dev. 701.0 Min. 52 Max. 3400



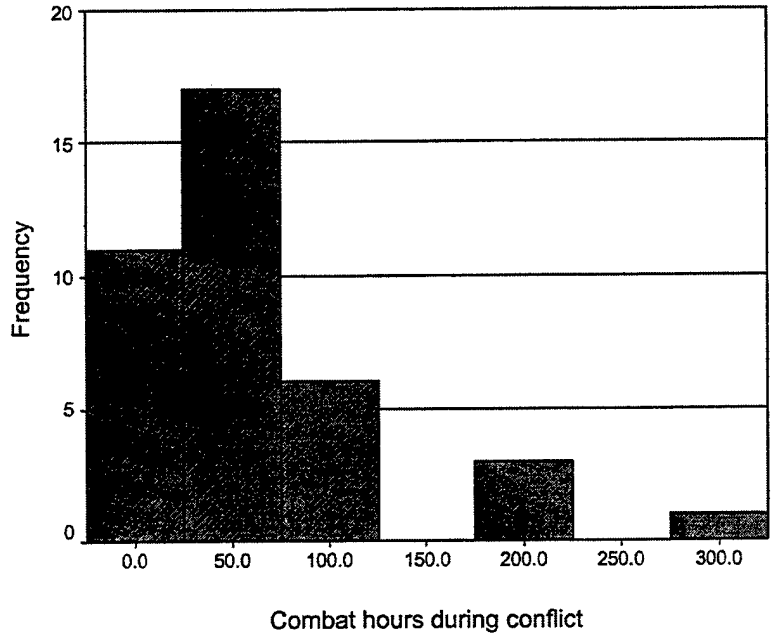
e. AH-64 flight hours in Iraq or surrounding areas:

Mean 214 Median 200 Std. Dev. 102.5 Min. 27 Max 400



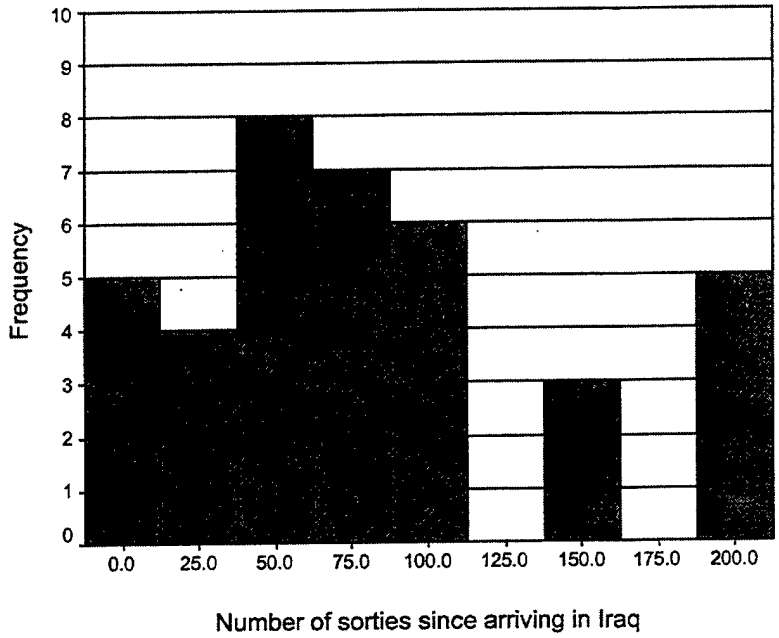
f. Combat hours during initial portion of conflict:

Mean 59 Median 50 Std. Dev. 66.3 Min. 0 Max 300



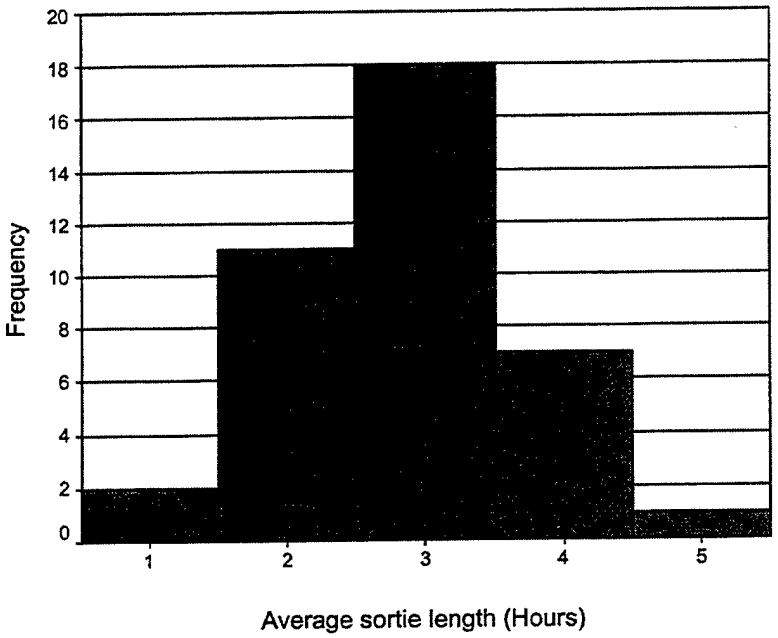
g. Estimated number of sorties since arriving in Iraq:

Mean 82 Median 68 Std. Dev. 60.2 Min. 4 Max. 200



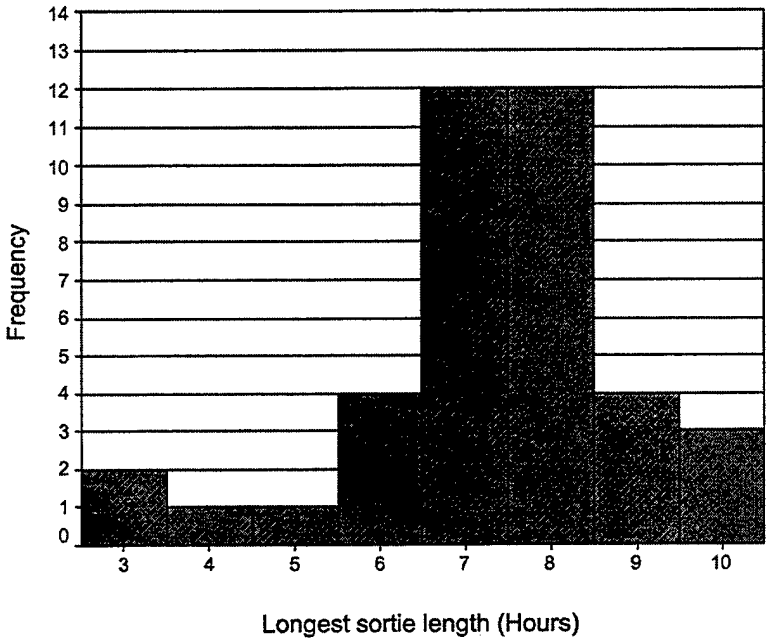
Average length (Hours):

Mean 2.7 Median 2.5 Std. Dev. 0.87 Min. 1 Max. 5



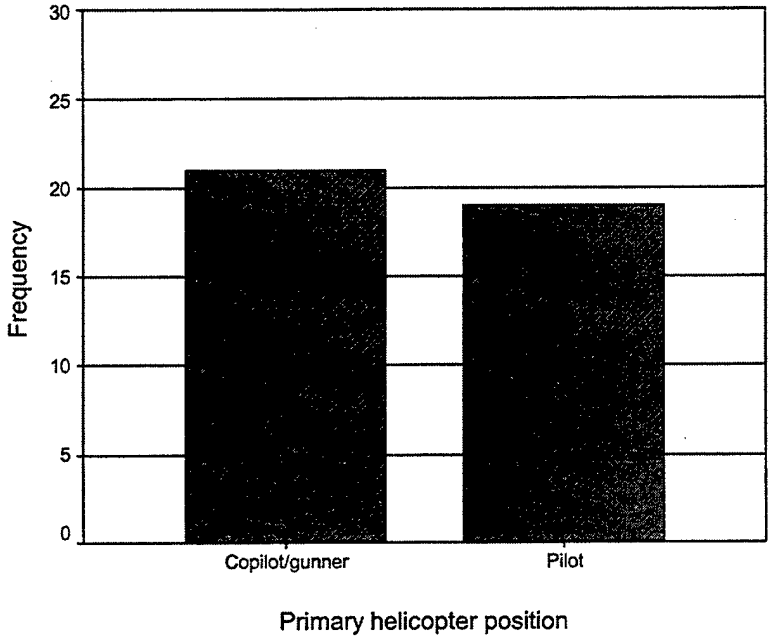
Longest length (Hours):

Mean 7.2 Median 7.3 Std. Dev. 1.6 Min. 2.5 Max. 10



h. While flying in Operation Iraqi Freedom, have you been primarily:

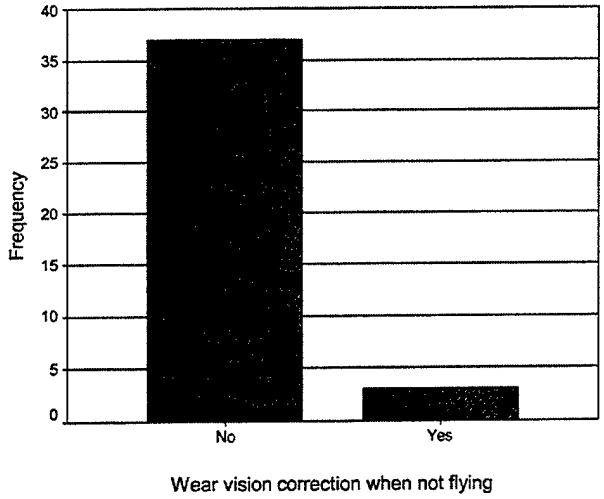
Pilot (19, 47.5%) Copilot/gunner (21, 52.5%)



2. Visual history:

a. Do you wear any type of vision correction when <u>not</u> flying?

Yes (3, 7.5%) No (37, 92.5%)



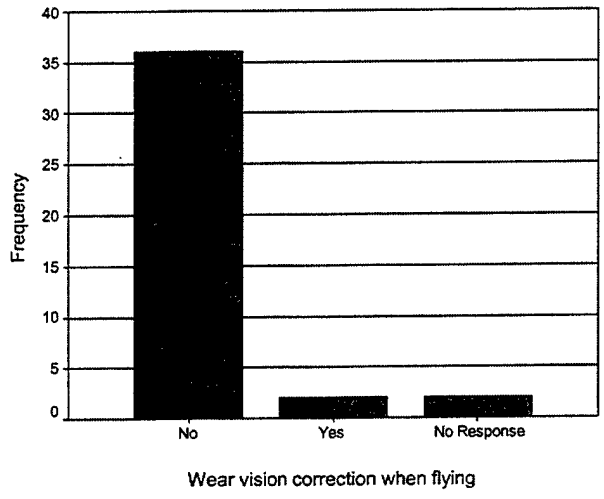
If "Yes" check all that apply:

(1) Glasses: Single vision _2_ -Bifocals _0_ - Trifocals _0_ - Progressive (No line) _0_

(2) Contacts: Single (mono)vision _2_ -Bifocal _0_

b. Do you wear any type of vision correction when flying?

Yes (2, 5%) No (36, 90%) No Response (2, 5%)



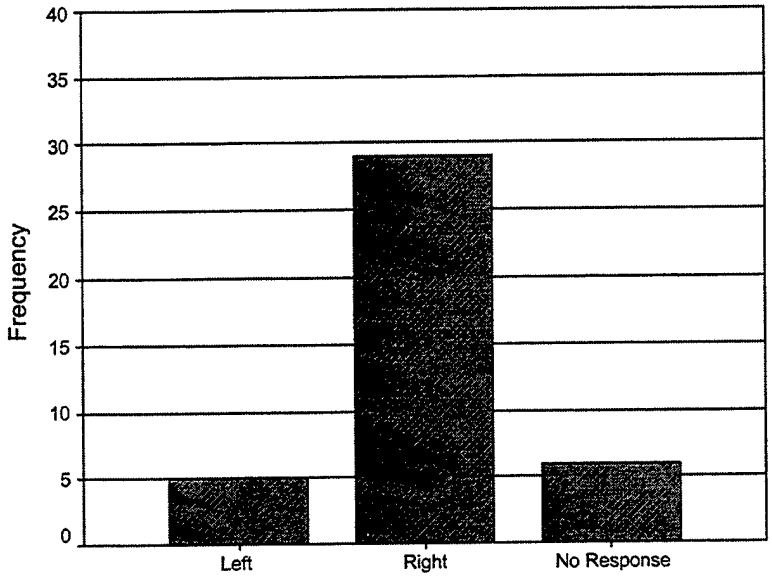
If "Yes" check all that apply:

(1) Glasses: Single vision _1_ -Bifocals _0_ - Trifocals _0_ - Progressive (No line) _0_

(2) Contacts: Single (mono)vision _2_ -Bifocal _0_

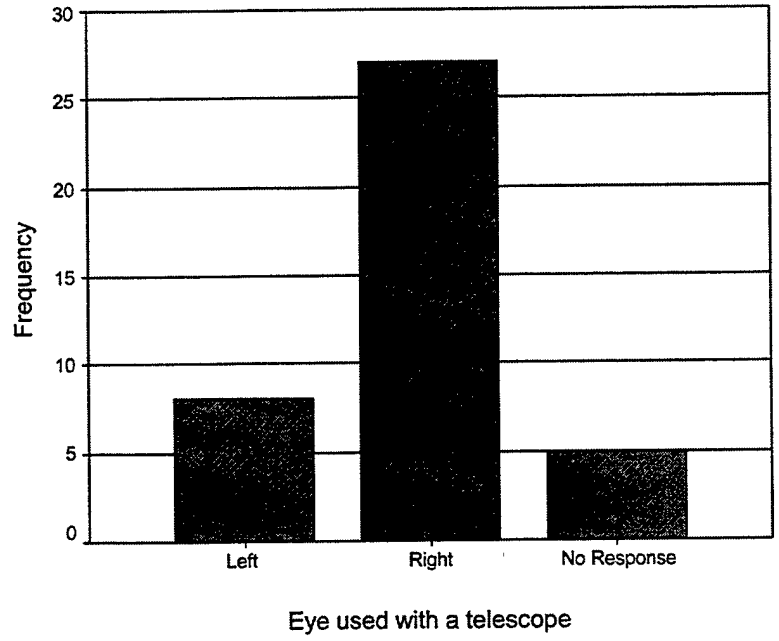
c. Which is your preferred sighting eye?

Right (29, 72.5%) Left (5, 12.5%) No Response (6, 15%)

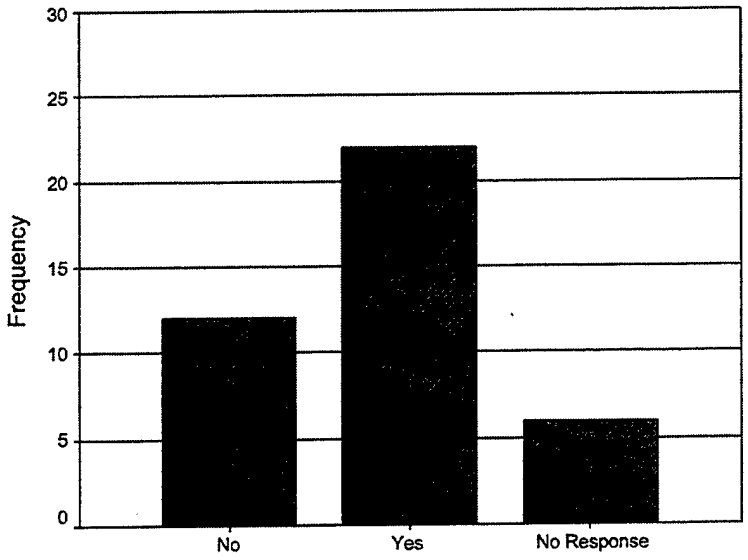


d. Which eye would you use with a telescope?

Right (27, 67.5%) Left (8, 20%) No Response (5, 12.5%)



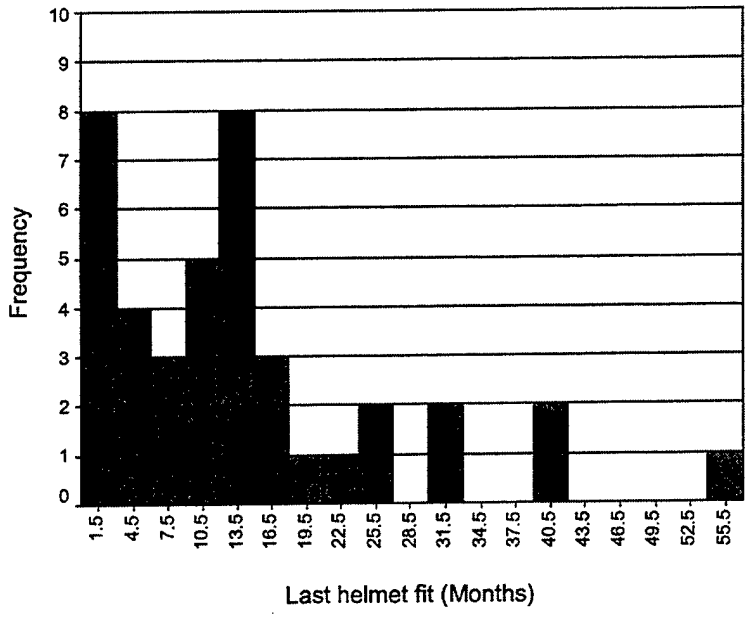
e. Is your better eye the same now (after AH-64 training and experience) as it was prior to your AH-64 experience? Yes (22, 55%) No (12, 30%) No Response (6, 15%)



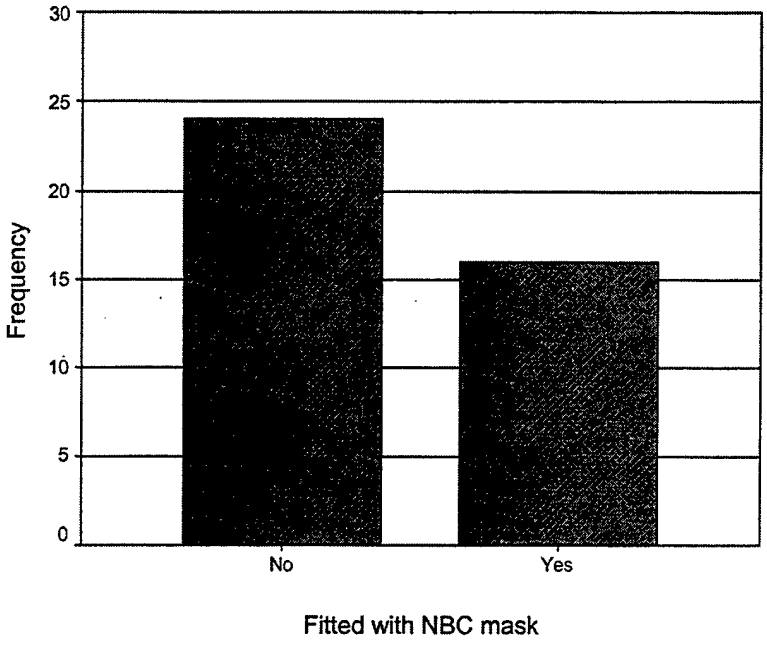
3. Helmet fit:

a. How long since last helmet fit (Months):

Mean 13 Median 11 Std. Dev. 12.3 Min. 1 Max. 56

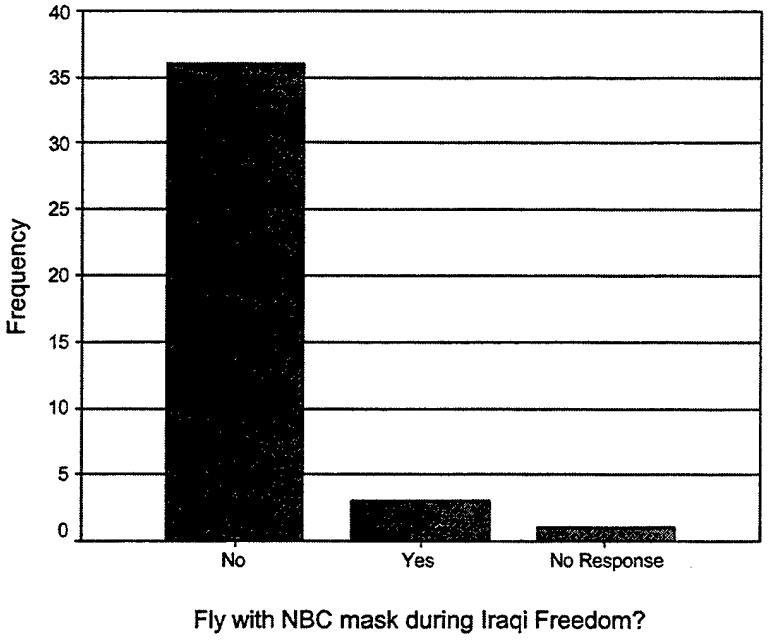


b. Was your helmet fitted with the NBC mask? (Circle one) Yes (16, 40%) No (24, 60%)



c. Did you fly with the NBC mask during Iraqi Freedom? (Circle one)

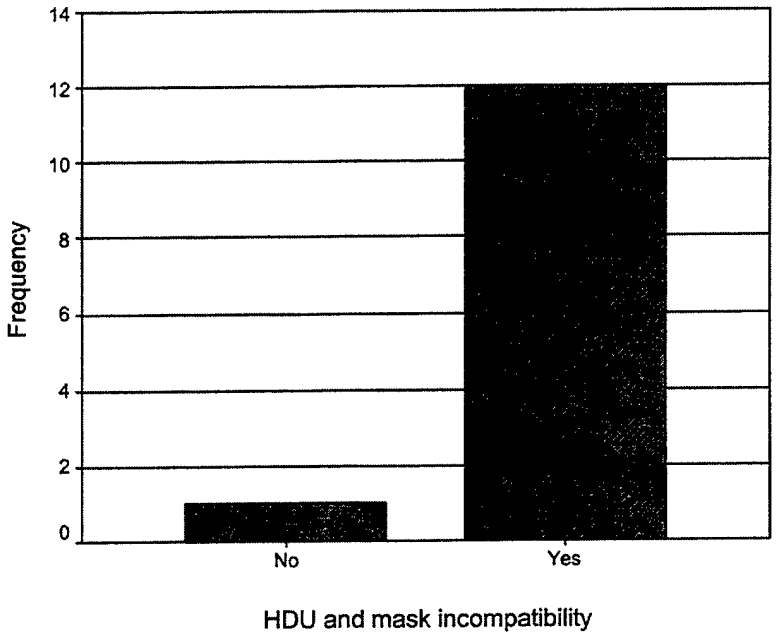
Yes (3, 7.5%) No (36, 90%) No Response (1, 2.5%)



If **YES**, approximate number of hours: 1, 1, 20.

