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Formulative Evaluation Study of a Prototype Near-Infrared Projection System: Night Vision Goggle Study

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U.S. Army Research Institute

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U.S. Army Aviation relies upon image intensifiers, such as night vision goggles (NVGs), for night nap-of-the-earth (NOE) flight. During initial flight training, OH-58 student pilots are expected to apply academic knowledge of NVG use in flight after limited review. To facilitate OH-58 students' transition to NVG flight, researchers projected images through a prototype near-infrared (IR) video projection system. Students received hands-on experience with the AN/PVS-5A NVGs, which are compatible with the projection system's output range. Instructor pilots rated OH-58 students' flight performance throughout the night/NVG phase of instruction. A strong positive effect on students' confidence (increase) and anxiety (decrease) levels was observed. No difference in flight performance was observed between matched pairs (experimental vs. control) of students. Additional research is planned in the areas of safety of flight, terrain navigation, special operations, mission planning, and threat recognition.

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FORMATIVE EVALUATION STUDY OF A PROTOTYPE NEAR-INFRARED PROJECTION SYSTEM: NIGHT VISION GOGGLE STUDY

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FORMULATIVE EVALUATION STUDY OF A PROTOTYPE NEAR-INFRARED PROJECTION SYSTEM: NIGHT VISION GOGGLE STUDY

Introduction

A critical and growing need exists for the continuous operational effectiveness of air-mobile military troops (Bonsper, 1987; Pengelley & Hewish, 1987). Darkness no longer conceals enemy troops (Hammes, 1987), as it need not deter Army aviators from mission accomplishment. Night vision system technology now enables Army aviators to detect and identify different types of terrain and aircraft under low-level light conditions (Verberk, 1986). However, with the increased ability and awareness comes the need for more training in complex night flight operations to offset hostile forces' increasing night mission capabilities (Bonsper, 1987).

According to Flightfax ("Night vision flying: A special report to the field," 1987), the increase in the complexity of night mission requirements poses additional risk to the Army aviator. Moreover, the risks incurred during complex night vision device (NVD) missions have risen in recent years, as evidenced by the steady increase of Class A accidents. Many of the reported accidents occurred during tactical terrain flight exercises. Enhancing safety and developing effective training are critical concerns. Tactical terrain flight and the safe use of night vision devices must be emphasized through training and practice at the unit level as well as within the aviation training arena. Effective initial training coupled with strong skills sustainment programs, theoretically, could foster generalization to the combat environment in the event of mobilization.

Should there be a hostile encounter with Warsaw Pact countries, Soviet tactics and technology dictate that U.S. Army aviators must perform continuous complex tactical maneuvers to maintain "low profiles" (i.e., remain nap-of-the-earth). U.S. Army aviators require substantially honed skills to perform their missions proficiently during night nap-of-the-earth (NOE) flight. Night vision devices offer an effective means for accomplishing this goal, and it is imperative that robust night vision goggle (NVG) training be provided to U.S. Army aviators ("Expanded night-fighting capability," 1987).

Background

Prior to flight training, Initial Entry Rotary Wing (IERW) course student aviators receive classroom instruction in NVG precepts and standards. Classroom instruction incorporates principles of night vision, the components, limits, and capabilities of the human vision system, and some hands-on experience with NVGs (i.e., location of switches and occasionally a glimpse through the tubes with caplugs in place). Upon arrival at the flightline, students receive a limited review before they are expected to apply classroom principles in flight.

IERW NVG flight training also embraces an academic introduction to safety issues prior to flight qualification. This qualification takes place in the student's "tracked" aircraft only; i.e., the student is qualified in only one helicopter during the IERW course. For example, the IERW Aeroscout students' NVG flight qualification requires a maximum of 15.6 hours in the OH-58 aircraft (excluding end-of-phase evaluation) with possible additional hours in the simulator, according to the February 1986 Flight Training Guide (FTG).

Problem

The transition from classroom to flight poses problems because many elements critical to NVG flight are difficult to effectively present to the student. Students are not currently exposed to what they will see or experience while flying under NVG conditions prior to their first NVG flight. For example, it is difficult to accurately describe, to the naive aviation student in the classroom setting, how terrain actually appears under the low visible and near-IR viewing conditions typical of NVG flight. All too often, IERW students are not exposed to low light level NVG flight, and it is under this condition that many accidents occur ("Flying goggles: A special report," 1987; "Night flying lessons learned," 1988). NVG flight training needs to be enhanced to both develop student confidence and reduce the student apprehension that is commonly associated with beginning NVG flight.

