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Spatial Disorientation Demonstration Flight for U.S. Army Aviators in the TH-67, UH-1 and UH-60 Helicopters

by
Arthur Estrada, Malcolm G. Braithwaite, Siobhan M. Hoffman, and Patricia A. LeDuc

Aircrew Health and Performance Division

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Spatial disorientation (SD) occurs when a pilot misperceives the position, motion, or attitude of his or her aircraft. In wartime, the risk of SD is heightened by the extra pressure on sensory and cognitive resources. During Operation Desert Shield/Storm, 81 percent of U.S. Army aviation nighttime accidents were ascribed to SD. An important countermeasure to SD is the aviator's awareness of his physiological vulnerability to SD and the circumstances in which SD is most likely to occur. Consequently, all military aviators must attend courses of instruction in SD. Most student pilots are given instruction during their flight training on how to overcome the effects of SD, but few air services provide a specific SD demonstration sortie to augment ground-based training. An in-flight demonstration of SD reinforces knowledge of the limitations of the orientation senses in flight and enhances aircrew awareness of potentially disorientating situations.

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Due to anticipated funding and asset changes at the U.S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama, flight training may be affected and undergo revision. In an effort to be responsive to future training requirements and as the developer of this SD flight training, USAARL is publishing this report, which contains the SD demonstration flight lesson plans for the UH-1, the UH-60 and the TH-67 helicopters.

Table of Contents

Introduction

Spatial disorientation (SD) occurs when a pilot misperceives the position, motion, or attitude of his or her aircraft. Such a misperception may have disastrous effects. SD was considered to be a significant factor in 291 (30 percent) Class A-C helicopter accidents in the U.S. Army in the 8-year period between 1987 and 1995 (Braithwaite, Groh and Alverez, 1997). One hundred and ten lives were lost in these accidents, and a cost of nearly $468 million was incurred. It should be remembered that only a small proportion of SD episodes lead to accidents, and that nonmishap incidents also impose operational costs in terms of reduced efficiency or abandonment of the mission. In wartime, the risk of SD is heightened by the extra pressure on sensory and cognitive resources. During Operation Desert Shield/Storm, 81 percent of U.S. Army aviation nighttime accidents were ascribed to SD (Durnford et al., 1995).

One of the most important countermeasures to SD is the aviator's awareness of his physiological vulnerability to SD and the operational circumstances and phases of flight in which SD is most likely to occur. Consequently, all military aviators must attend courses of instruction in SD. Despite regulations that mandate SD training, there is great variability in the quality, quantity, and frequency of this teaching, not only between nations and services within a nation, but within each service itself (Braithwaite, 1994). There is, therefore, room for improvement in all aspects of SD training. The didactic instruction given to initial entry rotary-wing (IERW) pilots and during refresher courses was addressed by the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Alabama, in response to a request from the U.S. Army School of Aviation Medicine (USASAM), Fort Rucker (Braithwaite, 1997b).

It has long been accepted that the demonstration of some of the illusions of SD and the limitations of the orientation senses during ground-based training is a vital part of the proper education of aviators. Most student pilots are given instruction during their flight training on how to overcome the effects of SD, but few air services provide a specific SD demonstration sortie to augment ground-based training. An in-flight demonstration of SD reinforces knowledge of the limitations of the orientation senses in flight and enhances aircrew awareness of potentially disorientating situations. In-flight SD training, on the other hand, consists of a series of flight procedures to teach aviators how to cope with disorientating circumstances and illusions (e.g., recovery from unusual attitudes during instrument flying).

It was in the pursuance of this philosophy that a specific SD demonstration flight was developed and has been used by the British Army over the last 15 years. The training flight aims to demonstrate the limitations of an aviator's orientation senses during helicopter maneuvers in flight. The demonstration cannot be conducted in a motion-based simulator because these devices cannot create the appropriate acceleration environment to induce an effective result. A recent analysis compared the incidence of British Army Air Corps SD accidents before and after the SD demonstration flight was introduced. The analysis revealed that there has been a significant reduction in the rate of SD related mishaps (Braithwaite, 1997a). Although there are confounding factors which affect this finding, it must be concluded that the training has been of benefit to British Army helicopter operations. Furthermore, in a

survey of 299 British Army helicopter aircrew (Durnford, 1992), 79 percent of aviators regarded the sortie as being a most valuable addition to the aeromedical training syllabus.