Did you experience incompatibility with the HDU and the mask? (Circle one)

Yes (12, 92.3%) No (1, 7.7%)



NOTE: Of the 12 respondents who noted incompatibilities with the HDU and mask, only 3 had actually flown with the NBC and IHADSS during OIF.
This oddity indicates some ambivalence in the structuring of the survey question.

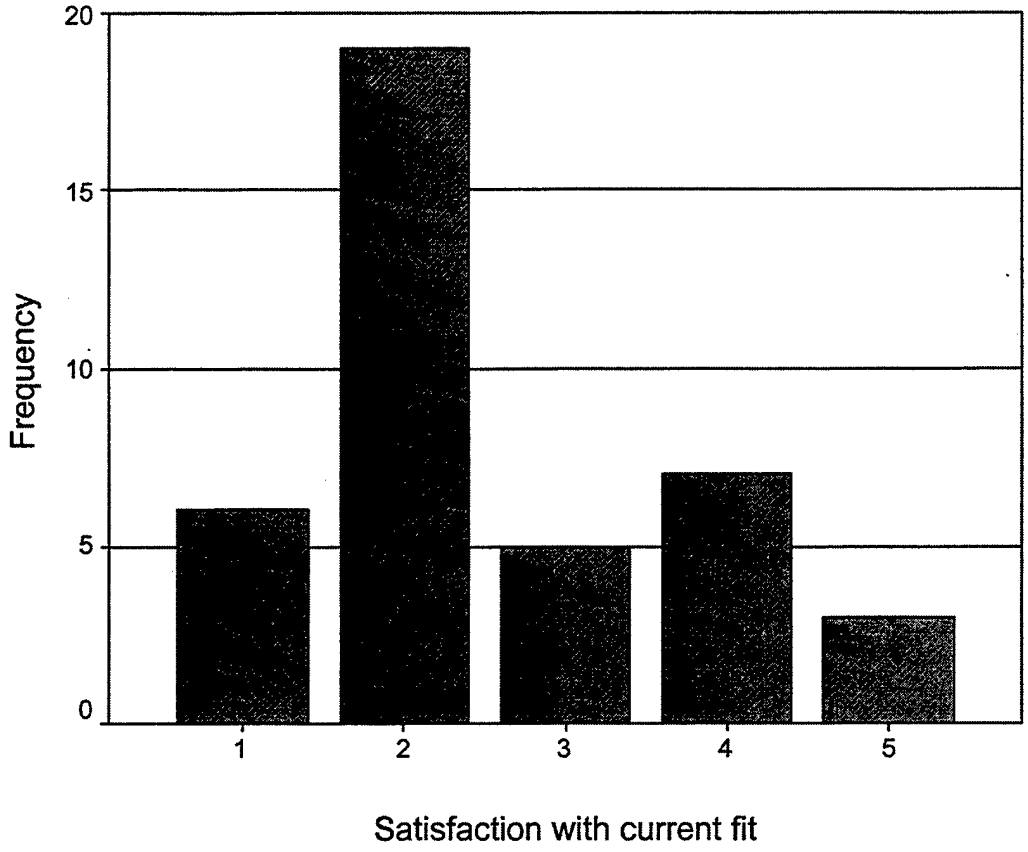
If **YES**, please explain:

-"Flew w/mask in simulator prior to deploying; peripheral vision in HDU minimal regardless of position on face."
-"Will not fit in front of my eye with mask on unless I turn the helmet."
-"During NBC Training while wearing HDU and mask I experienced difficulty with vision in the off axis positions (i.e., head to left)."
-"Used during training, nose clips must be made available in sufficient quantities. Nose clips improve fit/integration of mask and helmet."
-"When flying in simulator with the mask you cannot get a fit to read all the symbology. There is a trade off in the adjustment and accept the fact you will not see the full picture."
-"They don't work well together."
-"Very difficult to adjust HDU to proper position with mask on, and hooking up microphone."
-"Unable to see complete HDU video when wearing mask."
-"Helmet was not designed to incorporate a mask."
-"Mask fit is poor. Even with correct lens shape the HDU is nearly impossible to use fully (i.e., FOV)."
-"Lost all symbology in lower right and unable to move full left and right."

-"Prior to deploying, experience with mask was not pleasant. I had difficulty being able to see through HDU. For dayflight I didn't use it and for night wouldn't have been comfortable flying with HDU. Mainly used MPD video for night flight."
-"The notch in the eyesert does not allow for full viewing of the HDU image (I cannot get the HDU close enough)."
-"The mask was not compatible with the HDU. It places the HDU too far to the right."

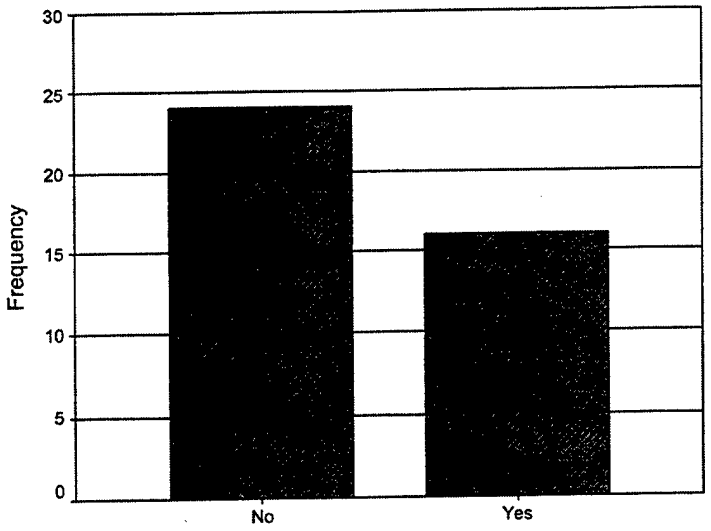
d. Rate satisfaction with current fit: (circle one)

1	2	3	4	5
Completely Satisfied	Somewhat satisfied	Neutral	Somewhat dissatisfied	Completely dissatisfied
(6, 15%)	(19, 47.5%)	(5, 12.5%)	(7, 17.5%)	(3, 7.5%)



e. Is your ability to view IHADSS imagery impacted by your helmet fit (e.g., helmet slippage impacts ability to maintain field of view)?

Yes (16, 40%) No (24, 60%)

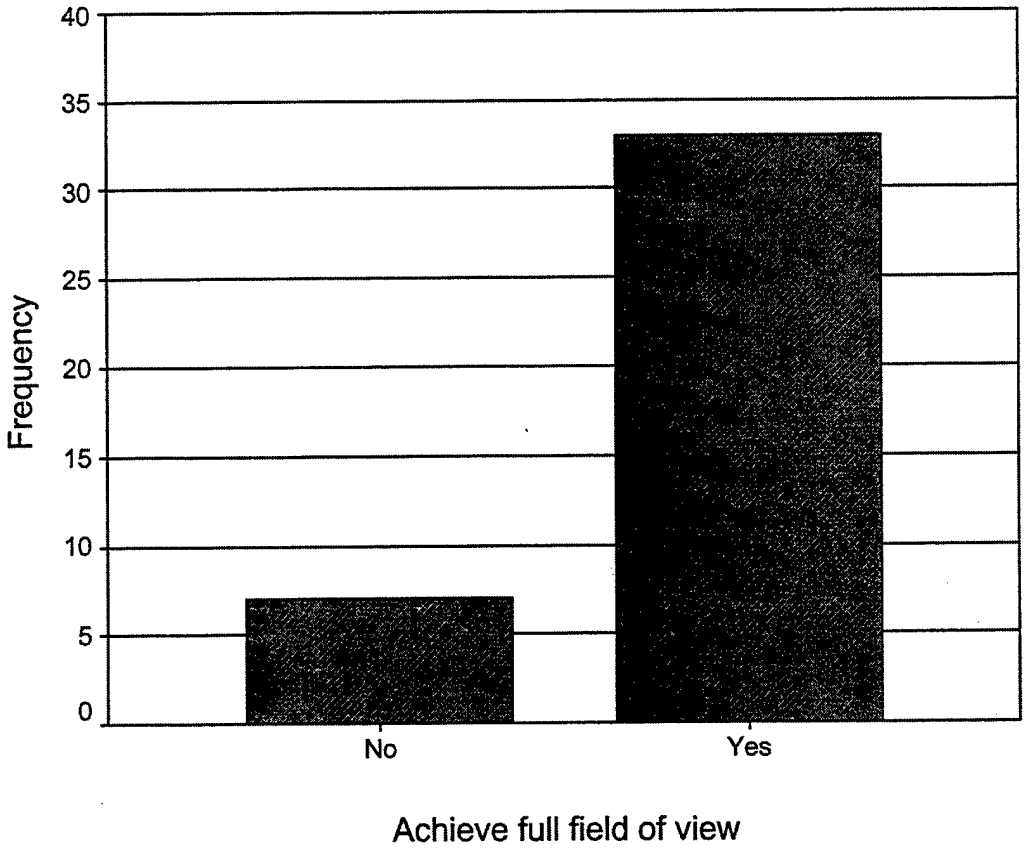


Ability to view IHADSS imagery impacted by helmet fit

If "**yes**," explain:

-"During extended flights (more than three) I shift my helmet due to hot spots and will lose TQ."
-"I should wear a large, but due to shortage I'm wearing a medium and have to look up to see imagery."
-"Must move helmet to the left to see through monocle."
-"I must ensure the helmet is shifted to the correct position on my head and turning my head to full left or right impacts IHADSS imagery."
-"Sometimes it is hard to see all symbology."
-"Improper fit makes it hard to view image after a sustained amount of time."
-"Sometimes when head moving."
-"Distance from eye occasionally causes a blind spot."
-"Only when wearing NVGs, the extra weight changes the fit and doesn't give a full field of view."
-"Since HDU is hard attached to helmet, when helmet moves or not on head right, it limits the FOV."
-"Helmet slides with head movement causing me to loose symbology."
-"Occasional slippage fore and aft affects FOV, constant adjustments in flight."
-"No one knows how to fit helmet properly."
-"I have to tilt my helmet back through flight to maintain visibility."
-"Helmet fit is crucial to flying the system. In my limited experience ALSE personnel aren't adequately trained in IHADSS fit."
-"Have to move helmet around to see well."
-"Requires constant helmet adjustment throughout flight."

f. Do you achieve a full field of view? Yes (33, 82.5%) No (7, 17.5%)

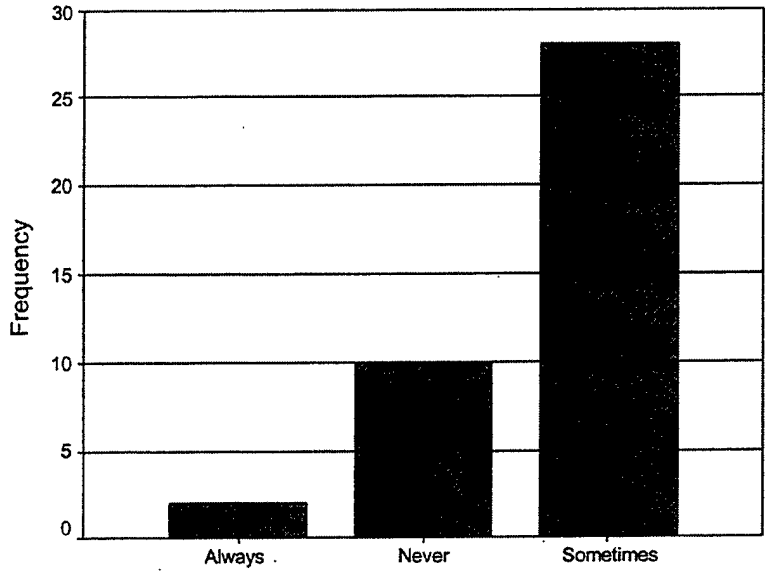


4. Aviation vision:

a. ***While*** flying the Apache, have you experienced?

Visual discomfort (e.g., eyestrain, fatigue):

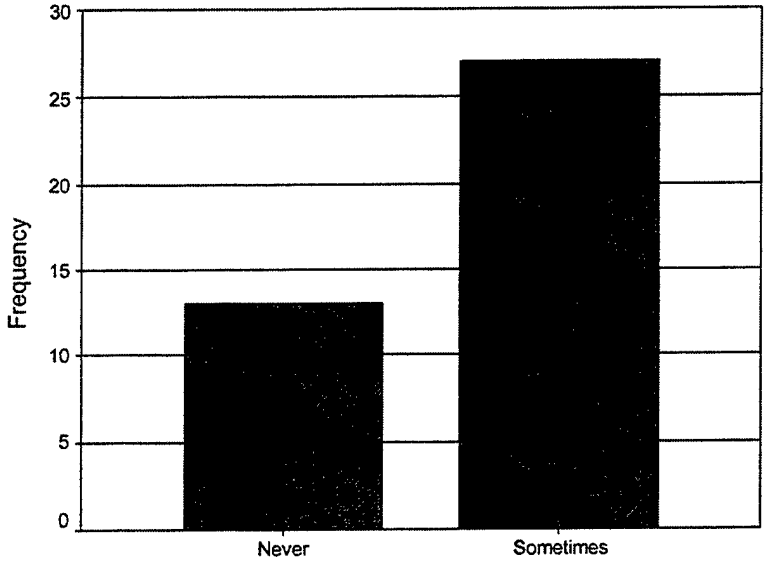
Never (10, 25%) Sometimes (28, 70%) Always (2, 5%)



Visual discomfort while flying

Headache:

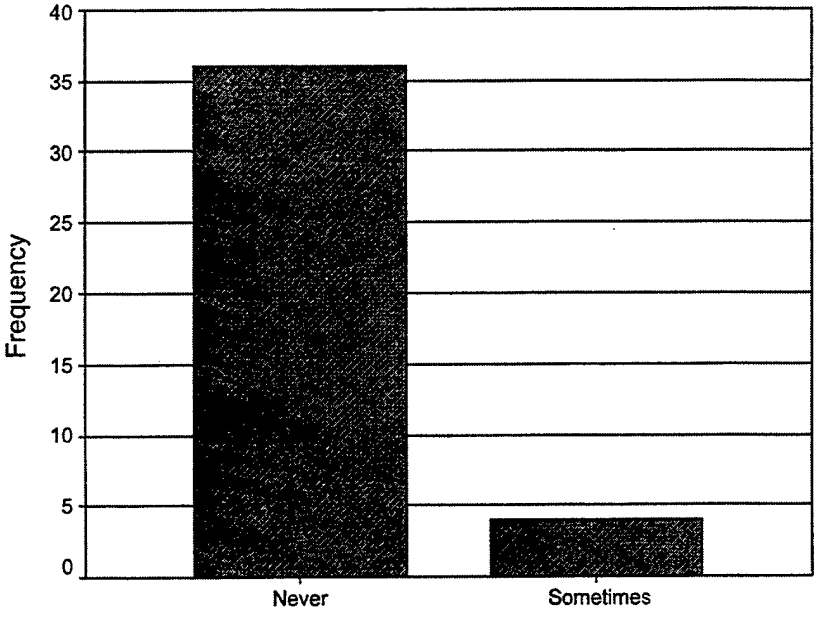
Never (13, 32.5%) Sometimes (27, 67.5%) Always (0, 0%)



Headache while flying

Double vision:

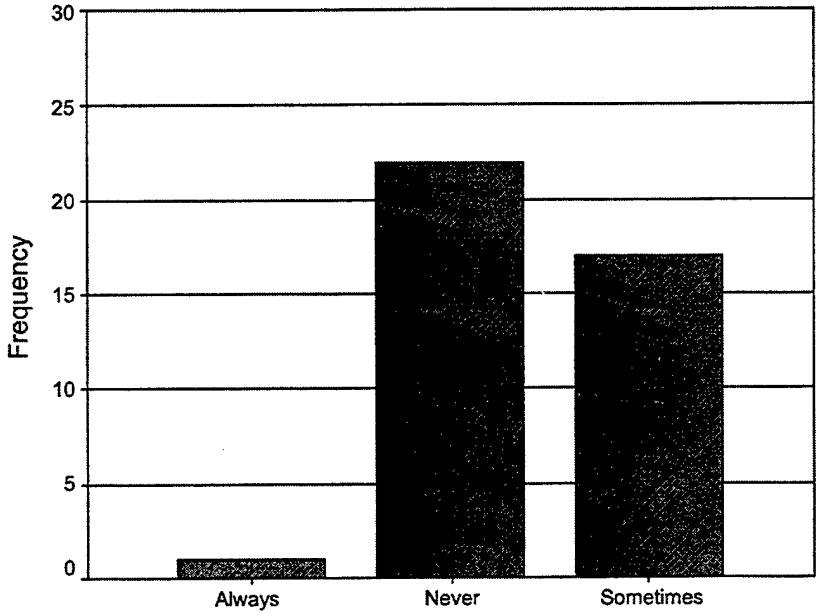
Never (36, 90%) Sometimes (4, 10%) Always (0, 0%)



Double vision while flying

Blurred vision:

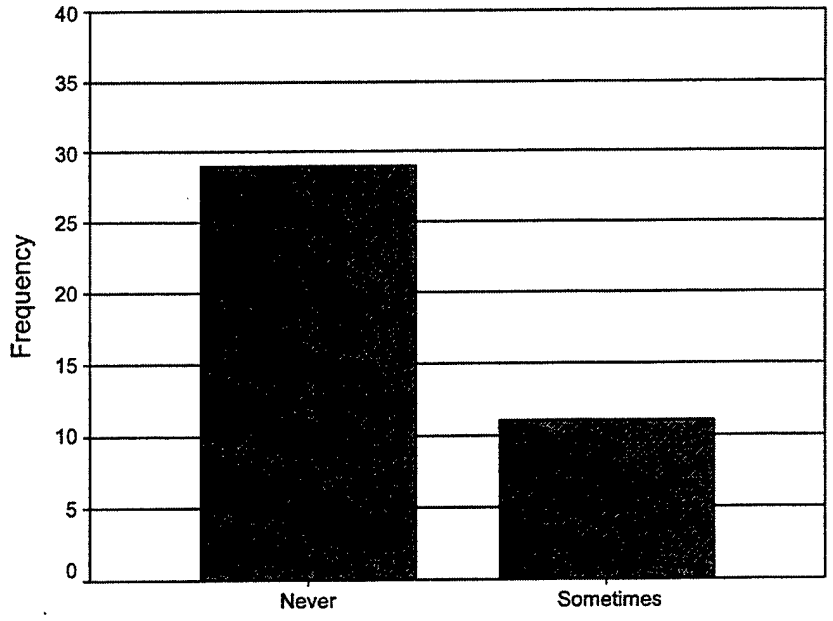
Never (22, 55%) Sometimes (17, 42.5%) Always (1, 2.5%)



Blurred vision while flying

Disorientation:

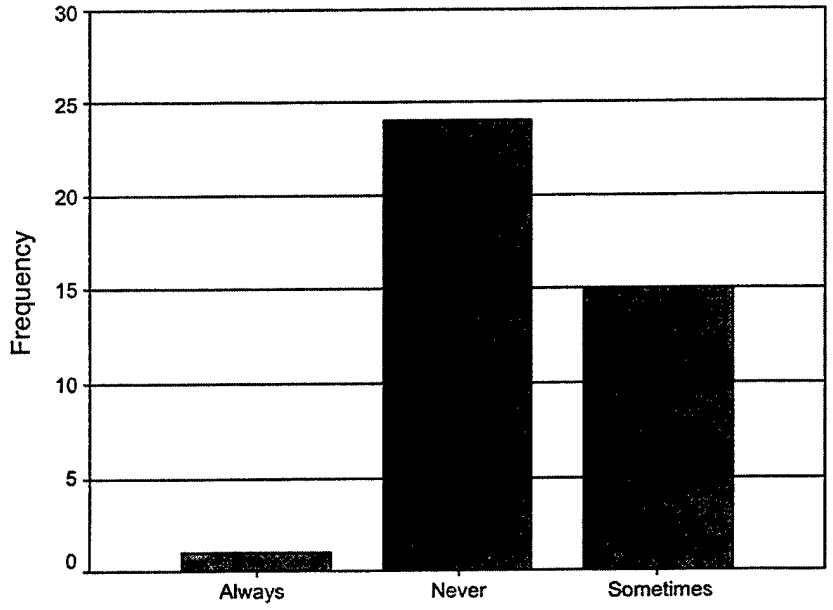
Never (29, 72.5%) Sometimes (11, 27.5%) Always (0, 0%)