A Potential Solution

As part of the U.S. Army Research Institute Aviation Research Task, "Techniques for Tactical Flight Training," a prototype Near-Infrared (IR) Video Projection System was developed in cooperation with the U.S. Army Communications and Electronics Command (CECOM) Center for Night Vision and Electro-Optics (C^2NV&EO) for Night Vision Goggle (NVG) Threat Training Research (See Appendix A) (Intano, Pedroni, & Rusche, 1989). This effort has been expanded to include research on a formative evaluation of the system in the NVG flightline environment.

Research Rationale and Purpose

To address the critical need for enriched training in NVG flight operations, ARIARDA researchers postulated that a pre-flight preview of NVG use and an exposure to the appearance of specific NVG NOE and terrain flight maneuvers (a.k.a. flight tasks) would be advantageous for student aviators. We believed that the benefits of such an experience would be apparent in the increased learning rates of the student pilots who attended the preview session.

The purpose of the proposed research effort was to provide formulative evaluation data for the prototype Near-IR Video Projection System using daytime videotape. The experimental daytime videotape was developed to facilitate the transition between academics and flight instruction for OH-58 track (Aeroscout) students enrolled in the IERW course.

Objectives

The specific objectives were to determine: 1) whether performance levels ("scores") were higher for students who attended the sessions with the prototype Near-IR Video Projection System than for a matched group of students who did not attend and 2) what overall benefits were realized by students who attended the sessions.

From the objectives, several predictions were made about the students attending the Near-IR Video Projection System sessions. The first prediction made was that the experimental group students would have a reduction in the initial apprehension typically associated with NVG flight, as well as an increase in confidence. The second prediction was that higher initial flight performance scores would result for students in the experimental group.

Method

Subjects

Eighty male Aeroscout students in four classes (88-9 through 88-12) of the IERW course served as subjects. A total of 34 students were in the experimental group; 42 students were in the control group. All students completed the phase within the research period.

Apparatus

The Prototype Near-IR Video Projection System. The prototype Near-IR Video Projection System emits energy in the red visible and near-IR ranges of the electromagnetic spectrum, from about 650 to 1100 nanometers (nm) (Intano et. al., 1989). An 87B Wratten filter is placed in front of the projector lens to attenuate the visible energy. The contrast, brightness, and resolution controls enable the system to project images simulating various flight conditions, for example, full moonlight with high angle (high contrast) or no moonlight (low contrast). The projection system operator can vary the images to depict a range of actual visual conditions. The projected images are amplified and detected by the AN/PVS-5/5A NVGs. The AN/PVS-5/5A NVGs, image intensifiers (I^2) which are in common use in Army aviation units worldwide, are responsive to the 400 to 900 nm range.[1] The system's features thus effect compatibility with NVG operation.

Two additional advantageous features inherent to the system are the methods for input and recording of the images to be later projected. First, the system will accept videotape, videodisc, or computer generated imagery as input media, which could be potentially expedient for establishing a standardized NVG training program. The second advantageous feature is that the recording of terrain flight maneuvers may be accomplished during daylight hours. This advantage allows the taping of maneuvers that are difficult or dangerous to perform in low light levels. To minimize unrealistic shadows, glare, and contrast, which are detected and exaggerated by the camera eye, recording is conducted during overcast conditions. For example, the sun produces harsh shadows around and beside objects within the terrain that are not present during flights when aviators must use NVGs to intensify ambient light. "Harsh" shadows and high contrast conditions may be experienced by aviators on high illumination nights when NVGs are typically <u>not</u> employed. The type of glare associated with the sun reflected off of buildings and water surfaces is not usually experienced by aviators at night; as such is the case, any means of minimizing the camera's efficiency at capturing this effect would be favorable. On the other hand, embellishing the effect of glare intensified by NVGs from visible light sources (e.g., aircraft anti-collision lights) is an effect that would be advantageous to exploit.

The prototype near-IR video projection system consists of a bell-shaped phosphorous tube measuring 5.5" diagonally which is mounted in a Bell Howitz monitor housing behind a lens with an effective focal length of 135mm (see Figure 1). Located below the lens is a panel concealing potentiometers for adjusting contrast and brightness levels, fine focus, and horizontal and vertical holds. Video inputs and outputs and a 525/875 line rate selection switch (RS-170 standard/RS-343 standard) are situated on the rear of the housing.

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[1]NVGs operate by intensifying reflected visible and near-IR energy.