A study was conducted by the USAARL in 1997 (Braithewaite et al, 1997). This project set out to determine whether the SD demonstration flight would be an effective adjunct in training aircrew in SD in the U.S. Army. The study concluded that the SD demonstration flight was a viable method of training U.S. Army aviators. Following the study, the demonstration flight was integrated into the IERW training syllabus.

Due to anticipated funding and asset changes at the U.S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama, flight training may be affected and undergo revision. In an effort to be responsive to future training requirements and as the developer of this SD flight training, USAARL is publishing this report containing the SD demonstration flight lesson plans for the TH-67, UH-1, and UH-60 helicopters.

Methods

In a TH-67 helicopter, the flight demonstration is commanded and flown by an instructor pilot (IP). The IP will conduct the training. Personnel to whom the maneuvers are being demonstrated occupy the other pilot station and a forward-facing passenger seat. Personnel are fully briefed on the nature of the demonstration.

In a UH-1 or UH-60 helicopter, the flight demonstration is commanded and flown by an IP and copilot. A flight surgeon or facilitator (a USASAM trainer) will conduct the training from a passenger/gunner's seat. Personnel to whom the maneuvers are being demonstrated occupy forward-facing passenger seats. Personnel are fully briefed on the nature of the demonstration.

Following a transit to the demonstration area, a series of forward flight and hover maneuvers are conducted. All doors should remain on and closed for this demonstration to eliminate wind and extra noise that may serve as a cue to the student. In turn, personnel are asked to sit free of the airframe structures other than the seat, note the aircraft's initial flight parameters, close their eyes and lower their dark visor, and as the "subject" student for that maneuver, to give a running commentary on their perception of the aircraft's flight path. In this way, the "subject" student is deprived of vision, the most important orientational sense, so that the limitations, particularly the unreliability of the nonvisual orientational senses, can be demonstrated. The other person/personnel (observer(s)) are asked to observe but not comment until after the maneuver is complete. The IP/flight surgeon/facilitator then debriefs the individual maneuver to include the physiology involved as it relates to that maneuver. All personnel experience at least one maneuver in each of the forward flight and hover groups.

References

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Braithwaite, M.G. 1997b. A review of training in spatial disorientation. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory. USAARL Technical Memorandum No. 97-20.

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Appendix A.

Spatial disorientation demonstration flight (TH-67 lesson plan).

DECEMBER 1999

SPATIAL DISORIENTATION DEMONSTRATION FLIGHT (TH-67 Lesson Plan)

TABLE OF CONTENTS

SECTION I. - ADMINISTRATIVE DATA

1. TASK(S) TAUGHT OR SUPPORTED:

TASK NUMBER	TASK TITLE
N/A	N/A

2. TASK(S) REINFORCED:

TASK NUMBER	TASK TITLE
N/A	N/A

3. ACADEMIC/FLIGHT HOURS:

	PEACETIME HOURS/TYPE	MOBILIZATION HOURS/TYPE
ACADEMIC	0.1/CO	0.1/CO
FLIGHT	0.4/PE	0.4/PE
TEST	.0	.0
TEST REVIEW	.0	.0
TOTAL HOURS	0.5	0.5

4. LIST THE LESSON NUMBER IN WHICH THE TERMINAL LEARNING OBJECTIVE/ENABLING LEARNING OBJECTIVE IS TESTED AND THE TEST RESULTS ARE REVIEWED: See above.

	HOURS	LESSON NO
TESTING:	N/A	N/A
REVIEW OF THE TEST RESULTS:	N/A	N/A

5. PREREQUISITE LESSON: Spatial Disorientation and Sensory Illusions of Flight, File 2/5/9/9E/UEA/UEC/UEE/4505-3, PFN# 4505.