Disorientation while flying

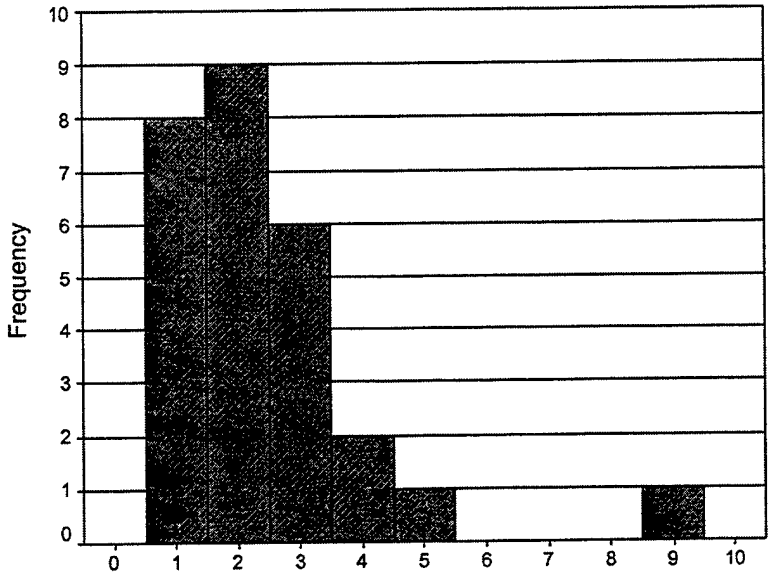
After-images:

Never (24, 60%) Sometimes (15, 37.5%) Always (1, 2.5%)



After-images while flying

b. If symptoms were reported in (a) above, please comment on length of time IHADSS was in use before symptoms occurred (Hours):
Mean 2.4 Median 2 Std. Dev. 1.7 Min. 1 Max. 9

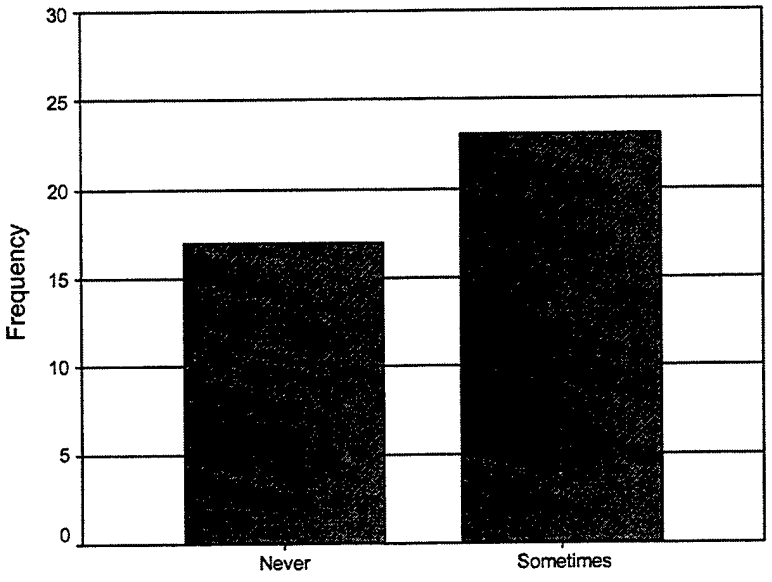


Length of time IHADSS was in use before symptoms (Hours)

c. ***After*** flying the Apache, have you experienced

Visual discomfort (e.g., eyestrain, fatigue):

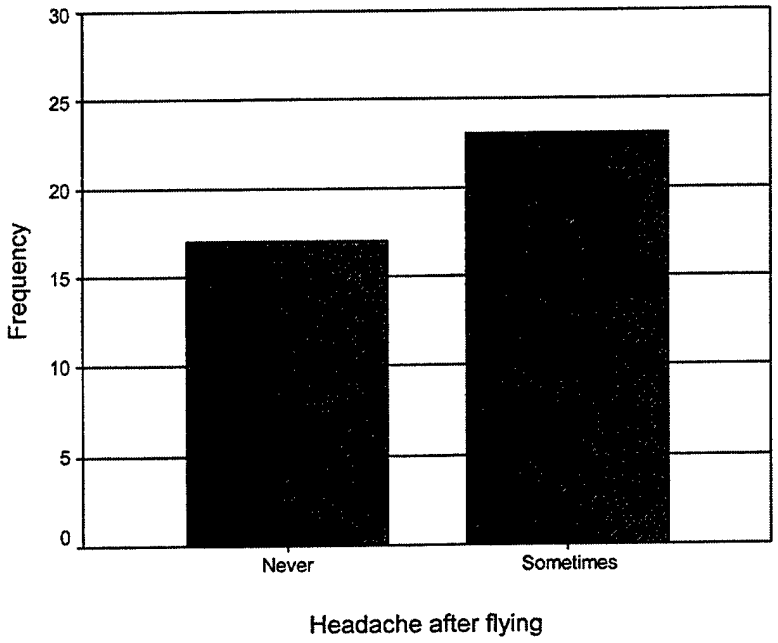
Never (17, 42.5%) Sometimes (23, 57.5%) Always (0, 0%)



Visual discomfort after flying

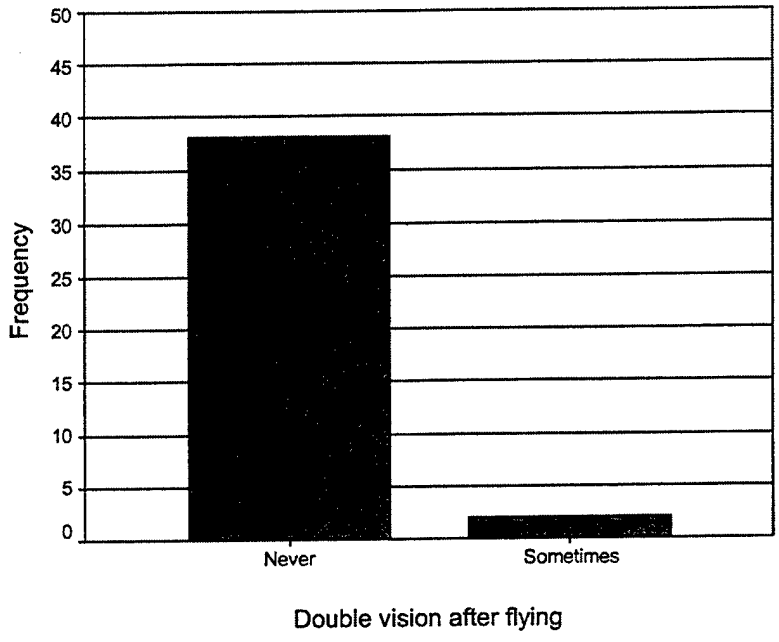
Headache:

Never (17, 42.5%) Sometimes (23, 57.5%) Always (0, 0%)



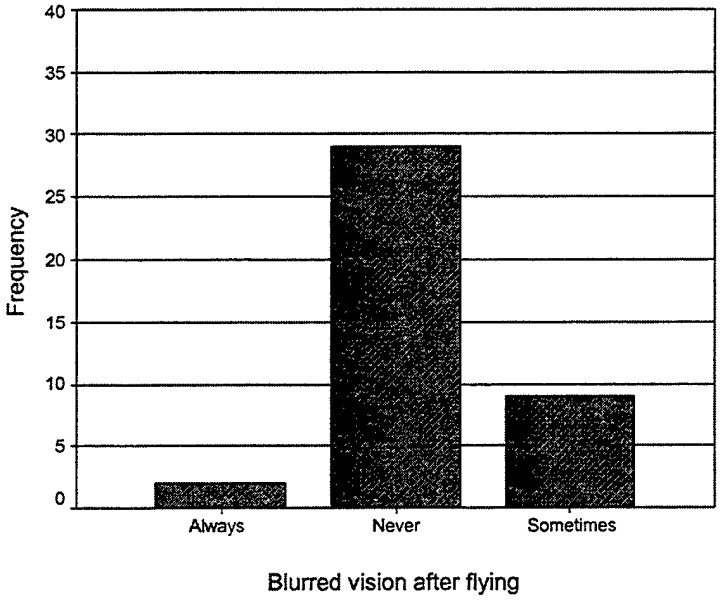
Double vision:

Never (38, 95%) Sometimes (2, 5%) Always (0, 0%)



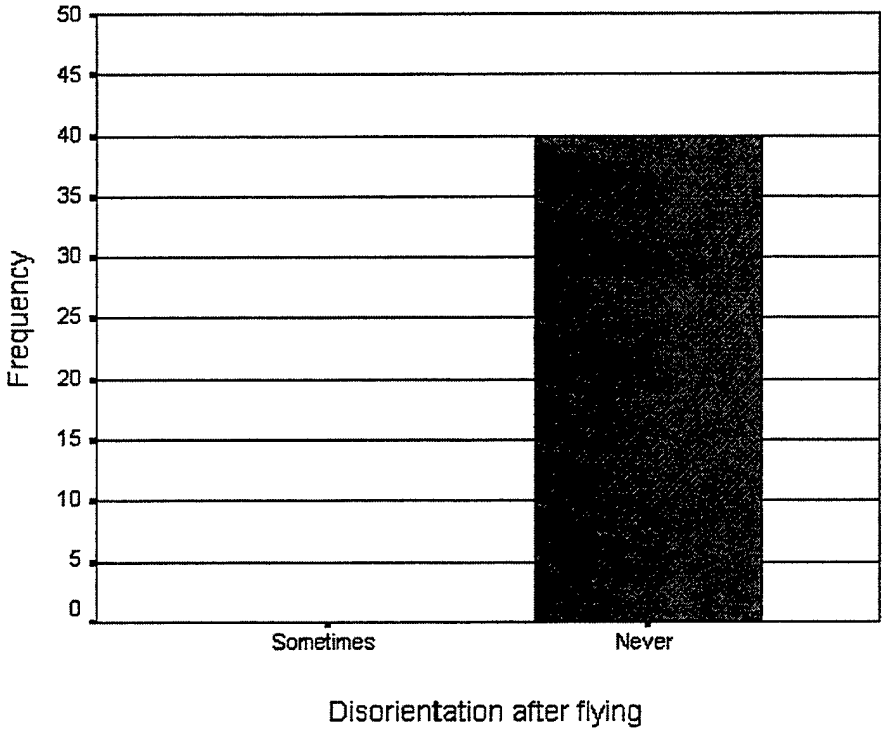
Blurred vision:

Never (29, 72.5%) Sometimes (9, 22.5%) Always (2, 5%)



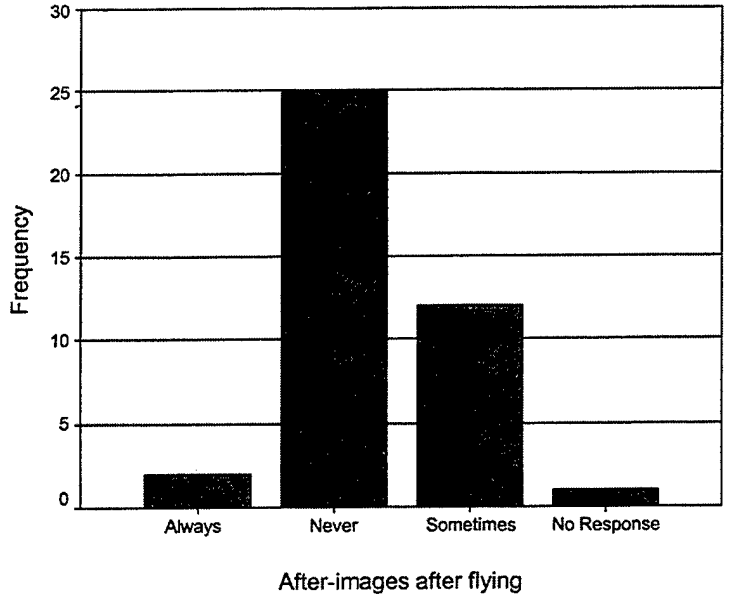
Disorientation:

Never (40, 100%) Sometimes (0, 0%) Always (0, 0%)



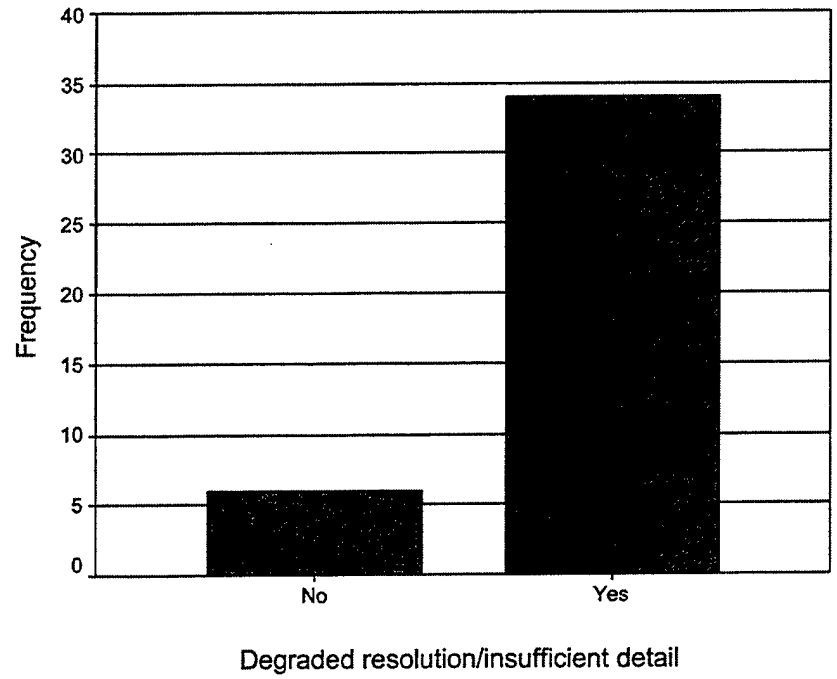
After-images:

Never (25, 62.5%) Sometimes (12, 30%) Always (2, 5%) No Response (1, 2.5%)

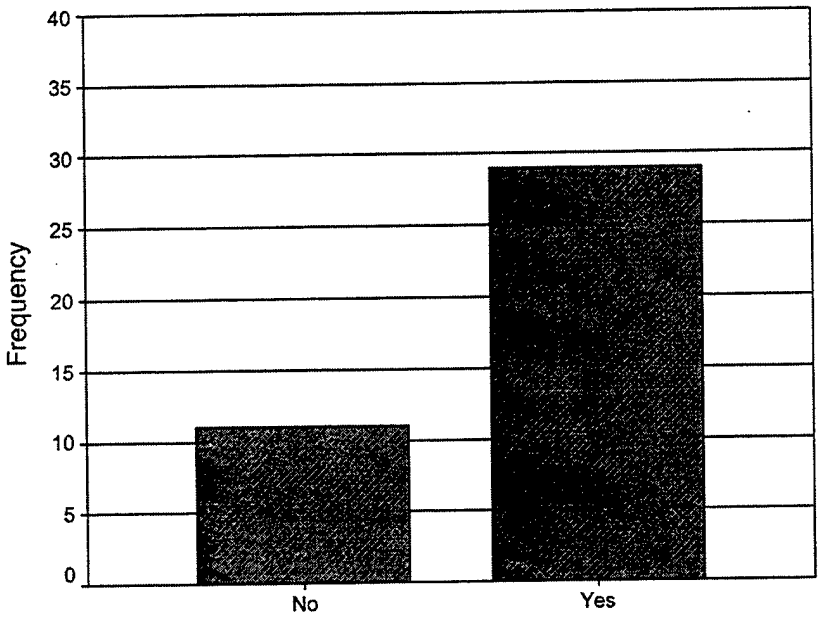


d. During Apache flight, have you experienced any of the following degraded visual cues? (Check all that apply)

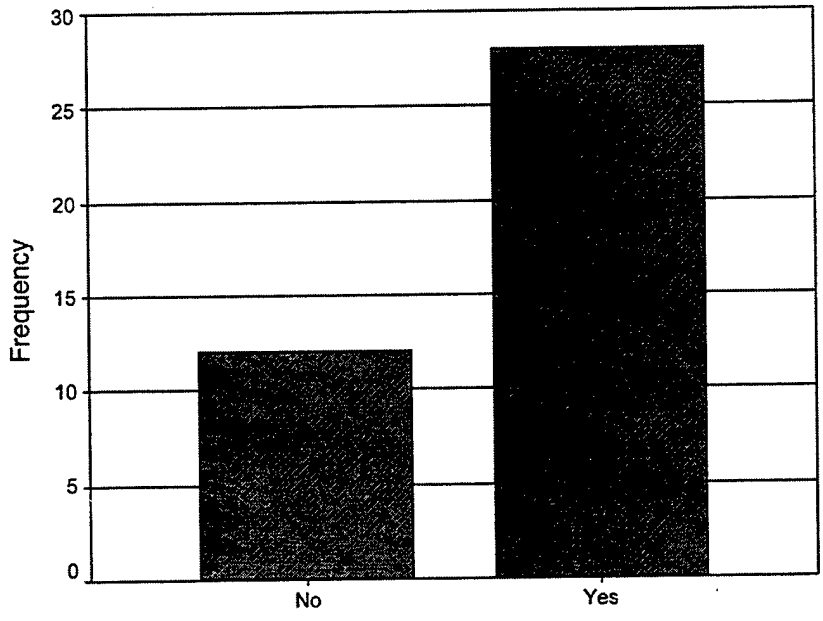
Degraded resolution/insufficient detail: Yes (34, 85%) No (6, 15%)



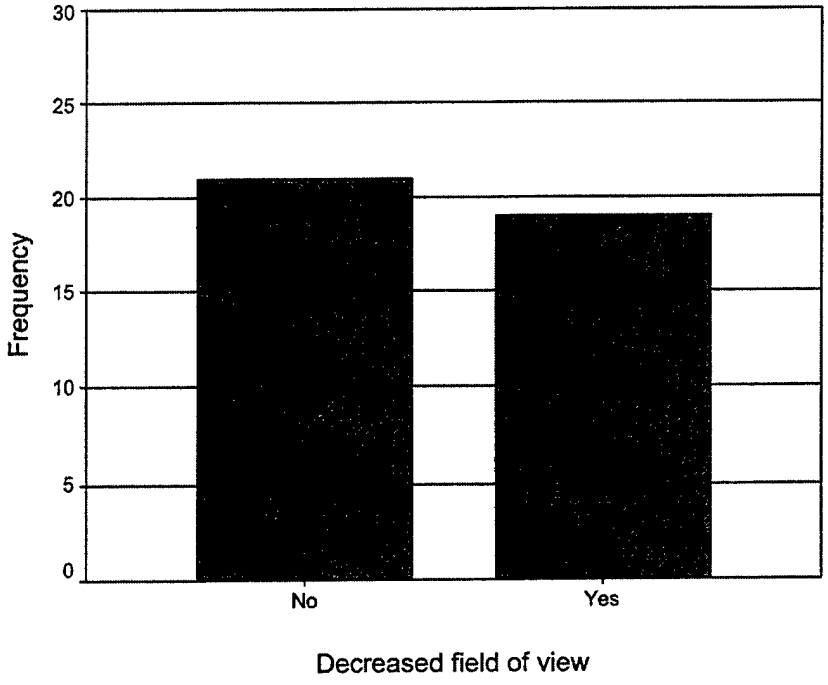
Loss of visual contact with horizon: Yes (29, 72.5%) No (11, 27.5%)



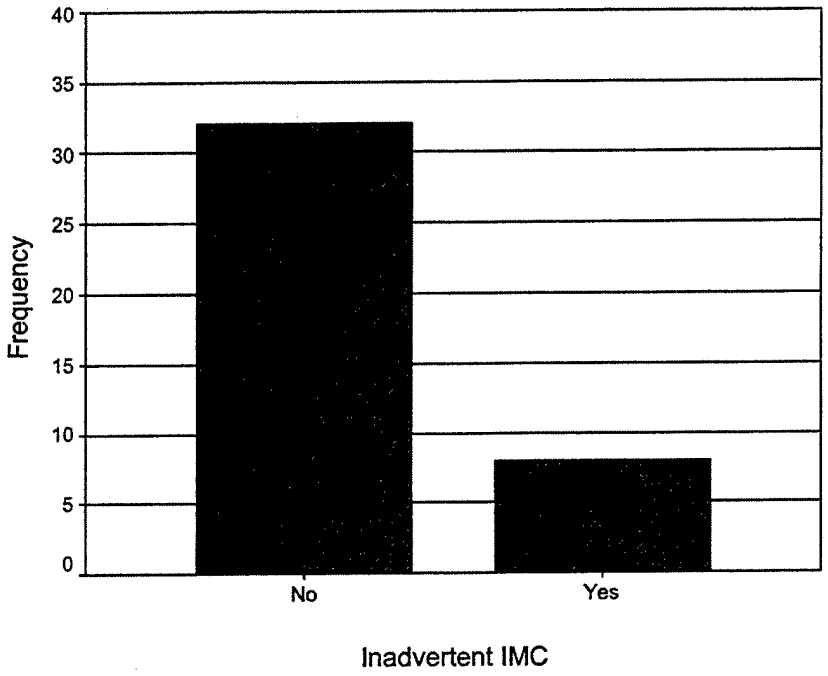
Impaired depth perception: Yes (28, 70%) No (12, 30%)