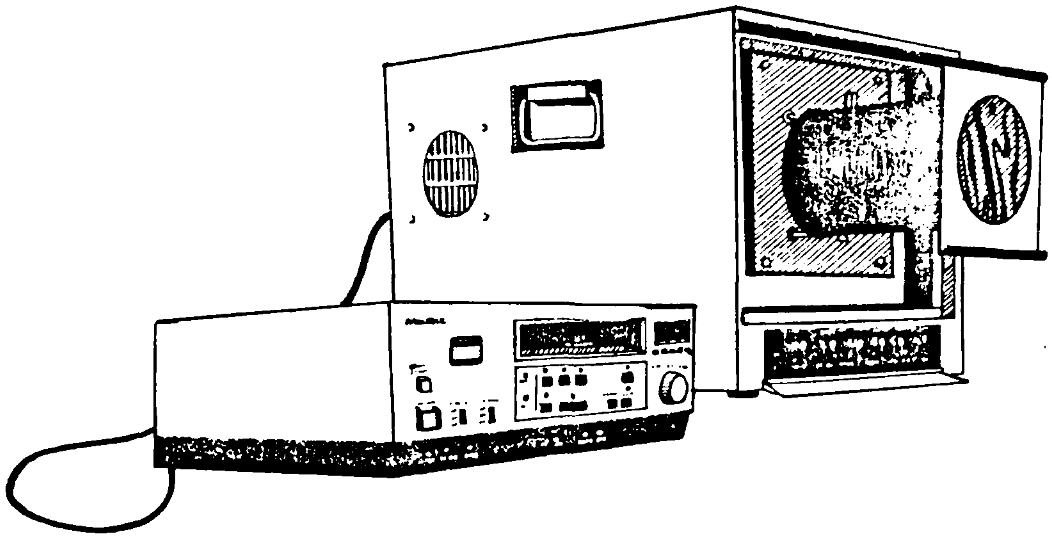

Figure 1. Diagram of the Prototype Near-IR Video Projection System.

During the experimental sessions, a Panasonic 1/2" VHS playback machine served as the input source device for the prototype Near-IR Video Projection System. Audio output was provided by a Sony monitor. Indicator lights on the apparatus were masked from view by black-out fabric. The prototype system was placed on a wheeled television cart. The images were projected onto a 86" by 86" surface material consisting of cotton/polyester fabric; some overlap was observed on either side of the screen surface. Each student wore a SPH-4 flight helmet mounted with a pair of AN/PVS-5A "cutaway" NVGs to view the projected images.

Materials

The questionnaire forms that were used during the course of the research appear in Appendix B. The IPs recorded subjective data on student performance using a questionnaire with Likert-type scaling (Siegel, Bergman, Federman, & Sellman, 1972). For example, the IPs were instructed to respond with a structured level of agreement/disagreement to the statement "the student asked questions or made comments indicating knowledge of NVG use or application."

Students in the experimental group responded to questions designed to assess benefits acquired by them during the experimental session; a two-page multiple-choice questionnaire was provided to them for this purpose during the debrief/feedback session. The IPs provided feedback on a one-page form. Students' academic profile data were kept on demographic information sheets, also in Appendix B.

Appendix C contains the flight performance gradeslip used by the IPs to record student flight performance scores. The IPs rated the students according to a six-point behaviorally anchored scale (Rowe, 1985). The scale ranged from "the student could not complete. . .the task" to ". . .performance was exemplary."

Procedure

Obtaining stimulus material. The flight tasks were flown and videotaped according to NVG standards specified in the OH-58 Aircrew Training Manual (ATM FC 1-215).[2] Five ATM flight tasks were videotaped successfully. approach to a hover, approach to ground, confined area operations, out-of-ground-effect (OGE) hover check, and masking/unmasking. Videotaping took place during daylight hours during several flight periods to include overcast and bright, sunny conditions. An NVG Instructor Pilot (IP) recorded the flight tasks through the cockpit windscreen of an OH-58A "Aeroscout" helicopter with a Panasonic hand-held camcorder using 1/2" VHS format tape. Two or three iterations of each task were mastered onto a 1/2" VHS tape, and the tape was dubbed with an IP's narration. In the narration, the IP emphasized several flight techniques (e.g., cuing, scanning, etc.) that are recommended for safe NVG flight.

Group selection. A matched-pairs procedure was used based on these variables: comparable UH-1 and OH-58 flight hours and three separate evaluation scores (i.e., OH-58 transition, basic combat skills and night academics). The technique proceeded well for the first two classes (88-9 and 88-10). However, for the remaining two classes (88-11 and 88-12), scores were more difficult to obtain and students were released from the basic combat skills phase sporadically. The problems encountered made the prior matching procedures impossible, resulting in a greater total of control group members.

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[2]U.S. Army Aviators rely on a set of reference manuals, known as Aircrew Training Manuals (ATMs), to provide flight task descriptions, conditions, and standards for performance. Each aircraft has an ATM (e.g., OH-58). All flight tasks for which an aviator is responsible are described in the aircraft-specific ATM, along with the standards and procedures for each task.