6. CLEARANCE AND ACCESS: Unclassified; foreign students may attend this class.

7. REFERENCE:

NUMBER	TITLE	PAGES	ADDITIONAL INFORMATION
FM 1-301	AEROMEDICAL TRAINING FOR FLIGHT PERSONNEL	8-1 - 8-13	Chapter 8

8. STUDENT STUDY ASSIGNMENT: None.

9. INSTRUCTOR REQUIREMENTS: One TH-67 flight instructor.

10. ADDITIONAL SUPPORT PERSONNEL REQUIREMENTS: None.

11. EQUIPMENT REQUIRED FOR THE INSTRUCTION: One TH-67 helicopter, an intercom system which accommodates all crew/students, and flight protective clothing and equipment per AR 95-1 (dark visor on helmet).

12. MATERIALS REQUIRED FOR THE INSTRUCTION:

INSTRUCTOR MATERIALS: Spatial Disorientation Demonstration Flight (TH-67 Lesson Plan).

STUDENT MATERIALS: None.

13. CLASSROOM, TRAINING AREA, AND/OR RANGE REQUIREMENTS: A flight training area and stagefield or landing zone (LZ) with low aviation activity is desirable.

14. AMMUNITION REQUIREMENT: None.

15. INSTRUCTIONAL GUIDANCE: The TH-67 instructor pilot will be proficient in the required enabling learning objective (ELO) flight maneuvers and will perform all ELO flight maneuvers within the standards established in the TH-67 Aircrew Training Program manual.

16. LESSON PLAN WRITTEN BY:

NAME	RANK	POSITION	DATE
_____ ARTHUR ESTRADA III	DAC	RESEARCH HELICOPTER PILOT, FSB, USAARL	15 DEC 99

17. PROPONENT LESSON PLAN APPROVAL AUTHORITY:

NAME	RANK	POSITION	DATE
_____ PATRICIA A. LEDUC	DAC	C, SPATIAL DIS-ORIENTATION TEAM, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ CORINA VANDEPOL	MAJ	DIRECTOR, AHPD, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ JOHN A. POWELL	COL	COMMANDER, USAARL	15 DEC 99

18. BRANCH SAFETY OFFICER APPROVAL:

NAME	RANK	POSITION	DATE
_____			

ANNUAL REVIEW

PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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SECTION II. - INTRODUCTION

Method of Instruction: PE. Instructor to student ratio is 1:2.

Time of Instruction: 0029 minutes.

Media: None.

MOTIVATOR:

NOTE: The flight instructor may use a motivator of his or her choice; however, he or she must ensure that it gains the students' attention, states the need for this training, and explains the terminal learning objective (TLO). A suggested motivator follows:

"There appears to be a killer stalking Army aviation. When it strikes, pilots are unable to see, believe, interpret, or process the information on their flight instruments. Instead, they rely on false information their senses provide, becoming victims of spatial disorientation (FLIGHTFAX, February 1997). Our goal today is to reinforce the academic instruction you've already received and to allow you to experience the physiological limitations of your orientation senses during actual flight. This training will enhance your awareness of potentially disorienting situations, allowing you to recognize what is happening, and how best to prevent it from happening."

TERMINAL LEARNING OBJECTIVE (TLO):

NOTE: Read the TLO requirements to the students.

At the completion of this lesson the student will:

ACTION: Be aware of the physiological limitations of the orientation senses and how to best prevent spatial disorientation.

CONDITION: In a TH-67 helicopter, secured in a seat.

STANDARD: In accordance with (IAW) FM 1-301, Aeromedical Training For Flight Personnel.

SAFETY REQUIREMENTS: The instructor pilot will ensure that the students receive a full crew briefing IAW the TH-67 Operator's Supplement prior to the flight.

NOTE: During the conduct of the various ELO flight maneuvers, there will be periods of reduced intercommunications with regards

to direction of turns and their magnitudes. Therefore, the observing students will be instructed to assist with airspace surveillance and to feel free to verbalize their concerns whenever safety appears to be compromised.

RISK ASSESSMENT LEVEL: Low.

ENVIRONMENTAL CONSIDERATIONS:

1. This demonstration flight will be conducted under visual flight rules (VFR) only. Since the training requires flight at altitudes of at least 500 feet above ground level (AGL), the worst weather should be forecast to be equal to or greater than 1000 feet ceilings and 3 miles visibility during the demonstration flight .