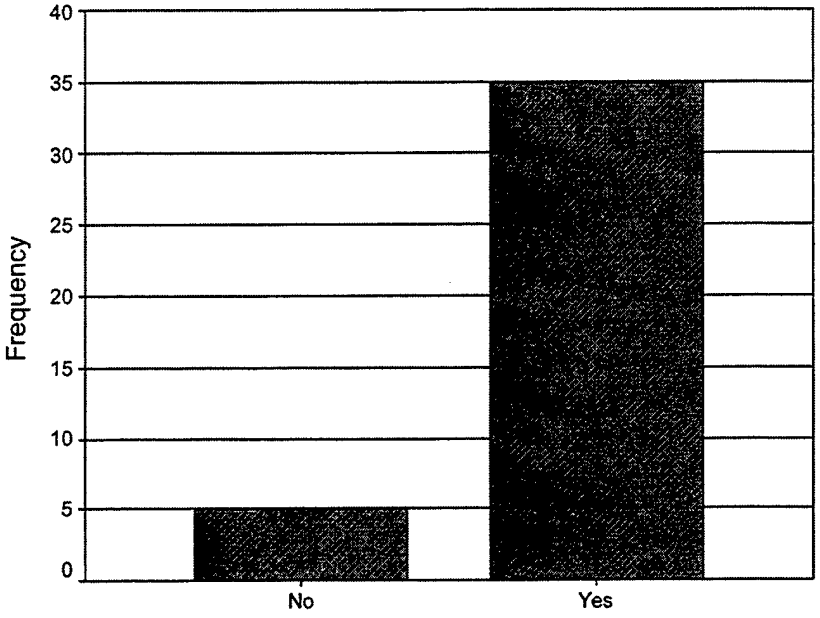
Decreased field of view: Yes (19, 47.5%) No (21, 52.5%)



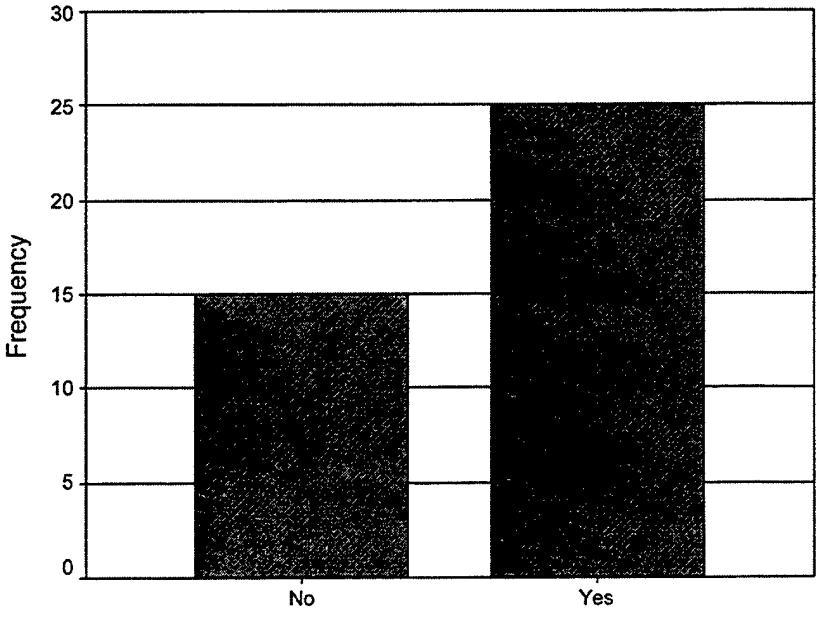
Inadvertent IMC: Yes (8, 20%) No (32, 80%)



Whiteout/brownout: Yes (35, 87.5%) No (5, 12.5%)



Blurring of image with head movement: Yes (25, 62.5%) No (15, 37.5%)



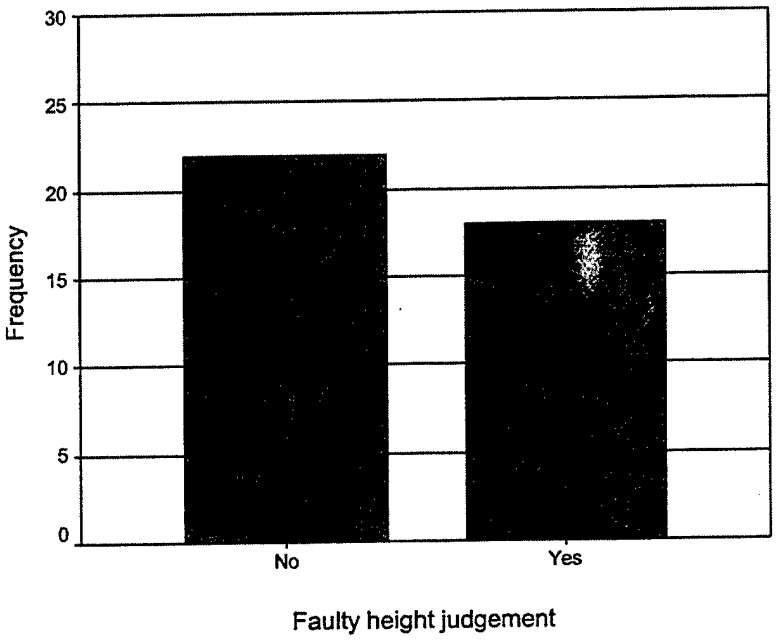
Comments:

-"This is aircraft dependent. Not all FLIR/TADS pictures equivalent. Overall performance is extremely sub-par when compared w/ next generation FLIR."
-"TADS slewing is slow, detail of FLIR picture degrades severely beyond one kilometer, and A/C coupling effect bleaches most of picture during turns. Picture brightness and contrast seem to increase or decrease with head movement."
-"If you bank the A/C the image degrades."
-"All things that are inherent with the design of the system; training and experience assist in reducing these conditions but everyone will experience these problems over time flying the system."
-"Varies dependent on A/C and meteorological conditions."
-"All these seem inherent to NVS flight."
-"Overall the system sucks."
-"Rarely use FLIR w/out some degraded visual cues."
-"All these are almost always associated w/ flying the TADS in NVS."
-"Most issues have occurred due to AC coupling."

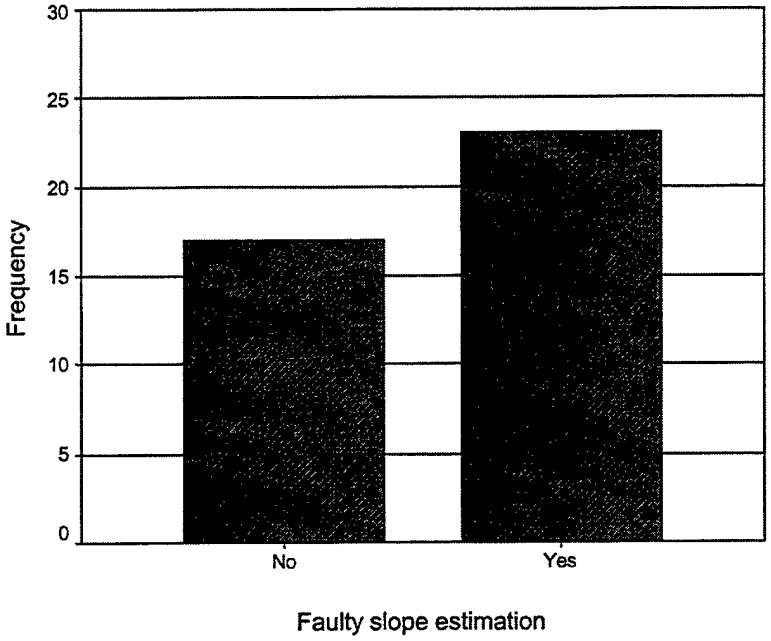
e. During Apache flight, have you experienced any of the following illusions? (Check all that apply)

Static illusions:

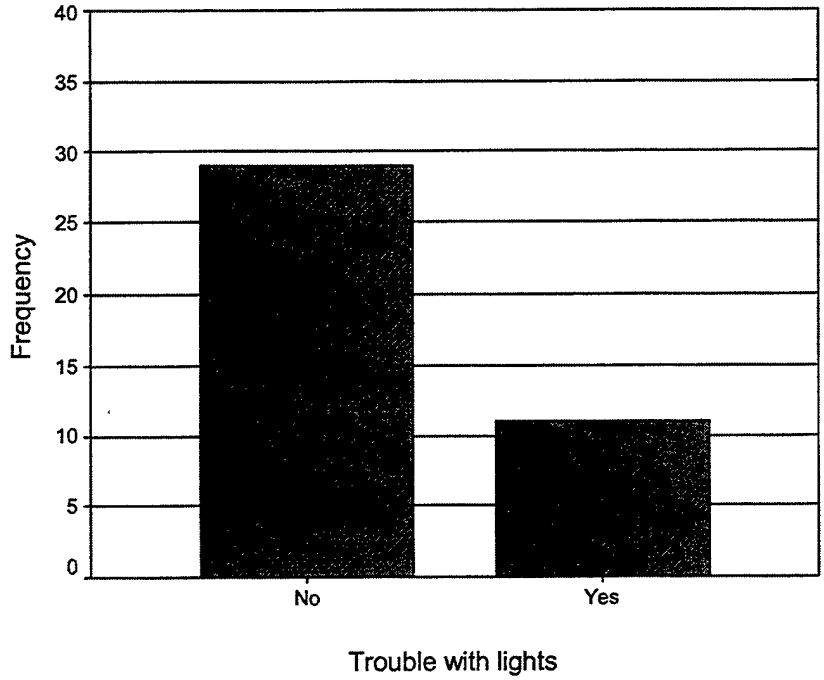
Faulty height judgment: Yes (18, 45%) No (22, 55%)



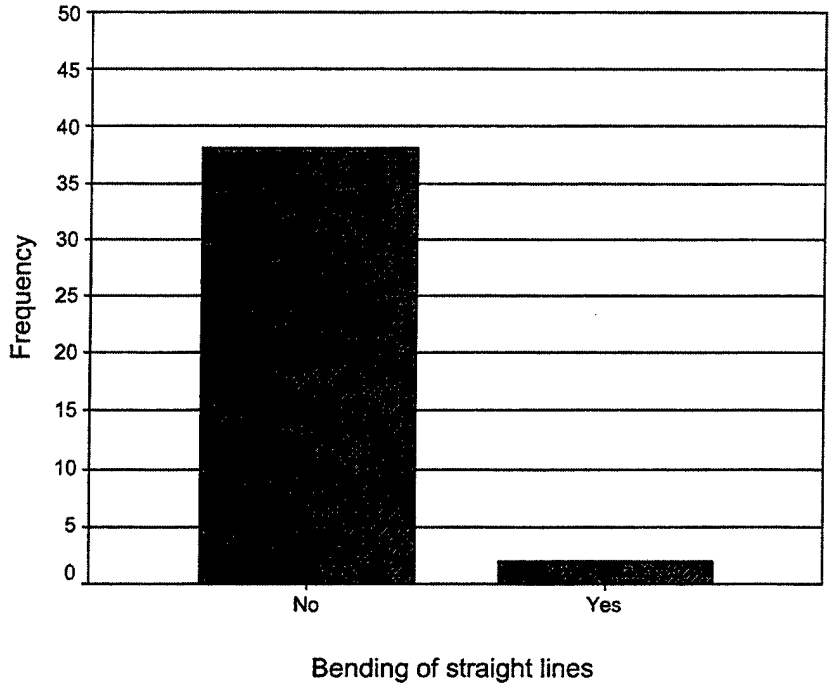
Faulty slope estimation: Yes (23, 57.5%) No (17, 42.5%)



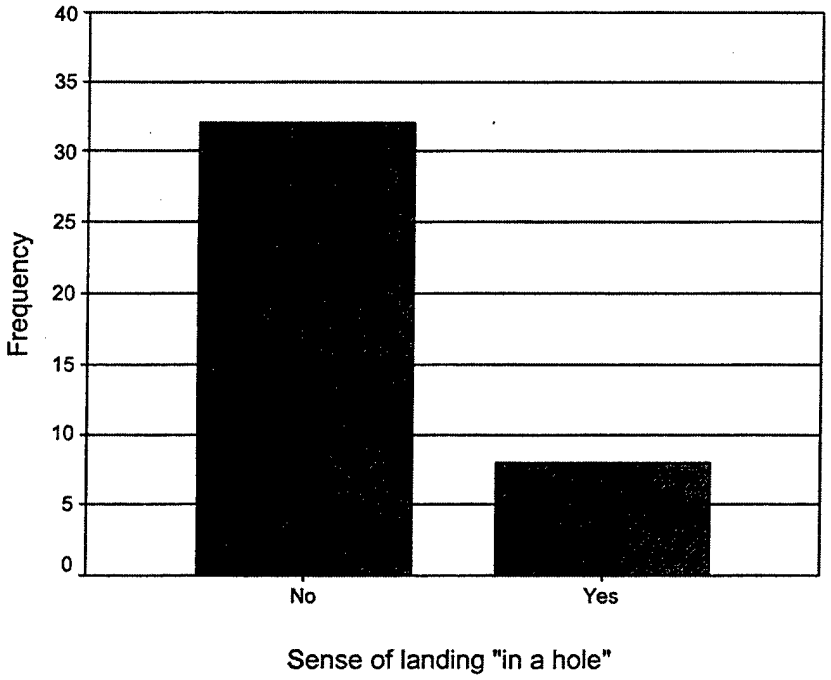
Trouble with lights: Yes (11, 27.5%) No (29, 72.5%)



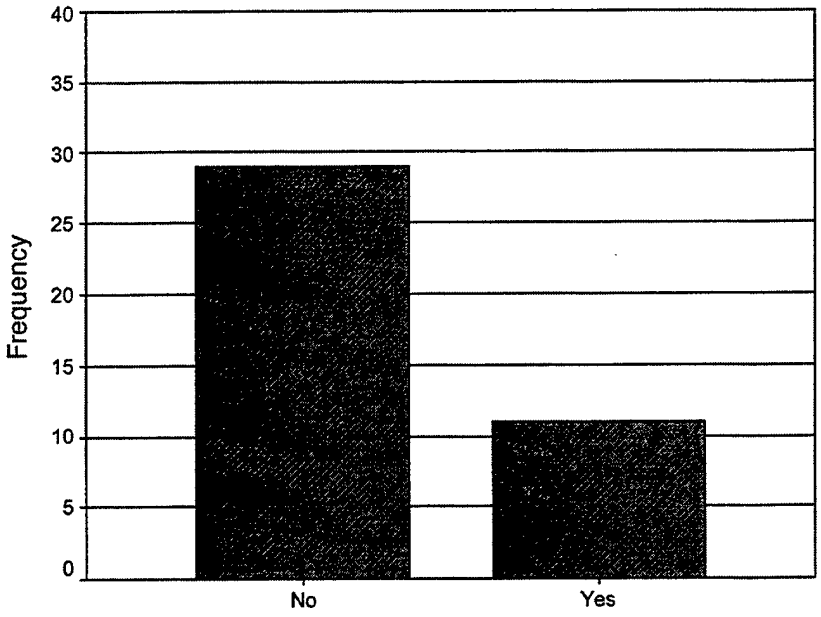
Bending of straight lines: Yes (2, 5%) No (38, 95%)



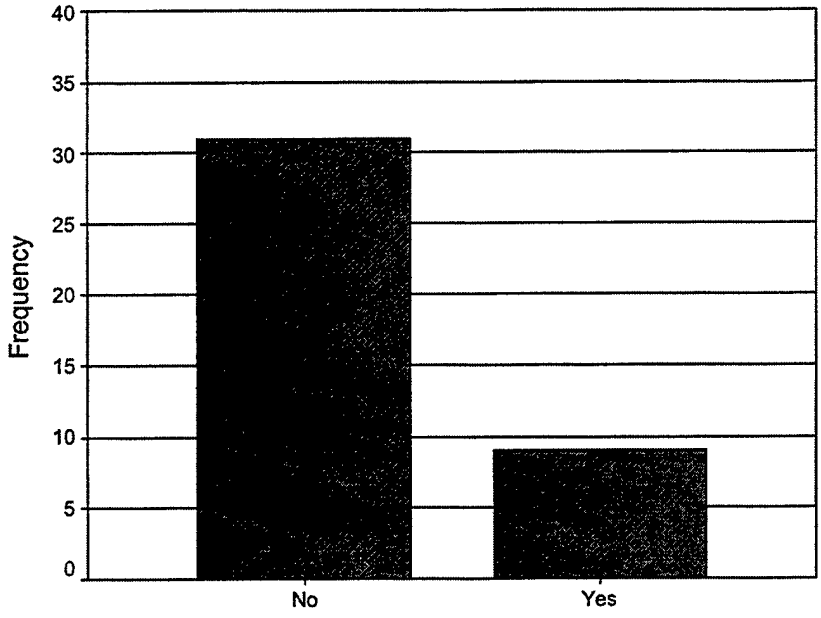
Sense of landing "in a hole": Yes (8, 20%) No (32, 80%)



Faulty altitude judgment: Yes (11, 27.5%) No (29, 72.5%)



Faulty clearance judgment: Yes (9, 22.5%) No (31, 77.5%)

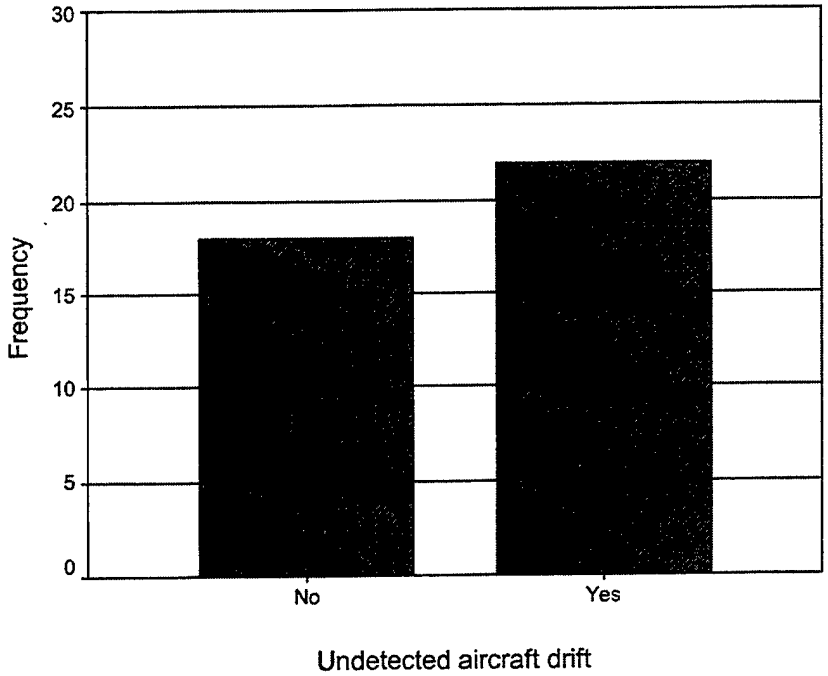


Comments:

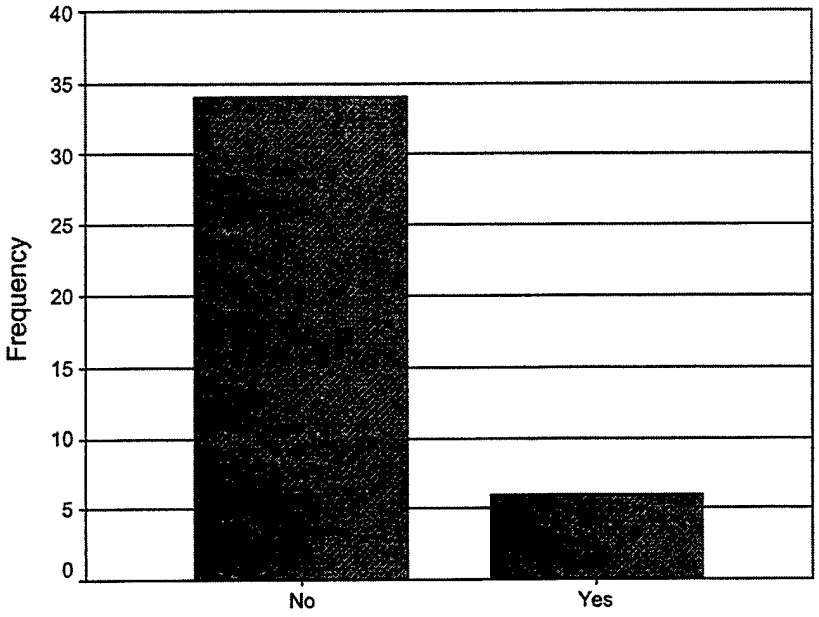
-"Loss of depth perception when using monocular cues, and retinal rivalry."
-"Back-seat mag[netic] compass needs to go away."
-"The monocular nature of the system causes these problems for me."
-"Binocular rivalry – sunrise/sunset."
-"Attitude can be misadjusted in the cockpit."
-"Symbology helps mitigate these."
-"The lack of detail in our system, plus a bleaching of the picture in turns causes a lot of these illusions."