Within each matched pair of students, one student was randomly chosen to be in the experimental group. The remaining student in each pair served as the control match. An effort was made to retain each pair with a single IP during the NVG phase. This consistency was impossible to maintain due to IP leave schedules, the prevailing IP shortage, and the IPs' normal practice of "swapping" students. To foster objectivity in the rating process, the IPs were kept naive to the research design until after the research period.

Treatment. Experimental group students were advised to arrive early on the scheduled evening and to draw issue on NVGs en route to the treatment session. The experimental treatment consisted of a single session with a duration of about forty minutes. The sessions were held in a light-proof conference room.

Students were seated at an oval table facing the screen in the conference room. The students were instructed to prepare their goggles for operation. An IP delivered a brief introduction to the session, to the researcher, and to the research method (i.e., the matching strategy). The IP also briefed the students regarding some of the tape's technical flaws (i.e., image reversal, contrast shifts, and some abrupt panning sequences). Students then viewed the 19-minute videotape and were permitted to question the IP on flight techniques (e.g., judging rate of closure). Prior to the close of the session, the criticality of perpetuating the confidentiality of the sessions's events was emphasized by the Company Commander, the Platoon Leader, and the principal researcher.

Concurrently, the control group students attended a session to witness a videotape on forward looking infrared (FLIR) systems. A second IP briefed those students to keep that session's events confidential. The control group students, although aware that some of their fellow students were situated in another room, were not told of the nature of the research.

Assessment. Subsequent to viewing the experimental videotape, all students flew a typical first NVG mission. Following each flight for the duration of this phase of training, the IPs completed a gradeslip and a questionnaire about their students' performance (see Appendixes B & C). Nine separate NVG tasks, targeted by subject matter expert (SME) IPs as problematic for the average IERW Aeroscout student, were listed on the gradeslip: takeoff, approach to a hover, approach to ground, approach with forward airspeed, slope operations, approach to a confined area, takeoff from a confined area, OGE hover check, and masking/unmasking.

The IPs were instructed to rate each student on the initial iteration of each of the nine targeted NVG tasks that were performed during a flight according to the six-point scale appearing on the gradeslip. IPs also recorded the total number of iterations that each task was performed during the flight. In each flight period, students performed at least one of the nine tasks, but never were all nine performed during a flight. There was an average of 5 targeted flight tasks performed across all students during the initial flights. The gradeslips and questionnaires were completed nightly by the IPs before being accumulated for weekly collection.

Student Debriefs

Students in classes 88-9, 88-11, and 88-12 were debriefed by the researchers (class 88-10 graduated and departed Ft. Rucker before a debriefing session was scheduled). A brief description of the near-IR projection system and the research approach was presented to both control and experimental group students, and the authors responded to all questions asked by the students. Experimental group students were then requested to complete the two-page questionnaire, designed to solicit feedback on their experience with the near-IR projection system.

IP Debrief

The Aeroscout IPs of B Co, 1-14th were debriefed subsequent to study completion. The IPs were informed of the study purpose, methodology, and preliminary results. Their feedback was solicited regarding the evaluation gradeslip and future research plans.

Results

Academic profile, flight performance, questionnaire response and debrief data for each student were compiled on a minicomputer for analysis. Analyses were conducted with SPSS^{X} and BMDP software.

NVG Flight Performance Levels

The data were subjected to a MANOVA to determine what effect lunar condition, previous NVG experience, and group (experimental vs. control) had on student flight performance levels. The initial performance of each of the nine flight tasks for each student was included in the analysis. None of the three main effects had a statistically significant impact on flight performance.

However, the interaction of lunar condition and previous NVG experience was significant (P=0.0276, 18, 100). The data were organized into a matrix in an effort to distinguish any trends present. No trends were identified. We postulated that the small sample size contributed to this finding and that more data are required before any explanation can be proffered.

The flight performance score means and standard deviations were statistically equivalent between the two groups on all nine tasks--when the initial score for each student was taken for analysis (see Table 1). Similar results were found for subsequent flight performance scores and are not shown in this report.

Table 1. First NVG flight performance of target tasks: Means & standard deviations.

	Experimental Group				Control Group			
TASK	$\bar{x}$	δ	mode	median	$\bar{x}$	δ	mode	median
Takeoff	3.2	.83	4	3	3.7	.96	3	3
Approach to hover	3.0	1.0	3	3	3.3	.98	3	3
Approach to ground	3.1	1.1	3	3	3.4	1.1	3	3
Approach w/ forward airspeed	2.9	.97	3	3	3.2	.95	3	3
Slope operations	3.4	1.1	4	4	3.4	1.2	3	3
Approach to confined area	3.1	1.2	3	3	3.0	.97	3	3
Takeoff from confined area	3.4	1.1	3	3	3.6	.92	3	3
OGE hover check	3.4	1.1	3	3	3.4	1.0	4	3.5
Masking/unmasking	3.6	1.1	4	4	3.7	.95	4	4