2. Wind speed should not exceed 20 knots. Greater wind speed will require a reevaluation of the risk assessment level.

EVALUATION: Because this training reinforces material already academically taught and evaluated, there is no formal evaluation. The flight instructor will provide oral quizzing relating to the physiological senses and spatial disorientation prior to, during and after the flight to ensure continuity of the academic and flight training.

INSTRUCTIONAL LEAD IN:

NOTE: The flight instructor may use an instructional lead in of his or her choice. A suggested instructional lead-in follows:

"The academic classes you attended at the School of Aviation Medicine provided the knowledge necessary to understand your orientation senses and the effects of spatial disorientation. This flight will reinforce that knowledge and provide you with a flight experience which will demonstrate your physiological limitations with regards to spatial orientation."

SECTION III. - PRESENTATION

WARNING: Because the ELO flight maneuvers require short periods during which the verbalization of direction of turns and their magnitudes would defeat the purpose of the training, the flight instructor will be especially alert to obstacle and collision avoidance. The flight instructor will be thoroughly familiar with each ELO flight maneuver, the sequence in which they will be performed, and the flight training areas in which they will be flown. If safety is ever compromised, the flight maneuver will be immediately terminated.

NOTE: The flight instructor will begin the presentation phase after takeoff and during the flight to the flight training area/stagefield/LZ.

NOTE: Inform the students of the Enabling Learning Objective requirements.

A. ENABLING LEARNING OBJECTIVE (ELO) #1:

ACTION: Explanation of ELO flight maneuvers and brief review of orientation senses.

CONDITION: In a TH-67 helicopter, secured in a seat, enroute to the flight training area/stagefield/LZ.

STANDARD: In accordance with FM 1-301.

Learning Step/Activity: Explain individual roles during ELO flight maneuvers and provide a brief review of orientation senses.

Method of Instruction: CO. Instructor to student ratio is 1:2.

Time of instruction: 0003 minutes.

Media: None.

NOTE: Provide general assurance that no violent maneuvers will be performed and that no maneuvers will exceed the aircraft's limitations per TH-67 Operator's Supplement.

a. Explanation of ELO flight maneuvers.

(1) Prior to the commencement of each ELO flight maneuver, one of the students will be identified as the “subject student.” (Each student will be a subject student during at least one high level ELO flight maneuver and one hover ELO flight maneuver.) The subject student will sit free of all airframe structures other than the seat. He or she will lower his/her dark visor and note the aircraft's initial parameters (airspeed, altitude and heading) as provided by the flight instructor. The subject student will then close

his/her eyes and provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading. **The IP will instruct the student to maintain a head position oriented as if flying the aircraft.**

(2) The other student will observe, but not comment, until after the ELO flight maneuver is terminated.

(3) At the completion of each ELO flight maneuver, the subject student will be instructed when to open his/her eyes. The observing student will be asked to tell the subject student what actually happened.

b. The flight instructor will briefly review orientation senses.

Three sensory systems are especially important in maintaining equilibrium, orientation, and balance. They are the proprioceptive system, the vestibular system, and the visual system. Normally, the combined functioning of these senses maintains equilibrium and spatial orientation.

NOTE: The contribution of hearing to orientation is small and variable; e.g., changes in the sound of rotor blade rotation caused by angles of bank. It cannot be relied upon until you have had a great deal of experience in that type of aircraft, and so will not be mentioned further.

(1) Visual sense. Of the three sensory systems, the visual system is the most important in maintaining equilibrium and spatial orientation. (Stress the overwhelming contribution of vision to orientation and that spatial disorientation is primarily a problem associated with poor external visual conditions. Explain that it is due to the importance of vision that the subject student will be deprived of his/her vision during the subsequent ELO flight maneuvers.)

(2) Vestibular system. This system is the motion- and gravity-detecting organ located in the inner ear. The vestibular apparatus consists of two distinct structures: the semicircular canals (sense angular accelerations) and the otolith organs (sense linear accelerations).

(3) Proprioceptive system. This system reacts to the sensations resulting from pressures on joints, muscles, and skin and also from slight changes in the position of internal organs.

NOTE: Conduct a check on learning and summarize the learning step/activity.

B. ENABLING LEARNING OBJECTIVE (ELO) #2:

ACTION: Demonstrate the limitations of performance of the semicircular canals (ELO Flight Maneuver #1).