Dynamic illusions:

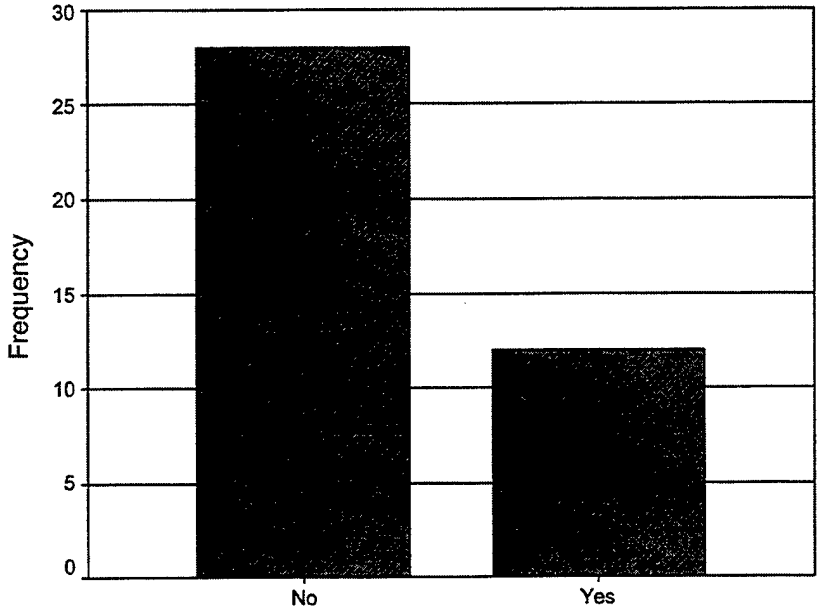
Undetected aircraft drift: Yes (22, 55%) No (18, 45%)



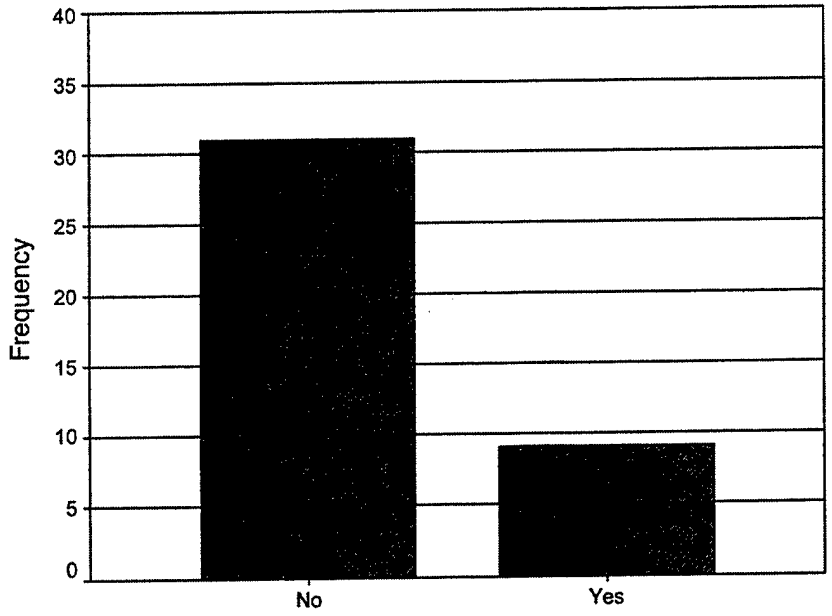
No sensation of movement: Yes (6, 15%) No (34, 85%)



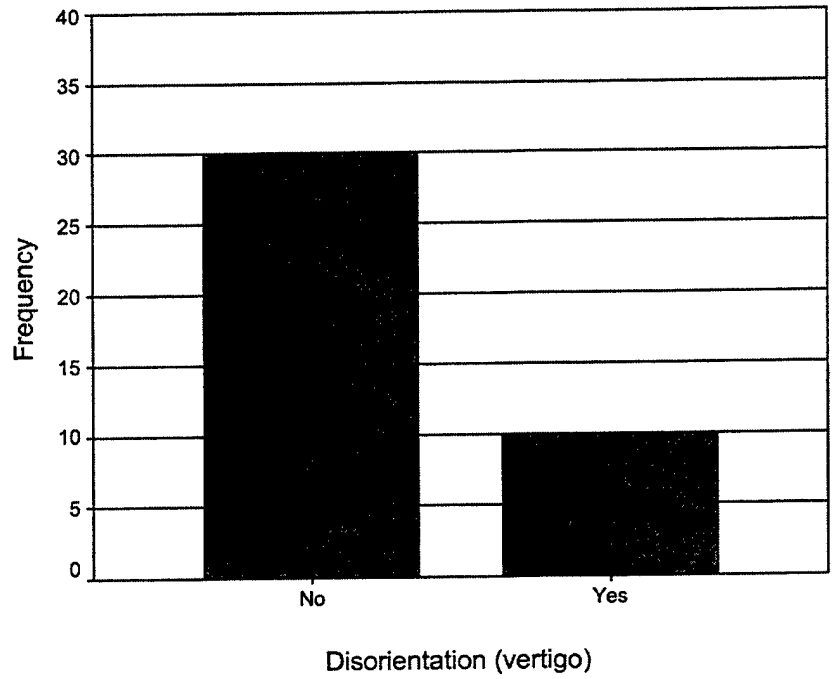
Illusory aircraft drift: Yes (12, 30%) No (28, 70%)



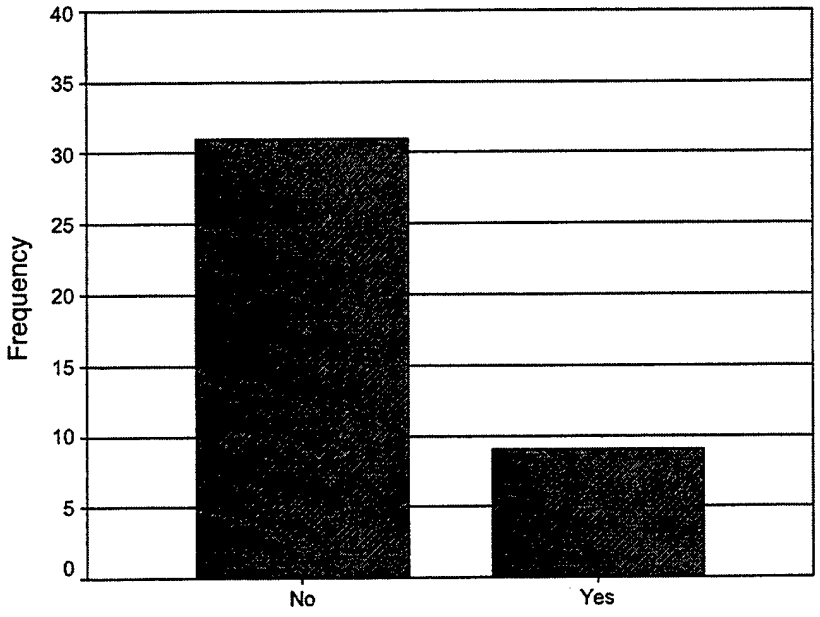
Illusory rearward flight: Yes (9, 22.5%) No (31, 77.5%)



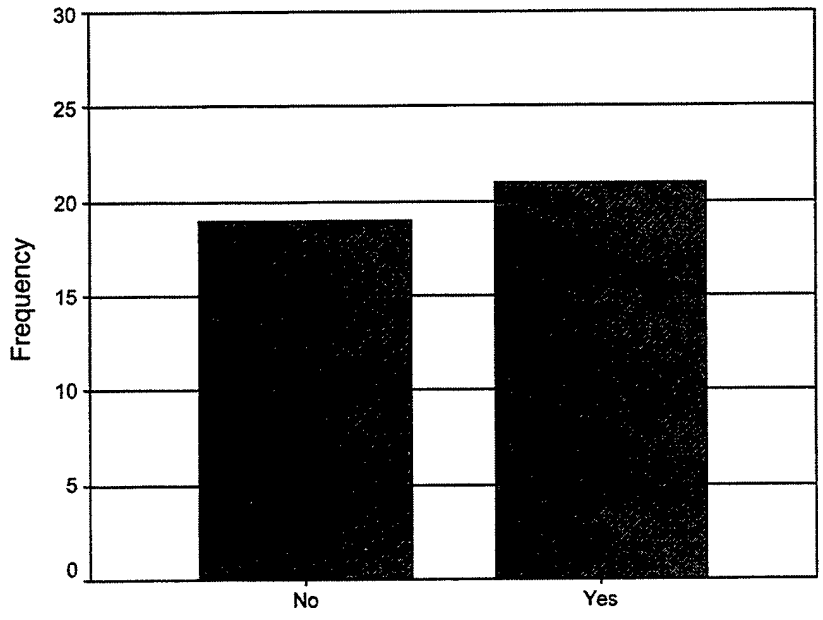
Disorientation (vertigo): Yes (10, 25%) No (30, 75%)



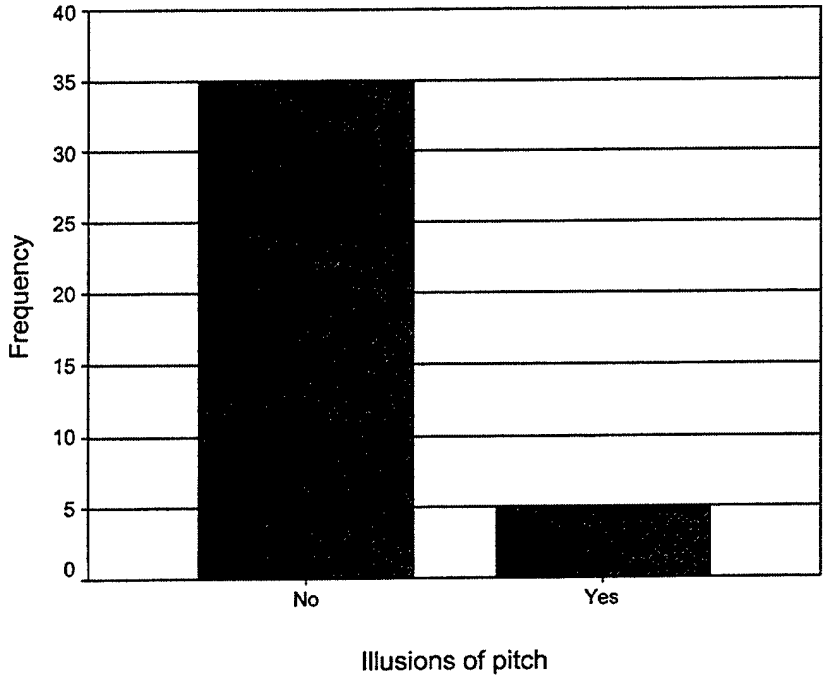
Faulty airspeed judgment: Yes (9, 22.5%) No (31, 77.5%)



Faulty closure judgment: Yes (21, 52.5%) No (19, 47.5%)



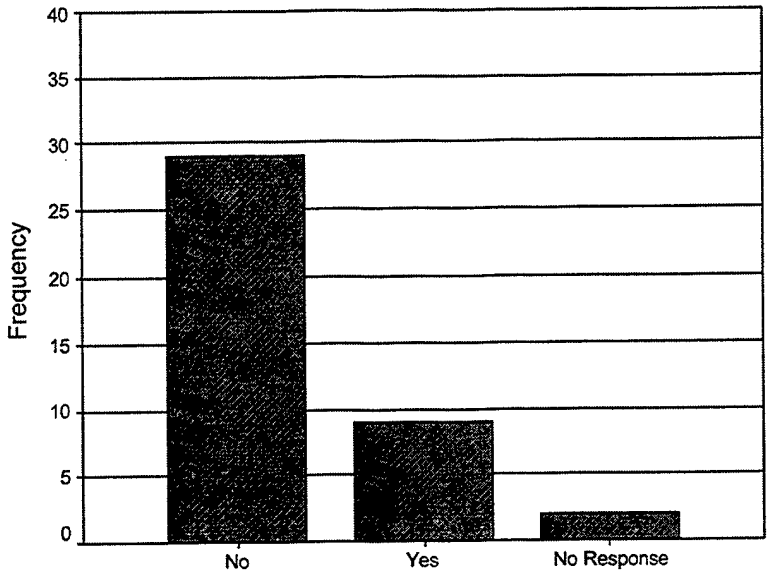
Illusions of pitch: Yes (5, 12.5%) No (35, 87.5%)



Comments:

-"These illusions usually occur from peripheral vision."
-"Normal stuff."
-"Symbology helps to mitigate these."
-"Most dynamic illusions are result of poor FLIR imagery."
-"Due to a loss of field of view with only an HDU."

f. Have you noted any change in your ability to see or interpret HMD symbology during any phase of flight? Yes (9, 22.5%) No (29, 72.5%) No Response (2, 5%)



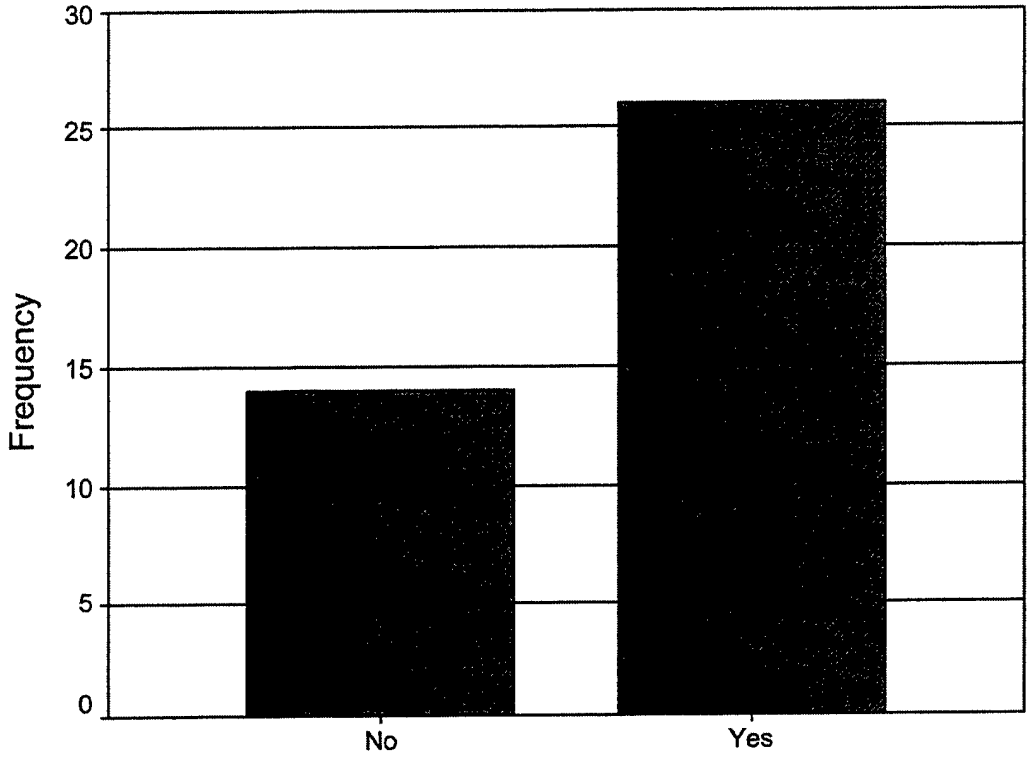
Change in ability to see or interpret HMD symbology during flight

If "**Yes,**" explain (e.g., description, duration, reason, etc.):

-"Experience = improvement."
-"While using hover mode, we look down to pick up near FLIR cues, which decreases ability to determine horizon."
-"During high resolution or contrast periods or high stress periods symbology can be loss or picture depending on current tasking."
-Symbology interpretation is degraded after long duty days and long NVS flights."
-"When TADS bleaches out on turns it makes the symbology harder to see."
-"My cross check has degraded during long (5+ hours) NVS flights."
-"It can require intense concentration, so the longer the NVS flight, the more exhausted you become."
-"My HMD perception gets better the longer I fly."
-"Helmet tends to rotate causing a lesser field of view."

g. When viewing through the HMD, can you focus clearly on the external scene and the symbology simultaneously?

Daytime: Yes (26, 65%) No (14, 35%)

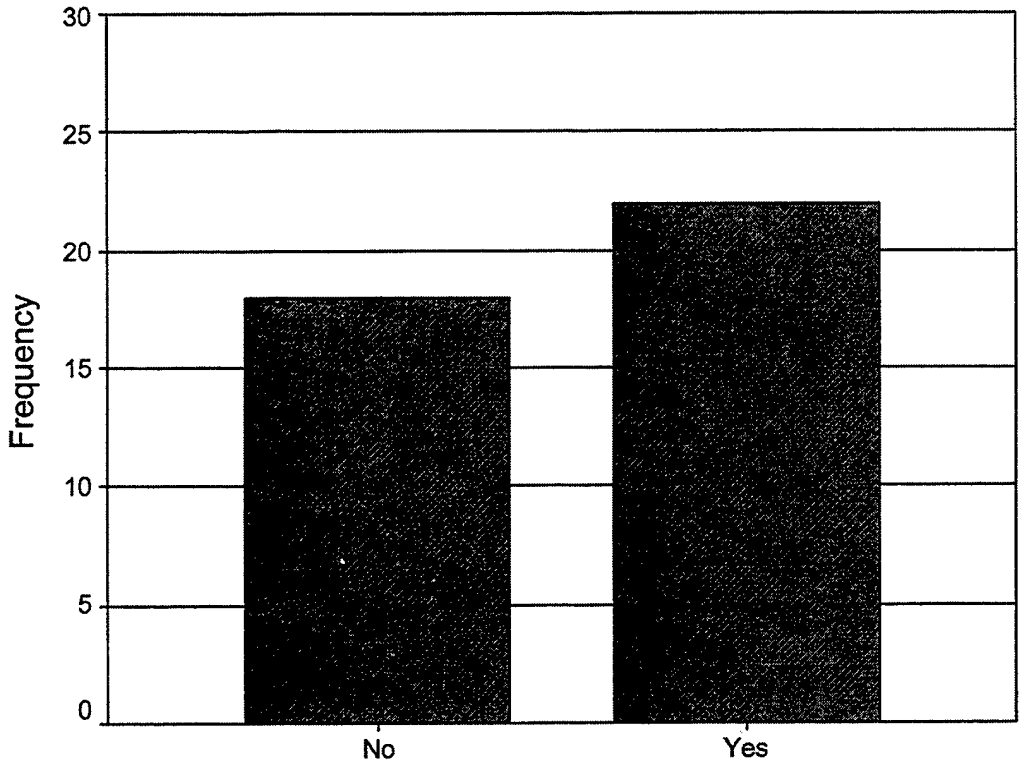


Daytime focus on external scene and symbology

If "Yes", explain:

-"Using infinity focus allows me to adjust symbology for minimal eye strain."
-"Central symbology only."
-"I guess I learned how to do the infinity focus well."
-"During daytime I use HMD only with no NVS."
-"Drive down Brightness and Contrast so that FLIR image isn't present. Use symbology like an HUD."
-"Symbology is overlaid with left-eye view."
-"Usually if brightness adjusted."
-"During the day I can see through the HDU and still see the symbology."
-"Takes time and practice. Not really until as of late."
-"If you focus it right, it will all be easy to see."
-"I adjust brightness and contrast and symbology brightness so I can see it perfectly even on sunny days."
-"I could not until about 4 years ago."
-"Because of binocular rivalry."
-"If scene is close enough and well-defined."

Nighttime: Yes (22, 55%) No (18, 45%)



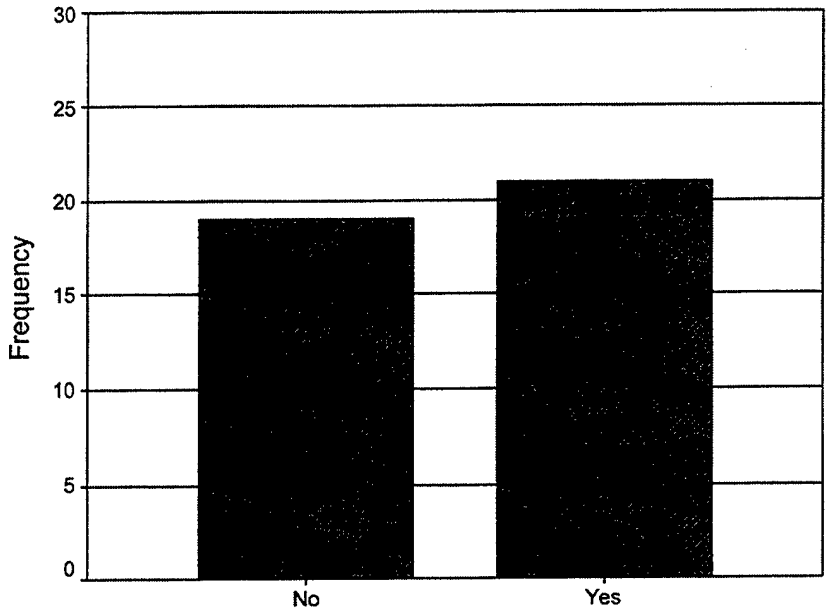
Nighttime focus on external scene and symbology

If "Yes", explain:

-"Central symbology only."
-"Under low tasking situation or "normal flight"; high stress situation it takes extreme concentration to view both."
-"Experience allows me to focus on FLIR cues and symbol cue simultaneously."
-"NVS is overlaid with lights at night."
-"If brightness is adjusted properly."
-"I view FLIR imagery at a very low intensity to make viewing lights through combiner lens possible."
-"If grayscale and infinity focus are done correctly, you can see external scene and symbology fine."
-"Catch symbology in peripheral vision."
-"I am left eye dominant."

h. During flight, does your vision sometimes unintentionally alternate between the two eyes?