Student Perceptions

Student debrief forms were analyzed with the frequency procedure in SPSS^{X}. The questions and response proportions are given in Appendix D. Overall, the encounter was an advantageous one for the students who experienced the near-IR projection system. Almost three-quarters (73.9%) of the responding experimental group students felt that the near-IR projection system fulfilled their expectations in simulating the appearance of NVG flight. Almost 70% of the responding students felt the images they viewed were realistic. Of those students who did not feel the images were realistic (30.4%), technical reasons were cited (e.g., scanning was not in the student's control). Of the students who did indicate that the techniques demonstrated on the tape were helpful, approach/departure, scanning and OGE hover check were the specific areas in which they felt the most benefit was derived. Two-thirds (65.2%) of the responding students found their experience with the near-IR projection system to be novel as compared to their other night/night vision goggle instruction.

On the other hand, 82.6% of the students indicated that they believed they would have learned just as well or as quickly had they not experienced the near-IR system. In light of the other overwhelmingly positive responses, we believe that this response may stem in part from the question's negative sentence structure, as compared with the structure of all of the other questions on the form (see Appendix D).

The students' comments were also examined for trends. The positive comments centered around an appreciation for exposure to "how things appear through goggles," an introduction to scanning techniques, and a familiarization with goggle operation and limitations. The less positive comments related to technical shortcomings of the film or the system (e.g., tape portrayed insufficient ambient light conditions, scanning not under students' control, or need to incorporate motion).

IP Opinions

No major trends were identified by examining the subjective questionnaires used by the IPs to assess the students' first flight performance (see Tables 2 & 3).

However, several major themes were brought out by the IPs during the debrief/feedback period. First, the IPs suggested that additional weather data and general comments be solicited by the gradeslip. Second, they specified that more structured training in gradeslip use would have prevented some of the gradeslip completion problems they encountered. Finally, the IPs suggested that the near-IR projection system also should be used in developing student aviators' skills in NVG navigation.

Table 2. NVG student evaluation IP opinion questionnaire part I: Responses for first flight

SCALE:
SA - Strongly Agree MA - Mildly Agree MD - Mildly Disagree
D - Disagree SD - Strongly Disagree N/A - Not Applicable

QUESTION	SA	A	MA	MD	D	SD	N/A
1. Student was familiar w/NVG mission procedures.							
Experimental Group	1	6	11	6	3	2	1
Control Group	1	11	19	6	7		
2. Student exhibited or expressed confidence in his/her NVG flight abilities.							
Experimental Group		4	12	8	3	2	1
Control Group		5	20	9	7		
3. Student had difficulty becoming oriented to object while the NVGs were operational.							
Experimental Group	3	7	13	6	1		
Control Group	4	11	16	8	5	1	
4. Student asked questions or made comments indicating knowledge of NVG use or application.							
Experimental Group		8	11	7	4		
Control Group	1	10	18	7	7		2
5. There was improvement in the student's performance compared to the student's previously previously evaluated flight.							
Experimental Group							25
Control Group		1*	1*				38
6. During an actual NVG flight, student was able to complete the required tasks with little or no observed apprehension.							
Experimental Group	1	2	7	11	4	5	
Control Group		6	10	16	7	6	
7. Student demonstrated a clear understanding when instructed in a task during NVG training.							
Experimental Group		8	15	4	3		
Control Group	1	12	21	7	3	1	
8. The student was able to perform a task to ATM standards in fewer iterations than student's previous NVG flight.							
Experimental Group					1*		26
Control Group		1*			1*	1*	37

* NOTE: These responses should have been "N/A" because this questionnaire related to the students' initial NVG flight performance.

Table 3. NVG student evaluation IP opinion questionnaire part II: Responses for first flight

QUESTION	Poor	Below Aver.	Aver.	Above Aver.	Profi-cient	N/A
1. How quickly did the student adapt to NVG use on this flight?						
Experimental Group	1	3	34	6		
Control Group		3	20	7		
2. How well was the student able to perform a newly-introduced task?						
Experimental Group		3	32	4		
Control Group	1	1	22	10		
*3. How well was the student able to perform a task that the student performed previously?						
Experimental Group			2*	1*		24
Control Group			3*	3*		36
*4. How well did the student perform on a task that was weak for him/her on a prior flight?						
Experimental Group			1*	1*		25
Control Group			2*	1*		39
5. Overall, how quickly is the student learning NVG flight procedures?						
Experimental Group		2	22	6		
Control Group			33	9		1

* NOTE: These responses should have been "N/A" because this questionnaire related to the students' <u>initial</u> NVG flight performance.