CONDITION: In a TH-67 helicopter, secured in a seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of performance of the semicircular canals.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #1.

(1) The flight instructor will assign the subject student who will then lower his/her dark visor.

(2) The flight instructor will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight instructor will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #1.

(1) Ten seconds after the subject student announces eyes closed, the flight instructor will initiate a gently increasing, yet detectable, left or right roll (3 degrees/second) until the aircraft achieves a turn of standard rate. The turn is continued for 360 degrees. The aircraft is then rolled wings-level at a rate that will be easily detected by the subject student. (The rate of rollout should be approximately twice as fast as the rate of entry or 6 degrees/second.)

NOTE: The initial roll is normally detected, but as the semicircular canal response decays, a false sensation of a return to straight and level flight is perceived. As the rollout to level flight is made, a sensation of turning in the opposite direction is perceived.

(2) After the rollout, the student is instructed to open his/her eyes once straight and level flight is again perceived.

c. After completion of ELO Flight Maneuver #1.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will then remind the students of the limitations of the physiology of semicircular canal performance.

NOTE: Conduct a check on learning and summarize the learning step/activity, stressing how easy it is to detect roll by vision, but how difficult it can be when deprived of it.

C. ENABLING LEARNING OBJECTIVE (ELO) #3:

ACTION: Demonstrate the limitations and illusions of the proprioceptive system and vestibular apparatus (ELO Flight Maneuver #2).

CONDITION: In a TH-67 helicopter, secured in a seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations and illusions of the proprioceptive system and the vestibular apparatus.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #2.

(1) The flight instructor will assign the other student to be the subject student who will then lower his/her dark visor.

(2) The flight instructor will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight instructor will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #2.

(1) Following the subject student's announcement of "eyes closed," the aircraft will be flown with no alteration of airspeed, altitude, or heading.

NOTE: Because of small aircraft movements from turbulence and the aerodynamic response of the helicopter which stimulate the proprioceptive system and/or the vestibular apparatus, students should perceive climbs, descents, or turns in unpredictable and varying amounts.

NOTE: On particularly calm days, minor pilot-induced turbulence may be necessary.

(2) After approximately 90 seconds, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #2.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will then discuss the erroneous sensations produced by brief stimulation of the proprioceptive system and vestibular apparatus.

NOTE: Conduct a check on learning and summarize the learning step/activity.

D. ENABLING LEARNING OBJECTIVE (ELO) #4:

ACTION: Demonstrate the limitations of the otolith organs (ELO Flight Maneuver #3).

CONDITION: In a TH-67 helicopter, secured in a seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of the otolith organs.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #3.

(1) The flight instructor will assign the other student to be the subject student who will then lower his/her dark visor.

(2) The instructor pilot will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and a heading which is ideally into the wind.

(3) The flight instructor will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #3.

(1) Following the subject student's announcement of "eyes closed," the flight instructor will initiate a deceleration which will result in a free air hover in 30-40 seconds. There will be no change of heading or altitude.

NOTE: Both the deceleration and the final nose-up pitch associated with the attitude change when slowing the aircraft usually convinces the student that a climb is taking place. In addition, a turn is often falsely perceived when balance variations are made to maintain straight and level flight.

(2) After establishment of the free air hover, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #3.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will then discuss the physiological limitations of the otolith organs and the somatogravic illusion.

NOTE: Conduct a check on learning and summarize the learning step/activity.

E. ENABLING LEARNING OBJECTIVE (ELO) #5:

ACTION: Demonstrate physiological limitations of detecting inadvertent descents. (ELO Flight Maneuver #4).

CONDITION: In a TH-67 helicopter, secured in a seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the physiological limitations of detecting inadvertent descents.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #4.

(1) The flight instructor will assign a subject student who will then lower his/her dark visor.

(2) The instructor pilot will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

NOTE: This flight maneuver will terminate at terrain flight altitudes, therefore, the flight instructor will ensure that a safe descent can be made within the training area. Additionally, the instructor pilot should plan the descent so as to terminate the flight maneuver in close proximity to a predetermined stagefield or LZ within which the next three enabling learning objectives will be performed.