Yes (21, 52.5%) No (19, 47.5%)



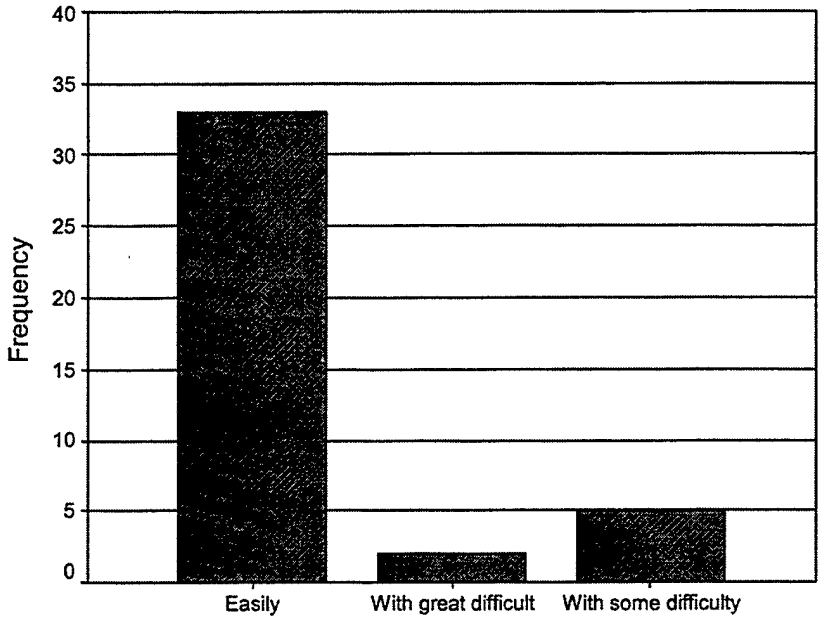
Vision unintentionally alternate between the two eyes

If "**Yes,**" comment:

-"Night dominance because of light sources."
-"By concentrating on my right eye, I can see the HMD."
-"Only noticeable during night flight around lighted areas."
-"Bright lights will make my left eye take over. I close my left eye to keep that from happening."
-"During times of high illumination."
-"At night fall or twilight or times when there is high ambient light or light sources."
-"Binocular rivalry."
-"When first flying night system."
-"Turning over powering light sources."
-"After a long flight."
-"During dusk, dawn, or when bright lights are present."
-"If HDU too bright."
-"Due to bright ground lights."
-"Unaided eye focus on light."
-"But this comes with experience."
-"Usually when I am becoming exhausted during NVS flight."
-"When something is brighter than the picture in the HDU."
-"It happens."
-"During long extended flights."
-"With bright lights."

i. To what degree can you purposely alternate between your two eyes?

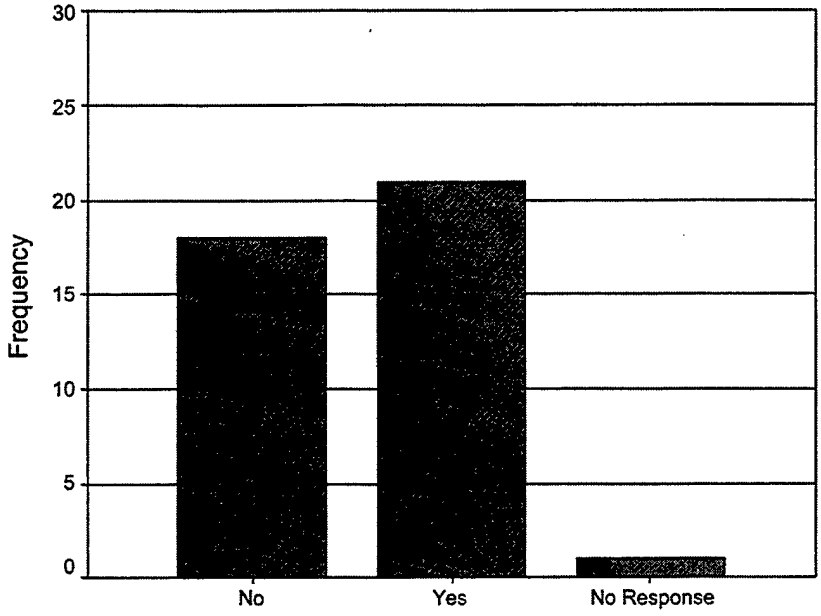
Easily (33, 82.5%) With **some** difficulty (5, 12.5%) With **great** difficulty (2, 5%)



Degree can purposely alternate between two eyes

Do you have any special methods to assist in switching?

Yes (21, 52.5%) No (18, 45%) No Response (1, 2.5%)



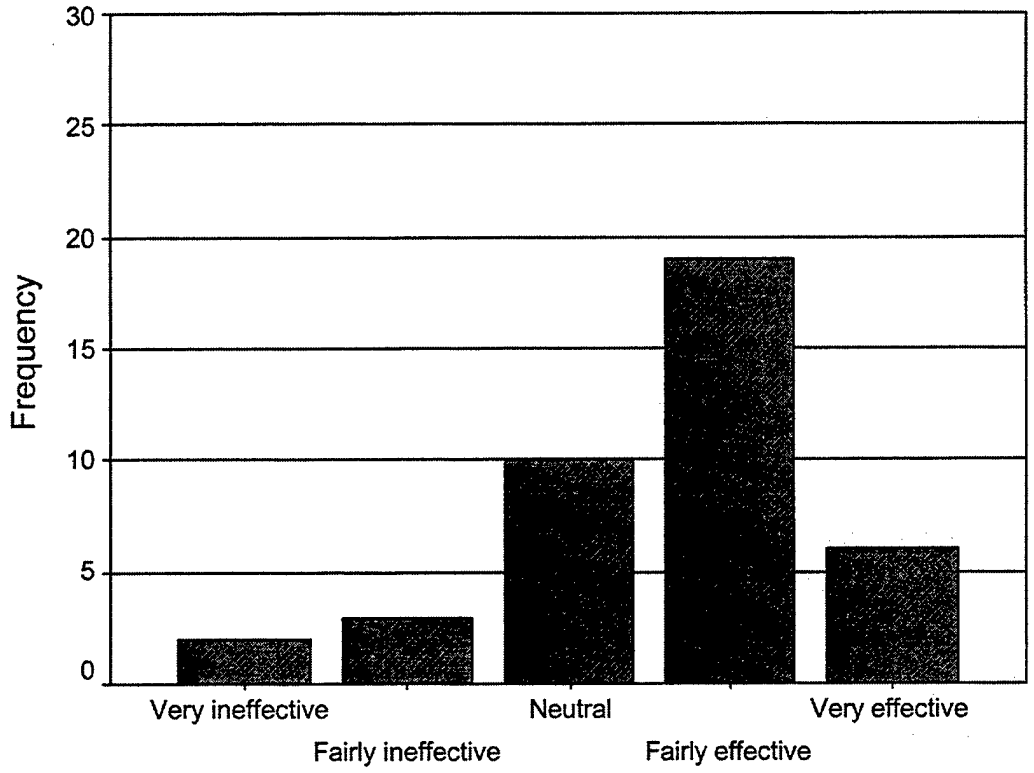
Special methods to assist in switching

If "**Yes**," comment:

-"Blink prior."
-"Squinting eye."
-"Close the eye you don't want to use."
-"Blink!"
-"It took a long time to learn how to do this easily."
-"Close the eye momentarily."
-"It is easier to accomplish if cockpit light environment is kept dim."
-"The ease of switching views comes with experience. I can now simultaneously view the picture with both eyes the majority of the time."
-"Close an eye if you have to."
-"Practice, and time."
-"Temporarily closing one eye."
-"Blinking."
-"Just do it."
-"Close one eye."
-"It is achieved with time and experience."
-"Close one eye."
-"If it has been awhile since I flew system I close one eye until the ability to alternate becomes easy again."
-"Very low intensity of image in combiner lens when possible allows me to switch which eye I use."
-"Keeping the HDU at a low brightness level, not overdriven so right eye dominance stays at a minimum."
-"Slightly close one of the eyes."
-"I look for external unaided cues with left eye and internal cues (instruments, MPDs, controls, etc.) with left eye."
-"Close the other eye."

5. How effective has the IHADSS system been in Operation Iraqi Freedom (circle one)?

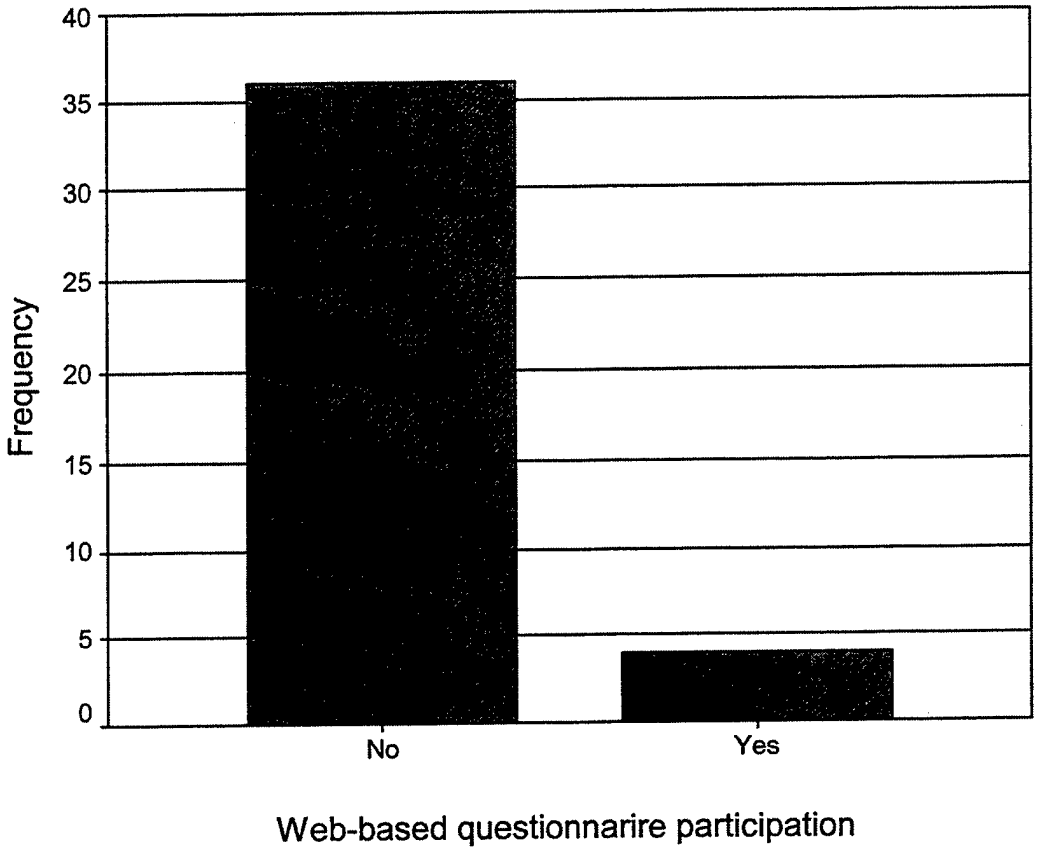
1	2	3	4	5
Very ineffective	Fairly ineffective	Neutral	Fairly effective	Very effective
(2, 5%)	(3, 7.5%)	(10, 25%)	(19, 47.5%)	(6, 15%)



IHADSS effectiveness in Operation Iraqi Freedom

6. In 2000, a web-based questionnaire similar to this one was conducted by USAARL, Fort Rucker. It was advertised in FlightFax and offered over the Internet. Did you participate?

Yes (4, 10%) No (36, 90%)



Appendix C.

Interview data.

Subject 1

Have you had any specific problems with using the IHADSS in this environment?

-Most significant problem I've seen/experienced is when I have night vision goggles mounted and I'm also using the HDU and even with the counter-weight the helmet's not adjusted for the additional weight so that tends to modify your sight picture. Aside from that though, very minimal problems. FLIR is aircraft dependent, for the most part it's very difficult, especially flying TADS FLIR to distinguish – especially out in the desert – between horizon and ground and other aircraft flying trail. Most nights you're mostly looking at green blurs. Light green blurs and dark green blurs. You can get it really well focused really well on the ground, but that doesn't mean that it's going to be [in focus] in decent flight. You can obviously mess with your level of gain to cut out the lights as much as you can, but not very high speed.

Have you had problems with maintaining the full FOV?

-No.

Have you had any problems with the combiner?

-Nope, I don't have to push it out any further. I flip it all the way back [and] it's normal.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

On missions that require me to look around during the day I won't always have the HDU on.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

There is a lag, but normally you're used to it. You know that there's going to be a lag so you're trained so that you don't turn your head real quick.

Is the IHADSS's 30 x 40 FOV sufficient?

-I've never had any problems with it. Not yet, it's good.

Do you under any situations rotate the IHADSS out of the way?

-When using night vision goggles.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-It would be interesting, but you get used to that weight on your right side. I'm fine with the monocular system.

What is the best feature of the IHADSS?

-I'd say it gives you a better lookout angel. Cockpit visibility is limited at night especially. It gives you that extended eye and allows us to defeat the structural impairments imposed by the aircraft.

What is the worst feature of the IHADSS?

-The fact that the FLIR is old. Gen (Generation) 1 FLIR is the worst part.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-I'd say maybe a universal visor that allows for proper movement of the HDU without inhibitions regardless of whether you have goggles out. Make it to where [the] combiner lens and the whole HDU can be moved freely without having to worry about jerking around your visor.

Is there any other issue you would like to raise about flying with the IHADSS?

-It definitely makes us unique.

Subject 2

Have you had any specific problems with using the IHADSS in this environment?

-No, it's actually kind of better in desert environments because of the hot and cold. It splits the difference from night to night. No, nothing specific in this environment.

*Have you noticed anything different with weather change?
-Yes, the last two days of rain. It has been pretty crappy.
Have you had problems with maintaining the full FOV?
-No, just the usual fitting problems in shifting of the helmet. After a certain amount of time you have to shift the helmet and re-adjust the IHADSS, but that's to be expected.
*Have you had any problems with the fit?
-I'm pretty comfortable with the fit. Any fit isn't going to be perfect for any extended period of time.
Have you had any problems with the combiner?
-No. No problems.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, for maintenance flights. Yes, generally for missions I'll use it for a sighting system.
*Do you find it more useful than other ways your doing it?
-Yes, just because of certain flights in different altitudes you start to loose horizons and stuff like that. It's easier to use symbology as opposed to trying to visually... I don't know.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-Yes, it's too slow. Just like you said, train for it.
Is the IHADSS's 30 x 40 FOV sufficient?
-No.
*What you think, just a ballpark guess to have something bigger?
-Probably add another 15 degrees both ways.
Do you under any situations rotate the IHADSS out of the way?
-Yes, I rotate out of the way as far as being on the ground and for ground taxiing because you don't get a good view when you are constantly shifting eyes to see the rotation of the aircraft and stuff. But in flight at night just close that eye.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-No, I like having one eye out.
What is the best feature of the IHADSS?
-Light weight.
What is the worst feature of the IHADSS?
-The maintenance issue. You have 4 different boxes, a bunch of problems that can come up with it. It's very different compared to $2,000 if you drop the goggles. But on this thing it takes about 4-5 [minutes] just to trouble shoot. What the real problem is - the maintainability.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-The acuity and the slew rate.
Is there any other issue you would like to raise about flying with the IHADSS?
-Without the symbology sometimes it would be pretty dangerous to fly.

Subject 3
Have you had any specific problems with using the IHADSS in this environment?
-No, it's adequate and sufficient.
Have you had problems with maintaining the full FOV?
-No sir.
Have you had any problems with the combiner?
-No sir.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes sir, just for symbology for flying or for sighting.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-Yes sir. By understanding it's capability.
Is the IHADSS's 30 x 40 FOV sufficient?
-No sir.
*How big would you like it, in degrees?
-Maybe 50x60 degrees.
Do you under any situations rotate the IHADSS out of the way?
-No.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I just like being able to have one unaided eye.
What is the best feature of the IHADSS?
-It's lightweight.
What is the worst feature of the IHADSS?
-The helmet itself, the wiring system. The IR harness is too fragile.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-I would upgrade the FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-No, sir.

Subject 4
Have you had any specific problems with using the IHADSS in this environment?
-Not me specifically, but using the IR [infrared] harnesses when it was really hot in the desert. I couldn't tell you how many got burnt out from the heat. For a while there, we were short helmets because of the IR harnesses.
*Was that in this particular Unit or was that across the battalion as a whole?
-Across the battalion and I think through that brigade as well, as far as Long Bow guys.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-I zero it in case I need to use it as a sight, but no - I prefer not to use it.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-Yes, by knowing it's slow. There's really nothing you can do.
Is the IHADSS's 30 x 40 FOV sufficient?
-No.
*What would you think would be a better size?
-Whatever they can give me depending on technology.
Do you under any situations rotate the IHADSS out of the way?
-If we have to pull to a hover and use the TADS system to look out and observe. It's a distraction if you're using TADS so I'll usually rotate out at that point. Also with ground taxiing.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Not sure, I think I'd have to see it. I prefer flying [with] goggles, but I don't know the monocular system has advantages. I do wish it were either/or. For me, I'm left eye dominant and when I'm flying system I really have to concentrate to see the system and sometimes I get a headache doing that. If I could put it on my left eye, for me, it would be easier.
What is the best feature of the IHADSS?
-It is light per say. The cords in itself drag it down quite a bit. Overall, helmet is light.
What is the worst feature of the IHADSS?
-If I had to pick one, I'd say the FLIR.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Start with the FLIR and work your way back. Upgrade the whole system. I despise the helmet, it's entirely too big.
Is there any other issue you would like to raise about flying with the IHADSS?
-No, that's it.

Subject 5
Have you had any specific problems with using the IHADSS in this environment?
-No problems there. However, it's harder to be associated with where you are over the ground. I think most of that comes from being familiar with the system as far as what things look like under the system as compared to during the day. Also, sometimes you can pick up movement, or you don't pick up movement in the system when you are at a hover or landing on terrain.
Have you had problems with maintaining the full FOV?
-Slightly, the biggest problem I have right now is I have the wrong size helmet because we are short on helmets. There is no padding in it, they took everything out so it would fit on. I won't be able to wear the NBC mask or a skullcap in there. It puts the HDU a little bit higher and over my eyes so I have to look up to see the whole FOV. Other than that, I can see the entire FOV.
*When you were training at Rucker, did you have the correct size helmet?
-Yes.
Have you had any problems with the combiner?
-Not really any problems, but I think during the day when you fly with it, it will change the color of some objects slightly. It's actually easier to see them with the other eye than turning the combiner on.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Almost always.
*Do you pretty much always use it, is that how you were trained or just preference?
-Most of it is preference, because I still have all of that symbology there. Especially in the front seat because the handles on the board will block part of your instruments so it's easier to get right off of the HDU and plus it has more information there that you can't get compared to the front seat. The only RALT (Radar Altimeter) they have is on display. The actual instruments are in the back seat.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-I think the pilot's night vision sensor is very adequate. The ANVS is good, but the TADS is only half that at 60 degrees per second, which I think is too slow. Just take your time, can't get in a rush.

Is the IHADSS's 30 x 40 FOV sufficient?
-I think it could be worked with. Bigger is always going to be better for us to be able to see, especially when everything becomes monocular vision so you have to use cues. Bigger would definitely be better to help my peripheral and to keep your situation awareness as far as what's around you as opposed to try and do a scanning. It makes it harder - because of the slew rate in the front seat - to keep proper scanning. If you turn your head too fast, the system tries to catch up and the sight just gets blurry.
Do you under any situations rotate the IHADSS out of the way?
-Not too often while I'm flying. When we get on the ground and I'm working inside the cockpit, I like to get it out of my face. It makes it easier to see things inside especially like on the EDU [Electronic Display Unit) on the right hand side of the cockpit when I have to type things in. You have to look over across the other side and look at your kneeboard at what grids you have to type in. That kind of information, it's easier when you have both eyes for when you have to fly with the instruments.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I think I like the monocular better. It feels a little weird to have one eye dark-adapted and one is not, but you can pick up things not just inside the cockpit but also on well-lit nights and things outside, and maybe other aircrafts. Whereas when you have a binocular system you can't see lights.
What is the best feature of the IHADSS?
-I think the best feature is the symbology. It gives you a lot of information, especially the velocity vector and acceleration cues. It kind of gives you a clue as to what the aircraft is going to do.
What is the worst feature of the IHADSS?
-Probably the worst is the fact that it's part of the airframe. Because if it breaks, than the airframe is broke and you can't fly it. Whereas say with goggles, if it breaks you take them off and grab a different pair and go fly. Maintenance is the bigger issue but on the same hand I'm not sure you can get a sizeable FLIR system to fit on a helmet, it would be too heavy and break everyone's necks. So it's kind of a toss up to what you want. The other thing would be if it does break, or if the airframe electrical system breaks, you're blind. Where as a goggle system is self-contained, self-operated.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Improve the quality of the FLIR and add a night vision capability like the ANVIS 6; the light intensifier system.
Is there any other issue you would like to raise about flying with the IHADSS?
-I think the only issue I would run into is kind of the differences is the fact that the sensor is in front of you and your head is a different portion, so you get the parallel effects when you look to the left or to the right. From the pilots station it's not as dramatic in the front seat and copilot/gunner station. But also, sometimes if you tilt your head to the left or the right the sensor doesn't move that way so it makes it a little easier to get disorientated. And the airframe itself is not so noticeable at night because the sensor is on the front so you can see forward and down. But during the daytime you can't see down, because the airframe the way it's built, it's just too big in that respect.

Subject 6

Have you had any specific problems with using the IHADSS in this environment?

-Not specific to the environment.

Have you had problems with maintaining the full FOV?

-Always. I loose the torque and usually the lower right portion of the picture. It don't matter what kind of configuration you try, you can't seem to get it.

Have you had any problems with the combiner?

-No.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-Yes, always. It's the way I was trained and then I became more comfortable with it, that way I don't have to take my eyes inside the cockpit to find the radar, altitude, or any of the symbology I need.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-The TADS (Target Acquisition Designation Sight) is way too slow, the PNVS is fast enough. Front seat, just slow my head down and wait for it to catch up until I can do anything.

Is the IHADSS's 30 x 40 FOV sufficient?

-No. [Not] on a 1x1 inch little screen in front of my eye. Unless they make that actually larger, I can't go more than double that. It's kind of hard to say without seeing it. But if they actually made the combiner lens bigger or get me a visor or something then yeah, I would like to really see chunk. 120 degrees left or right.

Do you under any situations rotate the IHADSS out of the way?

-If I want to ever use my visor. When I put my visor down on the ground for refuel then I move it out of the way. Flying instruments I move it out of the way.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-Yeah I think that would be cool, two eyes instead of one. If they're both FLIR I think that might be a bad thing. But if it was an I^2 (Image Intensification) they combined both pictures FLIR and NVG (Night Vision Goggles) I think it would be great. That's actually goggles and enhanced goggles in the picture.