Discussion

Although there were no statistically significant indicators of an improvement in aviator flight performance scores due to experiencing the prototype NVG video projection system, student perceptions clearly exhibited the positive influence of the system on their attitudes. Several methodological shortcomings were identified during the course of the research period.

The most conspicuous shortcomings encountered during the research are easily identified. The original intent to provide the students with a series of sessions demonstrating an array of flight tasks was unrealized, due to insufficient flight time for taping and other operational difficulties. Multiple treatment sessions may have been sufficient to produce a difference between groups in flight performance scores.

Moreover, a less casual approach to rating students' flight performance might have been elicited had the following methodological precaution been taken: Informing the IPs of a general research purpose without divulging specific objectives. According to IP feedback comments, this would have stimulated the IPs' full participation and commitment. Secondly, the authors should have explicitly trained the IPs on consistent gradeslip completion. The task was delegated instead to the NVG flight section leader.

Perhaps of more consequence are the difficulties in acquiring the performance database. Had the IPs been cognizant of a general research purpose, two desired outcomes may have been achieved. First, the matching procedure would have been left generally intact as intended. Second, the IPs would have guaranteed that each pair of students performed all of the target tasks every flight period, thus establishing a much more complete database.

Several pronounced operational shortcomings also occurred. The authors and the assisting IPs learned a great deal about recording techniques on trial-and-error bases. The hand-held camcorder amplifies the slightest movement of the photographer. The projector increases the effect. Scanning movement was therefore difficult to emulate without creating discomfort in some students. Other lessons learned involving videotaping include the optimum light conditions under which taping should be conducted--overcast daylight. On bright, sunny afternoons, the camcorder augmented the tape's changes in contrast, which did not realistically simulate NVG flight. Accordingly, flight tasks had to be retaped several times to obtain useful sequences until the authorized flight time was consumed, leaving the researchers with a limited set of media from which to develop a training videotape. These technical shortfalls are due to the prototypical nature of the system and equipment. A better videotaping method (i.e., gyrostabilization) and a production model projection system do exist, and they should circumvent most of the technical shortcomings identified during the course of the research.

Perhaps future research efforts will prevent a replication of these shortcomings, allowing a richer database to be established. The lessons learned during this research effort may provide an avenue for acquiring irrefutable proof of concept.

The well-defined effect of the prototype near-IR projection system on student attitudes, coupled with the absence of detrimental effect on student flight performance, indicates a promising potential for the production model projection system.[3] Considering this, the prototype near-IR projection system has demonstrated potential for serving as a transitional training apparatus for OH-58 track IERW students prior to NVG flight.

A sound flight performance database as well as additional operational and methodological information would support the USAAVNC in the preparation and development of the proposed Night Vision Device Training and Operation Facility. The Facility is being fashioned after the only operational lab currently in existence, the Night Imaging and Threat Evaluation (NITE) Lab, located at the Marine Aviation Weapons and Tactics Squadron-One (MAWTS-1) at the Marine Corps Air Station, Yuma, AZ. The Marine Corps shares U.S. Army Aviation's goal: to provide aviators with training to enable them to maximize mission effectiveness while also maximizing safety. The training devices and equipment at both sites will share a common purpose: to demonstrate to high-time and student aviators how terrain appears through NVGs under a range of conditions. The near-IR video projection system plays an essential, integral role within the Facility.

Although the NITE Lab is operational, the Marines have not qualitatively or quantitatively measured the effectiveness of the Lab or their production model near-IR video projection system. By expanding the current research effort, ARIARDA could furnish MAWTS-1 with critical data about the projection system's training effectiveness and potential.

Conclusions

The prototype NVG video projection system has proven to be effective in familiarizing student aviators with night vision goggle operation and the appearance of NVG flight. In an expanded study with the necessary and appropriate methodological modifications, the potential exists for the flight performance data to show a pronounced improvement for aviators who view a series of NVG flight mission while wearing I^2 devices prior to actually performing in flight.

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[3]An additional attribute of the production model over the prototype near-IR projection system is that it has a modified output range (830 to 1200 nm) and power curve that increases its compatibility with the AN/AVS-6 Aviator Night Vision Imaging System (ANVIS), which is currently being fielded to aviation units worldwide, thereby increasing the projector's feasibility.

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APPENDIX A

Prototype Near-IR Projection

System Specifications

SPECIFICATIONS FOR THE NVS 12-XXXXXXX SERIES MONITORS.

LJF CORPORATION NVS 12-XXXXXX Monitor Specifications

Flat-faced CRT

CRT Diagonal

10.0 in/278.0 mm.

CRT display area

56.7 in^2/365.8 cm^2.

CRT deflection angle

60°.

Weight

25 lb/11.2 Kg.

Resolution

600 TV lines center.

400 TV lines corner.

High Voltage

Up to 12 KV at 0_uA.