(3) The flight instructor will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #4.

(1) After the subject student announces “eyes closed,” the instructor pilot will initiate a detectable left or right turn while gently entering an undetectable descent (less than 500 feet per minute). During the descent, it is acceptable for the instructor pilot to perform variable right and left turns. Upon reaching a safe terrain flight altitude, ideally, in close proximity of a predetermined stagefield or LZ, the instructor pilot will establish straight and level flight.

NOTE: The student, remembering ELO Flight Maneuver #2, usually states that he/she has rolled out straight and level, unaware of the change in altitude.

(2) After establishment of straight and level terrain flight, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #4.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will then discuss how easily a pilot can become unaware of an inadvertent descent in restricted visibility (fog, dust, snow, and night operations).

NOTE: Conduct a check on learning and summarize the learning step/activity.

WARNING: The following ELO Fight Maneuvers (ELO's #6 through #8) are performed in a landing zone or at a stagefield, therefore, it is imperative that a comprehensive assessment of the hazards be conducted. The terrain should be familiar to the flight instructor, and the observing student must assist with airspace surveillance.

NOTE: During this series of hovering maneuvers, each student will experience being a subject student at least once.

F. ENABLING LEARNING OBJECTIVE (ELO) #6:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #5).

CONDITION: In a TH-67 helicopter, secured in a seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #5.

(1) The flight instructor will assign the other subject student who will then lower his/her dark visor.

(2) The flight instructor will establish the aircraft in a stable 3 feet hover.

(3) The flight instructor will announce the aircraft altitude, heading and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #5.

(1) After the subject student announces "eyes closed," the instructor pilot will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the instructor pilot will end the exercise with the establishment of a backward climb at 10-15 knots.

(2) During the hovering maneuvers, the flight instructor will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the backward climb is established, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #5 exercise.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

G. ENABLING LEARNING OBJECTIVE (ELO) #7:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #6).

CONDITION: In a TH-67 helicopter, secured seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #6.

(1) The flight instructor will assign a different subject student who will then lower his/her dark visor.

(2) The flight instructor will establish the aircraft in a stable 3 feet hover.

(3) The flight instructor will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #6.

(1) After the subject student announces "eyes closed," the flight instructor will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the flight instructor will very gently land without the subject student realizing it. After landing, the IP may continue minor cyclic inputs to simulate hovering flight.

(2) During the hovering maneuvers, the flight instructor will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the aircraft is gently landed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #6 exercise.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

H. ENABLING LEARNING OBJECTIVE (ELO) #8:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #7).

CONDITION: In a TH-67 helicopter, secured in a seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TH-67 Aircrew Training Program manual.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:2.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #7.

(1) The flight instructor will assign a different subject student who will then lower his/her dark visor.

(2) The flight instructor will establish the aircraft in a stable 3 feet hover.

(3) The flight instructor will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject student may need to cover his/her eyes with his/her hands.)

(4) The flight instructor will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #7.

(1) After the subject student announces "eyes closed," the instructor pilot will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the instructor pilot will end the exercise with a gentle transition to forward flight.

(2) During the hovering maneuvers, the flight instructor will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the transition to forward flight is completed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #7 exercise.

(1) The observing student will be asked to tell the subject student what actually happened.

(2) The flight instructor will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

SECTION IV. - SUMMARY

Method of Instruction: CO. Instructor to student ratio is 1:2.

Time of Instruction: 0003 minutes.

Media: None.

1. REVIEW/SUMMARIZE

a. On the return flight to the basefield, the flight instructor will discuss the Spatial Disorientation Demonstration Flight. He/she will make particular reference to the significance of undetectable maneuvers and erroneous sensory information cues.

b. The students are reassured that they are all physiologically normal, but that humans are just not "designed" for flight. The objective of the demonstration flight is to provide them with an idea of the limitations of their own physiology in the environment in which they operate and the phases of flight commonly associated with spatial disorientation.

c. Advise the students that the best way to avoid and counter the effects of spatial disorientation is to achieve a working knowledge of the limitations of the orientation senses and to maintain proficiency at instrument flying.

2. CHECK ON LEARNING.

a. Solicit student questions and explanations.

b. Questions and answers.