What is the best feature of the IHADSS?

-Symbology.

What is the worst feature of the IHADSS?

-Degradation of picture when you maneuver the aircraft. I'm going to make a right hand turn so the whole damn screen is going to go blank. It is for the birds. That S&*T is dangerous. And, the fact that I can't tell the difference between the garden hose and a tree at 500 meters away from the farm. Being able to discern objects at a distance.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-Make it I^2 so that it's both images so I can see rights. And do something about the fact that the actual scene content so I can discern objects.

Is there any other issue you would like to raise about flying with the IHADSS?

-No that's it.

Subject 7

Have you had any specific problems with using the IHADSS in this environment?

-No, none specific.

Have you had problems with maintaining the full FOV?
-No, I know how to adjust it if I need to. The worst part about it is the actual FLIR itself.
Have you had any problems with the combiner?
-Yes, the combiner. Whenever you're flying around it slips down (inaudible), it might get bent up. It's nothing having a combiner liner then an actual HDU in the aircraft itself with so many people using it, it kind of gets beat up a little bit.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-I do out here, but I don't use it usually for referencing and heading and stuff. More for the line of sight in case in engage a target. Just for tactical.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-The PNVS (Pilot Night Vision Sensor) no. TADS, yes. When I was flying front seat and constantly moving head scan or not doing the whip of your neck trying to fall behind you. It's about the only thing you can do.
Is the IHADSS's 30 x 40 FOV sufficient?
-I guess it's about as best as you can get right now. I they can make a better one that'd be nice.
Do you under any situations rotate the IHADSS out of the way?
- If I do it it's ground taxi and I'll turn the searchlights on. If not I'll just go strictly with the light system and the symbology. Just doing unaided fight line, instruments or ground taxi with a white light I won't use it.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Yes, I would like to try it out.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-Probably the picture stuff you get old FLIR style in the first generation FLIR. And maybe one other thing it would nicer if you had a more user friendly, adjustable to mold to your face.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Being able to adjust your focus and on your display desk panel having a place where you can keep the pipe easy, not mess with it, instead of having to reach back. Or having to change your sizing center hanger your eye focus. Instead, maybe having a knob and screws, just having a knob where you can adjust it because every one is different
Is there any other issue you would like to raise about flying with the IHADSS?
-I'm surprised that they don't have more accidents in the Apache. Just the fact that they use such an old system.

Subject 8
Have you had any specific problems with using the IHADSS in this environment?
-No, sir.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Rarely, only during gunnery. I've never felt comfortable with wearing it. I think if I did wear it, I'd get used to it, but I never have.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-(Did not ask subject this question)
Is the IHADSS's 30 x 40 FOV sufficient?
-I think it's sufficient but I think it'd be nice if it could be a little larger. A 40x60.
Do you under any situations rotate the IHADSS out of the way?
-I'm one of those guys who take it off whenever I can in a FARP (Forward Area Refueling and Rearming Point). So a night of FARP I rotate it out. I think a big part of that is it takes time to learn how to adjust your gray scale correctly and your focus. If you mess up on those you can end up getting headaches and strain your eyes. I would do that, and I got in the habit of when I didn't have to use it, to rotate it off my head. Now I think I still do it in a FARP out of habit, and it's more comfortable for me looking around my cockpit without the HDU (Helmet Display Unit). The only time if it's ever an issue in my mind is, [the] best thing would be right console at night. Specifically the SINGARS radio, HDU makes it rather difficult and takes some time getting used to. Sometimes it's easier moving it out of the way.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-It would depend on how free you are to scan the rest of your cockpit. I'm big on scanning my instruments.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-I think I'd have to say, reliability of the picture. Being a maintenance guy, there are multiple reasons to have issues with your picture.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Sizing and centering, I don't know why it's adjustable. It's supposed to be sizing and centering the same for every person, so why do we have the ability to change it. Why wasn't it not engineered or designed so that it was always at the correct size?
*What is the number of things from the fact that it's GEN 1 clear through the boxes in the environment?
-I think it takes a while to learn what's normal...what isn't bad...what's common. I've seen a lot of times guys coming over from other aircrafts they have a lot of goggle time they are always complaining about their picture. When you look at it and it's perfectly normal, they fly with less than we have learned to be accustomed to.
Is there any other issue you would like to raise about flying with the IHADSS?
-I wish there was a way to do away with the cable from the HDU entirely. It catches on things, I'm always messing with the clips, always trying to get it right.

Subject 9
Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-Nope.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-HDU, yes, the FLIR, no. I use it for symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-PNVS, it's fine. I rarely if ever use the TADS any more but when I do, it's too slow. I compensate by experience, just knowing that it's going to be slower and that it's going to move back and forth once I stop moving my head until it actually doesn't.
Is the IHADSS's 30 x 40 FOV sufficient?
-I'd like to see it bigger but I'm able to do what I have to do with what I got. I'd like to see full 90 degrees, that'd be nice. 45 Degrees to either side would be really nice, but I think at that point, the symbology or the FLIR image would get so small and unusable, especially closer in.
Do you under any situations rotate the IHADSS out of the way?
-Not very often I usually take it off [like] subject number 8 said in the FARP (Forward Area Refueling and Rearming Point). But the way I adjust mine, I can look underneath it for anything in the cockpit.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I would try it I would be a test bed for that. But like (subject) number 8 said, being able to monitor your cockpit instruments becomes increasingly difficult when you have both eyes occupied with the combiner lenses.
What is the best feature of the IHADSS?
-The symbology.
What is the worst feature of the IHADSS?
-The delicate nature of the SSU's and the SEU (Sight Electronics Unit). The fact that it's too easily interrupted, and will too easily freeze your picture where it's at if there is the slightest glitch in the system. The IR (Infrared) box in the cockpit isn't big enough, if you have to move your head around to look at something on your right console or if you have to lean forward to see something back behind you you'll get that IHADSS to freeze where it's at. That tends to make things... check six doesn't work.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-I'd add a couple of things to the symbology itself, things that I can't imagine that would be too hard to add that would be a great help. Indicators of what radio I'm on, at least at the very minimum the guy at the back seat is usually on the radio as it is. Something [at] the bottom left, just above the {inaudible], indicating 1,2 or 3. Making the adapt cord more easily accessible or something else, making the buttons easier to use. That's about it.
Is there any other issue you would like to raise about flying with the IHADSS?
-No.

Subject 10
Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-Not that a slew type can effect.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, but no symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-I would say the TADS at times are too slow, for quick hand movements. During engagement, causes dual seat pressure primarily on the front seat. I flew a lot more actually with goggles more than I flew with TADS. But when I was actually on the control, I prefer using TADS than goggles because of symbology and the FLIR imagery. NVG's (Night Vision Goggles) were limited at times for ambient light in this environment, so the TADS slew rate would be slower at times so I'd have to make adjustments for that, in turn focus on that unaided imagery to catch on by aided sight, basically train yourself.

Is the IHADSS's 30 x 40 FOV sufficient?

-No, 40x60 would be preferable.

Do you under any situations rotate the IHADSS out of the way?

-In the front seat yes, to do engagements. I have attempted to try and do gunnery and helmet sight and try and do it off of my HDU for sighting apt but found the binocular too much where I wasn't able to adapt effectively and would start out engaging by picking up with the system and the HDU and then transition out of its way. At times of engagements I would rotate it out of the way of the head mount display, at times when flying with NVG's would move it out of the way to use the NVG's for obstacle points assistance in a flight situation.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-I'd like to try it but I don't think I'd be comfortable flying with it. Other than training but I don't think I'd want to take it any further than that right now because I like to have the unaided assistance when I am in training.

What is the best feature of the IHADSS?

-The symbology.

What is the worst feature of the IHADSS?

- The inability of the FLIR picture to adapt reliably to the environment. You go from an area of high contrast in an airfield, with a lot of objects that typically have a lot of concrete buildings that are able to absorb infrared heat throughout the day. At night, they distribute heat to the low areas of contrast over trees or desert sands or where ever they are flying at. You have to continually work at adjusting your picture, to make it richly seen enough to get a clear picture to use FLIR interpretation. So you are always working with the brightness contrast levels of FLIR to get it better. You can always make your user adjustments better than what the system can do for you.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

- Make it more effective to fly with. Reduction in the number of cables. You're attached on both sides, with the system I find the one cable with the other is interfering with my ability to move my [inaudible]. It is an uncomfortable situation where it is kinking. If you could integrate the system to where it was helmet mounted to the same helmet using one cable where you have three [it would then] come out one side, you can adjust it and put control on your situation better.

Is there any other issue you would like to raise about flying with the IHADSS?

-Nothing comes to mind right now.

Subject 11

Have you had any specific problems with using the IHADSS in this environment?

-I have found as a primary trainer out here it's not so much my problem, but it's a problem with those less experienced with the environment out here. Poor performance on magnification of AC (aircraft) cup(.?); It affects lack of depth perception... can be a problem. Identification of

what they are asking us to do, the system doesn't have the capabilities to allow for us to be able to determine exactly what we are looking at in the degree that is necessary. Whether it's friend or foe.

Have you had problems with maintaining the full FOV?

-No, I have not had any problems maintaining my FOV. Again it's based on principle of adjusting and adapting to the system. We don't have a competent system that we are able to train individuals to show them and let them know the full accurate view.

Have you had any problems with the combiner?

-In this environment it's going to relate more to the total fact of when we are putting the body armor and the air safe vest on. If you don't get your body armor fitted correctly it has a tendency to creep up. Some guys are having a problem to where it's knocking off their HDU, it rises up and it's difficult to see items especially on the right console panel to see in the back to get to your APU (Aircraft Power Unit) and ADF (unidentified).

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-Yes, sir. Basically I get rid of the FLIR image over lay, and just use the symbology in a HUD (Heads-Up Display) fashion.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-The slew rate and PNVS if fine, the TADS you know is slow. By training yourself to slow down your head movements so that you don't get out of sequence between video image and definition.

Is the IHADSS's 30 x 40 FOV sufficient?

-No, we would all like to have more. Then again compensate by increasing the scan, we move. our heads to make it work. Basically we adjust them a lot in the way you fly because of the limitations of the system.

Do you under any situations rotate the IHADSS out of the way?

-Mainly I just rotate it out when I'm doing ground task and ground (inaudible).

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-It would be nice to have both [monocular and binocular] available to switch in between the two.

What is the best feature of the IHADSS?

-For me, the fact that it is over one eye right now, having adapted to being used to using that one unaided eye works out well, of course having the symbology presented in the display helps us out a lot.

What is the worst feature of the IHADSS?

-The helmet. The fitting procedure doesn't allow for an accustomed fit. The chin strap could be improved neck strap is not...stuff gets burnt up too much, you can't get it pulled tight enough. You get problems with the IR (Infrared) harness. In this environment I've worn out the headband until it's completely gone. If I ever have hot spot problems it's usually with the ear cup.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-I would change one thing on it, grade up to a dual helmet.

Is there any other issue you would like to raise about flying with the IHADSS?

-(inaudible)

Subject 12

Have you had any specific problems with using the IHADSS in this environment?

-The only thing specific is, it took me a while to work out is the size of the image, in corners I was loosing parts of my symbology.

Have you had problems with maintaining the full FOV?

-With the bottom corners.

Have you had any problems with the combiner?

-No.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-I do, just about 100% of the time when I use flight symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-Slow head down for TADS (Target Acquisition Designation Sight).

Is the IHADSS's 30 x 40 FOV sufficient?

-It's sufficient.

Do you under any situations rotate the IHADSS out of the way?

-For comfort reasons no, but of course for IMC. If I had to I would.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-I'd give it a shot. My concern would be that under the monocular system I should have a free eye that's obscured from my cockpit. With the binocular system, I would be concerned about not being able to seeing certain cues in the cockpit.

What is the best feature of the IHADSS?

-Symbology.

What is the worst feature of the IHADSS?

-Controls for display adjustment panel is too low.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-Upgrade the FLIR.

Is there any other issue you would like to raise about flying with the IHADSS?

-I^2 (Image Intensification).

Subject 13

Have you had any specific problems with using the IHADSS in this environment?

-No.

Have you had problems with maintaining the full FOV?

-It takes experience to adjust helmet properly and taking the time to adjust HDU.

Have you had any problems with the combiner?

-No.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-Primarily use it for Symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-PNVS (Pilot Night Vision Sensor) is adequate TADS (Target Acquisition Designation Sight) is too slow for FLIR (Forward Looking Infrared). But you get used to it. TADS for flying could be the 120 degrees just like the PNVS would be useful.

Is the IHADSS's 30 x 40 FOV sufficient?

-What I'm used to. Gives me the opportunity to still look underneath the lamps if I had to.

Do you under any situations rotate the IHADSS out of the way?
-Me personally no. At anytime I can look under it if I had to.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Yes if we get FLIR system. Need an unaided eye to use FLIR.
What is the best feature of the IHADSS?
-Better than cobra for sighting and engaging target.
What is the worst feature of the IHADSS?
-No. I haven't had any major problems.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Next generation of FLIR, especially in urban environments. We cannot support the infantry in close quarters, stuff that they require us to do now at night with ease that we could if we had a better FLIR system.
Is there any other issue you would like to raise about flying with the IHADSS?
- IHADSS glasses useless without major reworking. Contacts are more of adapting, just getting used to it.

Subject 14
Have you had any specific problems with using the IHADSS in this environment?
-Contrast.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Not usually. Use the ORT (Optical Relay Tube).
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-TADS too slow. PNVS is ok. To compensate I turn my head slower.
Is the IHADSS's 30 x 40 FOV sufficient?
-No basis for comparison. Bigger is always better.
Do you under any situations rotate the IHADSS out of the way?
-Instruments on the ground refueling, on ground FARP. Look at a map. only really busy.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I would like to try it. But I kind of like having one eye available.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-Picture too grainy. Old generation FLIR.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-FLIR upgrade
Is there any other issue you would like to raise about flying with the IHADSS?
-No. Look into I^2. Combine FLIR with goggles.

Subject 15

Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-Yes, I learned to adjust the DAP (Display Adjust Panel).
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it?
If so, how?
-Slow down head movement.
Is the IHADSS's 30 x 40 FOV sufficient?
-Yes.
Do you under any situations rotate the IHADSS out of the way?
-Never.
If weight and CG were not an issue, would you want a binocular HMD design?
Why or why not?
-No.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-DAP needs to moved.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-I would improve the FLIR technology from generation 1 up to 3 or 4.

Subject 16

Have you had any specific problems with using the IHADSS in this environment?
-No major ones, just the usual. The terrain and everything else is kind of flat, trying to associate and break up the different background and features.
Have you had problems with maintaining the full FOV?
-I haven't had any problems, just making sure I get the good size and centering before I take off.
Have you had any problems with the combiner?
-The only problems that I have, is sometimes the spring gets a little worn and loose.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Sometimes, any time I am doing maintenance flights I want to have the symbology there to reference so I can maintain symbology and look outside at the same time and check the ground reference.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it?
If so, how?
-The PNVS no, I think it's about right. TADS, it is too slow but if you train yourself you can learn to slow your head down so it isn't a big problem. Maybe a little faster.
Is the IHADSS's 30 x 40 FOV sufficient?
-With the current combiner with everything else, yes.

Do you under any situations rotate the IHADSS out of the way?
-No real reason why I have to move it out of the way.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Yes, I might try that.
What is the best feature of the IHADSS?
-Overall, I think it's a really good system.
What is the worst feature of the IHADSS?
-Sometimes you can get a little disoriented, and in some case you don't get the full outside effect. There is no roll axis in the clear TADS.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Add a FLIR system.
Is there any other issue you would like to raise about flying with the IHADSS?
-Keep improving things better.

Subject 17
Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-The only problem I have, is the helmet doesn't fit. It's too loose.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Very rarely, for symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-TADS is too slow, PNVS is fine. I compensate through experience, just knowing.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think it could be larger.
Do you under any situations rotate the IHADSS out of the way?
-Only when I use NVG's (Night Vision Goggles).
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Yes, I would like to see it in the system they have the FLIR (Forward Looking Infrared). The only problem with that is you'd have to flip it up a lot more to do things inside the aircraft.
What is the best feature of the IHADSS?
-I like the symbology.
What is the worst feature of the IHADSS?
-I guess the monocular.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Upgrade the quality of the FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-No.

Subject 18

Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-I do, not so much the system as far as its FLIR capability, but just the symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-PNVS is good, as far as the TADS, it can be at times. I'm used to a good slow slew rate now where I don't have any problems.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think so.
Do you under any situations rotate the IHADSS out of the way?
-Yes sir, quite often actually in the front seat. A lot of times when I go up in goggles and if I'm working on tasks inside the cockpit.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I'd try it, but my concern would be the ease of moving it aside to go with goggles.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-I think it's the FLIR capability.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Improve the FLIR capability.
Is there any other issue you would like to raise about flying with the IHADSS?
-None.

Subject 19

Have you had any specific problems with using the IHADSS in this environment?
-In this environment, the system has been more effective than other environments for me. FLIR cues are more defined in the desert, during limited visibility, the FLIR can see through a lot of the sand and dust.
Have you had problems with maintaining the full FOV?
-None.
Have you had any problems with the combiner?
-The biggest problem with the combiner lenses is there is a small spring on the back of the lenses that keep tension on it. When it becomes weak or bent, the combiner lens just pops through.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes and no. Depends on the mission. Any day combat mission I'll use it.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[The PNVS] I think is adequate. The TADS is a lot slower, but I've developed techniques to overcome that just by slower head movements to reduce disorientation effects.

Is the IHADSS's 30 x 40 FOV sufficient?
-It's fine for me.
Do you under any situations rotate the IHADSS out of the way?
-Cross over day/night or dawn/dusk. Only other time I'd say is, flying over a city or town where there is lot of bright lights.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I would say probably not, because I use my left eye. I like having the ability to alternate between visions. I would love to see a combine FLIR goggle picture, but I don't know if dual lenses is the right answer. If they could get it into one, that would be great.
What is the best feature of the IHADSS?
-The fact that it is not attached to the aircraft, then it can follow through the infrared.
What is the worst feature of the IHADSS?
-The size, in this aircraft in the right situations you can pull the circuit breaker with the visor.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Make it a little less bulky.
Is there any other issue you would like to raise about flying with the IHADSS?
-That's it.

Subject 20
Have you had any specific problems with using the IHADSS in this environment?
-Not related to the environment, only the equipment with some generic problems. Overall it works O.K.
Have you had problems with maintaining the full FOV?
-When you turn your head, at times it will cut off one side or the other depending on which side you turn your head to. Some of that is helmet fit, but it seems when you get the helmet on your head tight enough to keep that from happening, than you're your helmet is uncomfortable all the time instead of some of the time.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Not if I can help it, if you're going to shoot something you got to see it or expect to shoot something. I will fly with it attached but not in front of my eye unless I have to use the symbology. Or when shooting or when I have to have the engine page up and the flight page, if I need a third set of flight symbology for whatever reason then I'll use it for that.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[The PNVS] I don't think so, it's just about right. TADS are way too slow. The transition between the two seats that's the biggest thing, it's an adjustment. [To compensate] I don't know how I do it, I just do it.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think it would be easier if you had more, but you learn to work with what you have.
Do you under any situations rotate the IHADSS out of the way?
-I guess if you get conditioned or used to looking through HDU to fly. I use my other eye primarily when I'm in close proximity to the ground like going into a FARP (Forward Area Refueling And Rearming Point) or something. I feel I need to use my other eye or both eyes to look at something close up, other than instruments but looking at a map or kneeboard.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Not with having seen that system, it's a hard one to answer because you're taking away the real world image. Your unaided eye has a definite purpose, for me, it's useful when you're coming in close. It's tight maneuvering and you got to make small control movements close to the ground. Or also at night for confirmation, it's a double check against your systems.
What is the best feature of the IHADSS?
-I guess it would probably be the symbology.
What is the worst feature of the IHADSS?
-Quality of the video.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Improve the video. I would like to have a video that shows me more detail and more texture.
Is there any other issue you would like to raise about flying with the IHADSS?
-The Longbow, the tint makes you uncomfortable like you are partially blind in one eye. It's like looking through a pair of sunglasses with one eye and not the other.

Subject 21
Have you had any specific problems with using the IHADSS in this environment?
-None. Better picture due to the dryness in the air.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, I use the symbology at all times.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-Adequate on the PNVS. [TADS] should be the same as the PNVS. When it's not the same, I let it catch up to me or turn my head slower.
Is the IHADSS's 30 x 40 FOV sufficient?
-More is better, but sufficient for out here.
Do you under any situations rotate the IHADSS out of the way?
-If I get a hotspot or with eyestrain, I rotate it out of the way. Other than that, I've have learned to have the symbology there at all times.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-If it had a better picture. Not with the current system, no. I'd give it a shot with the current system, I just feel you have to have that other eye.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-The picture, in the front seat TADS due to the FLIRsystem of the TADS.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-The infinity focus.
Is there any other issue you would like to raise about flying with the IHADSS?
-Priority for our aircraft, is getting a better picture of FLIR GEN (generation) 2, but the TADS are unusable.

Subject 22

Have you had any specific problems with using the IHADSS in this environment?

-Not really, it is harder due to the fact you don't have enough visual cues to find a plane of reference, i.e., houses and trees.

Have you had problems with maintaining the full FOV?

-No, not really. I do wish it is bigger, though.

Have you had any problems with the combiner?

-The lenses itself, no. Maybe smaller and lighter.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-Yes I do, for symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-[PNVS] I think is adequate, the TADS is not adequate, it's extremely slow. [I compensate on] depends on the type of terrain I'm flying. The more scanning you have to do, the more slowing you are going to have to make on the TADS.

Is the IHADSS's 30 x 40 FOV sufficient?