Input power

120 VAC, 50-60H_z +/- 3dB at 30V p-p.

Vertical scan rate

40 H_z-65H_z.

Vertical Retrace

650 $_u$S.

Horizontal scan rate

15.750 Khz - 26.250 KH_z.

Horizontal retrace

7.5 uS.

Video input

EIA standard RS-170, RS330 or RS-343 A compatible (0.5-2V p-p).

Differential input amplifier with 40 dB common mode rejection up to 6 V p-p.

Two looped through video inputs with A/B capability with composite video or the B input can be used for external sync.

Switched terminations.

Video controls

Contrast.

Brightness.

Vertical hold.

Horizontal hold.

Reduced Scan.

Polarity reversal.

Focus.

Height.

Width.

Internal/external sync.

Audio

Audio output with volume control.

Case

Rugged steel, beige and brown.

Environment:

Operating: 0 C to 50 C, 90% relative humidity (non-condensing).

Altitude: 10 000 feet (3000 meters).

APPENDIX B

Proof of Concept Study

Student & IP Data Materials

DEMOGRAPHIC DATA SHEET

Student #: ____________________ Date (DD/MM/YR): ______________

Class #: ____________________ FAST Score : ______________

Flight Eval Scores:

Primary: ___________ UH-1 Trans: ___________

UH-1 Instr 1: ______ UH-1 Instr 2: ___________

OH-58 Trans: ______ Basic Cbt: ___________

(Night Acad: _______) NVG Flight: ___________

Total cumulative UH-1 flight hours: ______________

Total cumulative OH-58 flight hours: ______________

Circle one: RA NG RES

Test Eval Flight Dates (DD/MM/YR)

1.	______________	**6.**	______________
2.	______________	**7.**	______________
3.	______________	**8.**	______________
4.	______________	**9.**	______________
5.	______________	**10.**	______________

COMMENTS: ____

Aeroscout Student Pilot
NVG Questionnaire

Please respond to the questions below by placing a check [ ] to the left of the response choice that applies.

1. What benefit(s), if any, did you derive from using the NVG projection system? (Check all that apply.)

   ______ a. It familiarized me with wearing NVGs.
   ______ b. It reinforced knowledge that I already had.
   ______ c. It reduced any apprehension I had prior to experiencing an NVG flight.
   ______ d. It helped me to learn how to recognize/identify/interpret objects in low-level light.
   ______ e. I derived no benefit.
   ______ f. Other (specify) ______________________________

2. Did the NVG projection system fulfill your expectations for what an NVG flight might look like?

   ______ a. Yes, (In what way?) ______________________________
   ______ b. No. (Why not?) ______________________________

3. Was the NVG projection system realistic, in your opinion?

   ______ a. Yes.
   ______ b. No.

4. Do you feel that the NVG projection system prepared you for your first NVG mission flight?

   ______ a. Yes. (In what way?) ______________________________
   ______ b. No. (Why not?) ______________________________

5. Did the NVG projection system provide cues that would be helpful in the performance of specific maneuvers and/or procedures?

   ______ a. Yes. (Which ones?) ______________________________
   ______ b. No. (Why not?) ______________________________

6. Do you think you would have learned to fly with NVGs as well or as quickly if you had not used the NVG projection system?

_____ a. Yes, I would have learned as well or as quickly.
_____ b. No, the simulator helped me to learn more quickly.

7. Was the information presented via the NVG projection system redundant to your other instruction?

_____ a. Yes.
_____ b. No.

Comments:

NVG Student Evaluation
IP Opinion Questionnaire

IP Name/Rank:______________________________ Date (DD/MM/YR):__________

Student Name:______________________________ Student SSN#: __________

NVG Flight #:__________________________ Student Class #: __________

Directions

Please respond to the statements below based on the NVG flight just completed with the student. Indicate by checking the appropriate column for Strongly Agree (SA), Agree (A), Mildly Agree (MA), Mildly Disagree (MD), Disagree (D), Strongly Disagree (SD), or it's Not Applicable (N/A).

	SA	A	MA	MD	D	SD	N/A
1. The student was familiar with NVG mission procedures.							
2. The student exhibited or expressed confidence in his/her NVG flight abilities.							
3. The student had difficulty becoming oriented to objects while the NVGs were operational.							
4. The student asked questions or made comments indicating knowledge of NVG use or application.							
5. There was improvement in the student's performance compared to the student's previously evaluated flight.							
6. During an actual NVG flight, the student was able to complete the required tasks with little or no observed apprehension.							
7. The student demonstrated a clear understanding when instructed in a task during NVG training.							
8. The student was able to perform a task to ATM standards in fewer iterations than the student's previous NVG flight.							