NOTE: No specific questions are required. The flight instructor can quiz any demonstrated weak areas.

c. Correct students' misunderstandings.

3. TRANSITION TO NEXT LESSON. N/A.

SECTION V. - STUDENT EVALUATION

1. TESTING REQUIREMENTS: None.

2. FEEDBACK REQUIREMENTS: None.

Appendix B.

Spatial disorientation demonstration flight (UH-1 lesson plan).

DECEMBER 1999

SPATIAL DISORIENTATION DEMONSTRATION FLIGHT (UH-1 Lesson Plan)

TABLE OF CONTENTS

SECTION I. - ADMINISTRATIVE DATA

1. TASK(S) TAUGHT OR SUPPORTED:

TASK NUMBER	TASK TITLE
N/A	N/A

2. TASK(S) REINFORCED:

TASK NUMBER	TASK TITLE
N/A	N/A

3. ACADEMIC/FLIGHT HOURS:	PEACETIME HOURS/TYPE	MOBILIZATION HOURS/TYPE
ACADEMIC	0.1/CO	0.1/CO
FLIGHT	0.4/PE	0.4/PE
TEST	.0	.0
TEST REVIEW	.0	.0
TOTAL HOURS	0.5	0.5

4. LIST THE LESSON NUMBER IN WHICH THE TERMINAL LEARNING OBJECTIVE/ENABLING LEARNING OBJECTIVE IS TESTED AND THE TEST RESULTS ARE REVIEWED: See above.

	HOURS	LESSON NO
TESTING:	N/A	N/A
REVIEW OF THE TEST RESULTS:	N/A	N/A

5. PREREQUISITE LESSON: Spatial Disorientation and Sensory Illusions of Flight, File 2/5/9/9E/UEA/UEC/UEE/4505-3, PFN# 4505.

6. CLEARANCE AND ACCESS: Unclassified; foreign students may attend this class.

7. REFERENCE:

NUMBER	TITLE	PAGES	ADDITIONAL INFORMATION
FM 1-301	AEROMEDICAL TRAINING FOR FLIGHT PERSONNEL	8-1 - 8-13	Chapter 8

8. STUDENT STUDY ASSIGNMENT: None.

9. INSTRUCTOR REQUIREMENTS: One flight surgeon or facilitator (primary instructor) and one UH-1 pilot-in-command (to perform flight maneuvers). (NOTE: A UH-1 instructor pilot is desirable, but not necessary.) The flight surgeon/facilitator will be seated in the cockpit seat not used by the PIC.

10. ADDITIONAL SUPPORT PERSONNEL REQUIREMENTS: None.

11. EQUIPMENT REQUIRED FOR THE INSTRUCTION: One UH-1 helicopter with 3 forward-facing passenger seats, intercom system which accommodates all crew and passengers, and flight protective clothing and equipment per AR 95-1 (dark visor on helmet).

12. MATERIALS REQUIRED FOR THE INSTRUCTION:

INSTRUCTOR MATERIALS: Spatial Disorientation Demonstration Flight (UH-1 Lesson Plan).

STUDENT MATERIALS: None.

13. CLASSROOM, TRAINING AREA, AND/OR RANGE REQUIREMENTS: A flight training area and stagefield or landing zone (LZ) with low aviation activity is desirable.

14. AMMUNITION REQUIREMENT: None.

15. INSTRUCTIONAL GUIDANCE: The UH-1 pilot-in-command (PIC) will be proficient in the required enabling learning objective (ELO) flight maneuvers and will perform all ELO flight maneuvers within the standards established in Technical Circular (TC) 1-211 (Aircrew Training Manual, Utility Helicopter, UH-1).

16. LESSON PLAN WRITTEN BY:

NAME	RANK	POSITION	DATE
_____ ARTHUR ESTRADA III	DAC	RESEARCH HELICOPTER PILOT, FSB, USAARL	15 DEC 99

17. PROPONENT LESSON PLAN APPROVAL AUTHORITY:

NAME	RANK	POSITION	DATE
_____ PATRICIA A. LEDUC	DAC	C, SPATIAL DISORIENTATION TEAM, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ CORINA VANDEPOL	MAJ	DIRECTOR, AHPD, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ JOHN A. POWELL	COL	COMMANDER, USAARL	15 DEC 99

18. BRANCH SAFETY OFFICER APPROVAL:

NAME	RANK	POSITION	DATE
_____			

ANNUAL REVIEW

_____
PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

SECTION II. - INTRODUCTION

Method of Instruction: PE. Instructor to student ratio is 1:3.