-I believe bigger will be better, but it has to do with how much information you can process when you are looking through the system. One of the ways to solve the problem in this case, is to have a faster slew rate. But you have to work with what you have.

Do you under any situations rotate the IHADSS out of the way?

-Certain maneuvers when you are doing training just to make sure you are accurate. Or the FARP (Forward Area Refueling And Rearming Point) on the ground to relieve stress, and if I'm doing instruments.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-I'll give everything a shot at least once.

What is the best feature of the IHADSS?

-Best feature is the ability to focus outside the aircraft while flying and have a reference symbology at the same time.

What is the worst feature of the IHADSS?

- The worst I'd have to say has to be to include the picture and the slew rate of the TADS. Why are we flying around with late 60's technology, I have no idea.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

- It would have to be the picture and the slew rate.

Is there any other issue you would like to raise about flying with the IHADSS?

-The TADS on the attack helicopter are old.

Subject 23

Have you had any specific problems with using the IHADSS in this environment?

-No.

Have you had problems with maintaining the full FOV?

-Yes, equipment-wise, the DAP (Display Adjust Panel) is supposed to maintain the size and centering and it doesn't. Have difficulty adjusting it to size/centering for best FOV. The HDU is supposed to set on the cheek that gets your best FOV, but with the vibration of the aircraft causing a lot of irritation most pilots and myself have said the HDU is slightly off the cheek, which gives you a slightly less FOV.

Have you had any problems with the combiner?
-Yes, how it hangs with the cable while worn with the body armor, especially looking to the right. I've had a lot of problems to make several adjustments to look to the right without it catching. A lot of times the little nut that holds the combiner in place has gotten weak, the spring gets loose. You loose your FOV. I notice during night flights, the weight of the cables and equipment puts a lot of stress on your head and causes fatigue.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes I do, generally for off-axis viewing, cross-country flight and at low levels. Or if I'm doing all VACS, it's looking out the sides of the aircraft for RECON. But it's definitely in my eye for information.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[PNVS] Yes, TADS was never designed for flying. I've been in dual seat for a long time, I still feel it's totally inadequate for flying. We've trained the pilots to compensate for the lack of speed. But in a critical situation where you need to move you head very quickly, it becomes very dangerous. Main way of training people is to slow their head down.
Is the IHADSS's 30 x 40 FOV sufficient?
-No, I think it needs to be a lot wider. There's not enough information given to compensate by a lot of head movement.
Do you under any situations rotate the IHADSS out of the way?
-If I'm just flying straight level cross-country during the maintenance test flights, and maybe at night if there is a bright moon.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-If there was a better FLIR, I'd be willing to try it. But because we have to compensate for the lack of resolution, better visual acuity, we have to have an unaided eye.
What is the best feature of the IHADSS?
-It's being able to fly without one eye. That way you can look inside the cockpit. Where the one unaided eye has saved my life because I could not pick up something in the FLIR.
What is the worst feature of the IHADSS?
-Visual acuity and resolution.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Visual acuity.
Is there any other issue you would like to raise about flying with the IHADSS?
-It's not a bad system, needs improvement. The weight needs to be lighter, I can't stress enough the visual acuity and the focus needs to be improved greatly so I don't feel like I'm flying blind. FLIR needs improvement.

Subject 24
Have you had any specific problems with using the IHADSS in this environment?
-Not specifically with the IHADSS. The FLIR, lack of terrain features has been more difficult in this environment.
Have you had problems with maintaining the full FOV?
-It is harder to get the full picture when you are doing adjustments; it's probably basically due to the helmet fit.

Have you had any problems with the combiner?
-None.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, all the time for symbology. Except when I'm flying NVG's.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-PNVS (Pilot Night Vision Sensor) is fine, TADS are too slow. [I compensate] just by moving my head slower.
Is the IHADSS's 30 x 40 FOV sufficient?
-We've learned to deal with it because that's what we have obviously. If we had a larger FOV then we wouldn't have to move our head quite as much.
Do you under any situations rotate the IHADSS out of the way?
-No, I always fly with the systems.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-It would be worth a try.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-The visual acuity and the slew rate of the TADS.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Better visual acuity, better picture.
Is there any other issue you would like to raise about flying with the IHADSS?
-No.

Subject 25
Have you had any specific problems with using the IHADSS in this environment?
-No.
Have you had problems with maintaining the full FOV?
-Yes, the size and centering. Also turning my head, at times the cord will pull on it or it will get in the way to where it moves just enough to where I loose some of the FOV.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes for the most part, just for the symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-The PNVS is sufficient, but the TADS are too slow. [I compensate] by slowing head movement down.
Is the IHADSS's 30 x 40 FOV sufficient?
-An increased FOV would be better. But that's all I've known.
Do you under any situations rotate the IHADSS out of the way?
-Yes sometimes during the day to see proficient on scanning my instruments. When I'm wearing goggles I rotate it out and when I have some discomfort.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-No, I like the fact that you can look unaided with one eye.

What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-Quality of the picture.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Better picture.
Is there any other issue you would like to raise about flying with the IHADSS?
-Make it lighter in weight.

Subject 26
Have you had any specific problems with using the IHADSS in this environment?
-Nothing specific to the desert environment.
Have you had problems with maintaining the full FOV?
-Almost always throughout my career I've lost some of the symbology. You have to do constant helmet adjustment. Through experience I've learned to adjust, but it's a constant hassle and constant work and effort to keep all of the symbology.
Have you had any problems with the combiner?
-In these conditions it's constantly dusty and dirty. I've noticed some of them are starting to get scratched, and the rubber seal around them are constantly coming off.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-All the time, for the symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-The PNVS is fine. I've switched so easily between aided and unaided eyes I don't notice the slower movement of the TADS.
Is the IHADSS's 30 x 40 FOV sufficient?
-The way I use it, yes. The younger guys, probably no. I look under and around it.
Do you under any situations rotate the IHADSS out of the way?
-Just about never.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I have no desire to do that whatsoever. I think it would lead to a lot more special disorientation. Other than the desert, I have never been to a place where there isn't enough ambient light. You don't get a lot of ambient light and other cues from the unaided eye. You would lose all of that if you went to a binocular system.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-Visual acuity. I think it's criminal that we're still flying a system that's 30 years old.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Upgrade FLIR!
Is there any other issue you would like to raise about flying with the IHADSS?
-None.

Subject 27

Have you had any specific problems with using the IHADSS in this environment?

-Lack of resolution. A flat, featureless environment makes it extremely difficult to determine terrain changes and altitudes even from 100 feet.

Have you had problems with maintaining the full FOV?

-It's a continual adjustment with the helmet, I constantly have to change the HDU's position or the helmet's position. I can achieve a full FOV, it's just maintaining it.

Have you had any problems with the combiner?

-Rubber grommet that goes around the outside is constantly gone. We have a lot of problems with friction adjustment knobs coming apart as we are flying. I've had a couple fall off, where I loose the ability to keep the HDU position while it was falling. I can make adjustments.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-All the time, for symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-PNVS (Pilot Night Vision Sensor) is fine. TADS are ridiculously slow, I compensate through experience. With slow head movements and knowing the system I can make adjustments.

Is the IHADSS's 30 x 40 FOV sufficient?

-Yes I do.

Do you under any situations rotate the IHADSS out of the way?

-The only time is occasionally the right seat contrast adjustments to the DAP (Display Adjust Panel) don't allow you to properly optimize the gray scale in the hours of dust/dawn.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-I use my eyes independently, and I'd be apprehensive. If it was a solid piece rather than a binocular, two-tubed type of piece may present an awful lot of problems.

What is the best feature of the IHADSS?

-Symbology.

What is the worst feature of the IHADSS?

-Acuity.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-Upgrade the FLIR.

Is there any other issue you would like to raise about flying with the IHADSS?

No.

Subject 28

Have you had any specific problems with using the IHADSS in this environment?

-None.

Have you had problems with maintaining the full FOV?

-None.

Have you had any problems with the combiner?

-None.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-All flights, for the symbology.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-[PNVS (Pilot Night Vision Sensor) is] adequate, [the TADS] aren't. I move my head slower.

Is the IHADSS's 30 x 40 FOV sufficient?
-It could be a little bigger. For me, it's sufficient. You could increase it by a little bit, maybe 50x70.
Do you under any situations rotate the IHADSS out of the way?
-Instruments and goggles.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-No, I like the unaided eye.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-The reliability. We are still using 1974 technology when we have the capability of going to 2000 technology. [Also] it's the display unit, the DAP (Display Adjust Panel), DEU (Display Electronic Unit) and the SSU (Sight Sensing Unit).
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-GEN (generation) 3 FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-No.

Subject 29
Have you had any specific problems with using the IHADSS in this environment?
-Nothing specific.
Have you had problems with maintaining the full FOV?
-If you wear the body armor and NBC gear. Where the wires come up when you look right, I've had my helmet come off a couple of times.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes I do, pretty much all the time. Symbology reference.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[PNVS] is adequate, TADS is adequate.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think so.
Do you under any situations rotate the IHADSS out of the way?
-At night when I'm ground taxiing.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-No, I like the unaided eye.
What is the best feature of the IHADSS?
-Flying FLIR.
What is the worst feature of the IHADSS?
-The helmet fitting itself.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Get a new FLIR system immediately.
Is there any other issue you would like to raise about flying with the IHADSS?
-The helmet fitting and upgrade the system.

Subject 30

Have you had any specific problems with using the IHADSS in this environment?

-The only one that I've really had is having to override bore sight.

Have you had problems with maintaining the full FOV?

-For the most part, no. Mainly helmet fitting.

Have you had any problems with the combiner?

-Sometimes with the fitting of my helmet in a different aircraft. It doesn't extend out enough or I can't get it just right.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-No.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?

-I don't use the PNVS in the front seat. All I use is the TADS. I can readjust when I switch to goggles and to the TADS.

Is the IHADSS's 30 x 40 FOV sufficient?

-Yes I do. If you go larger, it'd take up more room in the front of your face on the helmet, and you'd loose peripheral.

Do you under any situations rotate the IHADSS out of the way?

-When I go into gunner mode, and usually if I'm not on the controls I'll roll it out.

If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-It's nice to have that unaided eye.

What is the best feature of the IHADSS?

-The information that's presented to you as a pilot in all formats flight/weapons. I think it provides a good amount of information used for the mission that we need to do. I think it's a great system, but also needs improvement.

What is the worst feature of the IHADSS?

-Reliability is a question. The amount depending on how your helmet is fit, the HDU can sit a little lower on you shoulder, depending on your anatomy.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?

-Upgrade the FLIR.

Is there any other issue you would like to raise about flying with the IHADSS?

-No.

Subject 31

Have you had any specific problems with using the IHADSS in this environment?

-System works great except the level of detail we have limits us in things we do, especially in target ID (identification) with close combat.

Have you had problems with maintaining the full FOV?

-No.

Have you had any problems with the combiner?

-The combiner lens and the monocle itself. Either the tightening screw, we loose the locking device and can't tighten it any more or the combiner lens screw comes loose to where you have to do some maintenance.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?

-Yes sir, for symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-The PNVS is OK. I wish the TADS could move faster. I compensate by moving my head slower.
Is the IHADSS's 30 x 40 FOV sufficient?
-I don't think anything can be better improved.
Do you under any situations rotate the IHADSS out of the way?
-At night when I'm ground taxiing, and in the front seat when I go up NVG.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I think we are better with the monocular because we use our unaided eye so much.
What is the best feature of the IHADSS?
-The whole system being able to detect where you are located, IHADSS.
What is the worst feature of the IHADSS?
-The actual sensor.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-GEN 3 FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-I think the Apache should have improved sight.

Subject 32
Have you had any specific problems with using the IHADSS in this environment?
-No response.
Have you had problems with maintaining the full FOV?
-None.
Have you had any problems with the combiner?
-No, I just make minor adjustments.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, for flight symbology and also cues.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[PNVS is] adequate. [TADS are] a little bit slower, but you can work with it through training and experience.
Is the IHADSS's 30 x 40 FOV sufficient?
-Sure.
Do you under any situations rotate the IHADSS out of the way?
-Never.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I would like to try it, just to see if it is any better.
What is the best feature of the IHADSS?
-It gives you a "heads-out" capability while you are flying. It gives you all your information; flight symbology and target information.
What is the worst feature of the IHADSS?
-In this environment, you have to wear so much gear. The clearance, sometimes the HDU will fall off your helmet, so the clearance from ALSE (Aviation Life Support Equipment) gear.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Make it a remote HDU, or change the way it's attached to the helmet so you have more Clearance.
Is there any other issue you would like to raise about flying with the IHADSS?
-GEN 3 FLIR.

Subject 33
Have you had any specific problems with using the IHADSS in this environment?
-It's with the individual aircraft. You have some systems failures and we had a dual IHADSS failure on the range in the middle of the night due to a bad DEU.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-All the time, it's the quickest way to bring our weapons system to bare on a target. About 90% of the information that I need to fly with I use symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[PNVS is adequate] and I'd say [the TADS] is adequate once you get use to the system.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think it's sufficient for flying, but I think it could be bigger.
Do you under any situations rotate the IHADSS out of the way?
-No, not in this environment.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I'd be willing to try something new, but I like being able to use my unaided eye.
What is the best feature of the IHADSS?
-The ease of weapon engagement from the back seat and the flight symbology.
What is the worst feature of the IHADSS?
-The imager itself.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Back up DEU.
Is there any other issue you would like to raise about flying with the IHADSS?
-No.

Subject 34
Have you had any specific problems with using the IHADSS in this environment?
-Yes, during the summer we went though a lot of IR (Infrared) harnesses.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-Sometimes, it gets a little loose.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, all the time [for] symbology engagements.

Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-I'm a front seater so I use TADS, and yes, it is too slow. I concentrate on moving my head slow, but I use goggles most of the time.
Is the IHADSS's 30 x 40 FOV sufficient?
-If weight weren't an issue, I'd try it. Bigger FOV.
Do you under any situations rotate the IHADSS out of the way?
-Yes, for goggles or during gunnery I rotate it out of the way to use my MPD (Multipurpose Display).
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-Sure, two eyes are better than one.
What is the best feature of the IHADSS?
-IR video.
What is the worst feature of the IHADSS?
-Slew rate of the TADS and sometimes the video, it's just sometimes you get an old TADS. Desperately needs an upgrade.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-GEN 2 or better FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-No, sir.

Subject 35
Have you had any specific problems with using the IHADSS in this environment?
-Yes, have a lot of problems with the IR (Infrared) harness. Specifically when it's hot, we have a little bit of problems of deforming from the heat.
Have you had problems with maintaining the full FOV?
-Sometimes, in the lower left-hand corner. It can be cut off.
Have you had any problems with the combiner?
-Just the friction portion of it sometimes breaking.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, sir. I use it for symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-I haven't had any issues with the slew rate of the PNVS, TADS, yes, I think it's too slow. If it was as fast as the PNVS, that would be great. Just by moving my head slower.
Is the IHADSS's 30 x 40 FOV sufficient?
-For the monocular, yes. I wonder if they made a larger FOV, if you'd loose some of the detail.
Do you under any situations rotate the IHADSS out of the way?
-Maybe sometimes if I'm doing some type of hood training.
If weight and CG were not an issue, would you want a binocular HMD design?
Why or why not?
-I think it would have its advantages, [but] the monocular gives you the ability to still look out unaided with your left eye.
What is the best feature of the IHADSS?
-The ability to see signatures of the other aircraft, just the FLIR in general.
What is the worst feature of the IHADSS?
-Using the older FLIR system, we are still using GEN 1 and the level of detail you get is poor.

If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-To upgrade FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-An upgraded system.

Subject 36
Have you had any specific problems with using the IHADSS in this environment?
-No, sir.
Have you had problems with maintaining the full FOV?
-No, sir. I've had my own helmet since '94 that exists outside the system. It took me several years but the helmet finally fits exactly the way it needs to.
Have you had any problems with the combiner?
-No, sir.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Absolutely not. I'm a big fan of symbology during the day, and instruments.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-Yes, [the PNVS is adequate] no [the TADS isn't]. The slower slew rate of the TADS is disorienting. The image quality of the TADS is not as good as the PNVS. I compensate by training and experience.
Is the IHADSS's 30 x 40 FOV sufficient?
-No, sir. I would like to go binocular with I^2 overlay.
Do you under any situations rotate the IHADSS out of the way?
-The only time is when I'm doing ground taxi, or simulated IMC.
If weight and CG were not an issue, would you want a binocular HMD design?
Why or why not?
-Absolutely.
What is the best feature of the IHADSS?
-In a combat environment, to rapidly point the gun and cut somebody in half if I need to.
What is the worst feature of the IHADSS?
-At night in poor FLIR conditions the ability to break out and contrast objects is detrimental to flight safety.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Upgrade it to I^2 and upgrade the FLIR to a 2-3.
Is there any other issue you would like to raise about flying with the IHADSS?
-No, sir.

Subject 37
Have you had any specific problems with using the IHADSS in this environment?
-Nothing specific. FLIR is the number one thing, it's hard to identify specific things at night. I can see better with goggles.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.

Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, all the time. It depends, if I'm flying I'll use symbology during the day, if I'm looking for targets I'll use FLIR.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-PNVS is adequate, [TADS] can get disoriented if you move your head too quickly, I just adjust and wait for the image to catch up.
Is the IHADSS's 30 x 40 FOV sufficient?
-I think so. Just the quality of the FLIR.
Do you under any situations rotate the IHADSS out of the way?
-If I'm using goggles.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-No. I like the unaided eye.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-FLIR picture is sometimes unusable; it's an older technology.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
-Upgrade the FLIR.

Subject 38
Have you had any specific problems with using the IHADSS in this environment?
-Only with the mask. It is ill equipped to fit the helmet we have that's fitted for your helmet for your head. There should be two separate helmets. You should have a helmet that is integrated with or fits underneath using the M48 mask.
Have you had problems with maintaining the full FOV?
-That's a problem in each aircraft because of the size and centering.
Have you had any problems with the combiner?
-Just that it's fragile.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Always. During the daytime I like to shoot the same way all the time. So if I shoot at night in FLIR, I'll shoot the daytime in FLIR.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-PNVS slew rate is fine, but the TADS isn't. The slew rate needs improvement to at least be just as fast as the PNVS. [Compensate by] just thinking ahead.
Is the IHADSS's 30 x 40 FOV sufficient?
-I don't think it's sufficient. If you could integrate it with a visor set up, that might be better.
Do you under any situations rotate the IHADSS out of the way?
-The only time I might, is just working on flight maneuvers that deal properaceptive flight.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?

-Yes because teaching new pilots to disregard what part of their brain is seeing is difficult. What one eye basically shuts off its electricity to the brain and the other one has to pick up all of them. I think it creates headaches. You learn to overcome it.
What is the best feature of the IHADSS?
-FLIR.
What is the worst feature of the IHADSS?
-The acquisition ability due to range
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Use a GEN 3 FLIR.
Is there any other issue you would like to raise about flying with the IHADSS?
- I think it's a good piece of equipment. I like all the information right in my eye so I can just look through it. I think it's a great system.

Subject 39
Have you had any specific problems with using the IHADSS in this environment?
-Only problems we've specifically had, is with the fit of the body armor [which] is bulky and rides up.
Have you had problems with maintaining the full FOV?
-No.
Have you had any problems with the combiner?
-No.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-Yes, primarily [for] symbology and only in adverse weather.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it?
If so, how?
-I would say yes, [the PNVS is adequate], [the TADS] no. Move your head slower or you'll get disoriented.
Is the IHADSS's 30 x 40 FOV sufficient?
-It's all I've known since I came in, but bigger is better.
Do you under any situations rotate the IHADSS out of the way?
-Only if it is bothering me.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I think it could be cool, I'll give it a shot. If it means I'll have a better resolution and better picture at night, yes.
What is the best feature of the IHADSS?
-Symbology.
What is the worst feature of the IHADSS?
-Picture resolution could be better.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-Improve the FLIR picture.
Is there any other issue you would like to raise about flying with the IHADSS?
-Put a new PNVS on there.

Subject 40

Have you had any specific problems with using the IHADSS in this environment?
-The helmet fit. Throughout the flight it tends to rotate forward.
Have you had problems with maintaining the full FOV?
-With loosing all the four corners.
Have you had any problems with the combiner?
-It seems like the center of they symbology is always up and to the right.
Do you use the IHADSS during the day? If so, in what way? Under what conditions?
-I do on my TADS, shooting off HDU. Daytime I leave HDU up for symbology.
Is the slew rate of the pilotage/targeting FLIR too slow? Do you compensate for it? If so, how?
-[PNVS] adequate, TADS are too slow. I slow down my head movements to compensate; it's something you have to get used to.
Is the IHADSS's 30 x 40 FOV sufficient?
-It depends on what you are doing. For a task engagement where you are looking at a specific target, it's plenty. For flying, it is sub-par by what is available. If you could at least double that or at least make it a wider FOV, more peripheral.
Do you under any situations rotate the IHADSS out of the way?
-The only time I ever rotate it out of the way is a ground run.
If weight and CG were not an issue, would you want a binocular HMD design? Why or why not?
-I think binocular system would be a real good thing, not the way ours is currently set up with that much bulk blocking your side of your peripheral.
What is the best feature of the IHADSS?
-When you are just wearing the IHADSS without goggles, the weight of that helmet is a lot lighter. There is a big difference between wearing those goggles and not wearing them, they are more comfortable.
What is the worst feature of the IHADSS?
-HDU resolution. Not so much just the FLIR, but the picture is not so clear, and the sensors need to be updated also.
If you could change one thing on the IHADSS to improve its effectiveness, what would it be?
-More FOV, and more resolution.
Is there any other issue you would like to raise about flying with the IHADSS?
-No, sir.

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