NVG Student Evaluation
IP Opinion Questionnaire-Part II

The questions below are intended for you, as the IP, to rate the student pilot's performance during tonight's NVG flight IAW ATM standards. Please indicate your response by checking the column for the appropriate phrase to the right of the question.

	Poor	Below Average	Average	Above Average	Profi-cient	N/A
1. How quickly did the student adapt to NVG use on this flight?						
2. How well was the student able to perform a newly-introduced task?						
3. How well was the student able to perform a task that the student per-formed previously?						
4. How well did the student perform on a task that was weak for him/her on a prior flight?						
5. Overall, how quickly is the student learning NVG flight procedures?						

Use the space below to make additional comments you feel are relevant to the student's NVG flight abilities.

____

____

____

____

____

APPENDIX C

Student Flight Performance Gradeslip

Aeroscout NVG
Student Flight Performance Gradeslip

IP Name/Rank:______________________ Date (DD/MM/YR):__________

Student Name:______________________ Student #:__________

NVG Flight #:______________________ Student Class #:__________

Ambient Light Conditions During Flight:______________________

Directions

Please use the following scale to describe the student's performance during tonight's flight. Base your response on the initial performance of the task, and rate the performance IAW ATM standards. Check the appropriate column for each task according to the following scale.

1. The student could not complete or failed to complete the task.
2. The student could not complete the task to ATM standards without physical assistance.
3. The student could not complete the task to ATM standards without verbal assistance.
4. The student completed the task with acceptable deviations from ATM standards.
5. The student completed the task in accordance with ATM standards.
6. The student's performance was exemplary.

Do not record a response for tasks that were not performed.

(To the left of each task, record the number of iterations that were necessary for the student to eventually complete the task to ATM standards.)

OH-58 NVG FLIGHT TASKS

# ITER.	TASK	1	2	3	4	5	6
_____	1. NVG Takeoff						
_____	2. NVG Approach-Hover						
_____	3. NVG Approach-Ground						
_____	4. NVG Approach-W/FWD/ A/S						
_____	5. Slope Operations						
	6. Confined Area Operations						
_____	6a. Approach						
_____	6b. Takeoff						
_____	7. OGE Hover Check						
_____	8. Masking and Unmasking						

APPENDIX D

Student Debrief Data

Aeroscout Student Pilot
NVG Questionnaire Responses
(Debrief)

1. What benefit(s), if any, did you derive from using the NVG projection system? (Check all that apply.)

- **10** a. It familiarized me with wearing NVGs.
- **5** b. It reinforced knowledge that I already had.
- **5** c. It reduced any apprehension I had prior to experiencing an NVG flight.
- **9** d. It helped me to learn how to recognize/identify/interpret objects in low-level light.
- **3** e. I derived no benefit.
- **2** f. Other: "scanning reinforced"; "presentation crude, but with further technical application I feel its a good idea.

2. Did the NVG projection system fulfill your expectations for what an NVG flight might look like?

17 (73.9%) a. Yes. (In what way?)
- scanning - 2
- depth perception - 2
- depends on ambient light - 4
- helpful - 5

6 (26.1%) b. No. (Why not?)
- technical criticism (operational/taping) - 5
- limited peripheral - 1

3. Was the NVG projection system realistic, in your opinion?

16 (69.6%) a. Yes.

7 (30.4%) b. No.
- scanning too fast/not under my control - 3
- problems with right/left orientation - 1
- needs motion - 1

4. Do you feel that the NVG projection system prepared you for your first NVG mission flight?

13 (56.5%) a. Yes. (In what way?)
- gave me a good idea what to expect - 3
- general cues - 2
- how things look under NVGs - 2
- approach cues - 1
- scanning - 1
- reinforced previous knowledge - 1

10 (43.5%) b. No. (Why not?)
technical criticism (operational/taping) - 5
film & actual flight are different - 5

5. Did the NVG projection system provide cues that would be helpful in the performance of specific maneuvers and/or procedures?

16 (69.6%) a. Yes. (Which ones?)
approach/departure cues - 5
scanning - 3
OGE hover check - 2
visual - 2
vague - 1
7 (30.4%) b. No. (Why not?)
cues are learned through experience - 4
technical criticism (operational/taping) - 2
what are cues? - 1

6. Do you think you would have learned to fly with NVGs as well or as quickly if you had not used the NVG projection system?

19 (82.6%) a. Yes, I would have learned as well or as quickly.
4 (17.4%) b. No, the simulator helped me to learn more quickly.

7. Was the information presented via the NVG projection system redundant to your other instruction?

8 (34.8%) a. Yes.
15 (65.2%) b. No.

GENERAL COMMENTS.

familiarization effect of the system - 6
the tape/system was a good idea - 8
learned some techniques - 2
good mounting experience - 1
suggestions for improvement - 9
limitations of tape/system increased apprehension - 1