Time of Instruction: 0029 minutes.

Media: None.

MOTIVATOR:

NOTE: The flight surgeon/facilitator will begin the introduction phase immediately following the passenger safety briefing conducted by the PIC.

NOTE: The flight surgeon/facilitator may use a motivator of his or her choice; however, he or she must ensure that it gains the students' attention, states the need for this training, and explains the terminal learning objective (TLO). A suggested motivator follows:

"There appears to be a killer stalking Army aviation. When it strikes, pilots are unable to see, believe, interpret, or process the information on their flight instruments. Instead, they rely on false information their senses provide, becoming victims of spatial disorientation (FLIGHTFAX, February 1997). Our goal today is to reinforce the academic instruction you've already received and to allow you to experience the physiological limitations of your orientation senses during actual flight. This training will enhance your awareness of potentially disorienting situations, allowing you to recognize what is happening, and how best to prevent it from happening."

TERMINAL LEARNING OBJECTIVE (TLO):

NOTE: Read the TLO requirements to the students.

At the completion of this lesson the student will:

ACTION: Be aware of the physiological limitations of the orientation senses and how to best prevent spatial disorientation.

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat.

STANDARD: In accordance with (IAW) FM 1-301, Aeromedical Training For Flight Personnel.

SAFETY REQUIREMENTS: The PIC will ensure that the students receive a full passenger safety briefing IAW TM 55-1520-210-10 prior to the flight.

NOTE: During the conduct of the various ELO flight maneuvers, there will be periods of reduced intercommunications with regards to direction of turns and their magnitudes. Therefore, the observing students will be instructed to assist with airspace surveillance and to feel free to verbalize their concerns whenever safety appears to be compromised.

RISK ASSESSMENT LEVEL: Low.

ENVIRONMENTAL CONSIDERATIONS:

1. This demonstration flight will be conducted under visual flight rules (VFR) only. Since the training requires flight at altitudes of at least 500 feet above ground level (AGL), the worst weather should be forecast to be equal to or greater than 1000 feet ceilings and 3 miles visibility during the demonstration flight .

2. Wind speed should not exceed 20 knots. Greater wind speeds will require a reevaluation of the risk assessment level.

EVALUATION: Because this training reinforces material already academically taught and evaluated, there is no formal evaluation. The flight surgeon/facilitator will provide oral quizzing relating to the physiological senses and spatial disorientation prior to, during and after the flight to ensure continuity of the academic and flight training.

INSTRUCTIONAL LEAD IN:

NOTE: The flight surgeon/facilitator may use an instructional lead in of his or her choice. A suggested instructional lead-in follows:

"The academic classes you attended at the School of Aviation Medicine provided the knowledge necessary to understand your orientation senses and the effects of spatial disorientation. This flight will reinforce that knowledge and provide you with a flight experience which will demonstrate your physiological limitations with regards to spatial orientation."

SECTION III. - PRESENTATION

WARNING: Because the ELO flight maneuvers require short periods during which the verbalization of direction of turns and their magnitudes would defeat the purpose of the training, the PIC and flight surgeon/facilitator will be especially alert to obstacle and collision avoidance. The flight crew will be thoroughly familiar with each ELO flight maneuver, the sequence in which they will be performed, and the flight training areas in which they will be flown. (This coordination will be conducted during the crew mission briefing prior to the arrival of the students.) During the conduct of the ELO flight maneuvers, the PIC will modify standard terminology. For example, instead of "Clear right?" or "Clear down?", he will request, "Clear to continue the maneuver?." The flight surgeon/facilitator, knowing the maneuver, will respond, "Clear to continue." If safety is ever compromised, standard terminology will be used to clearly state the situation and the flight maneuver will be immediately terminated.

NOTE: The flight surgeon/facilitator will begin the presentation phase after takeoff and during the flight to the training area.

NOTE: Inform the students of the Enabling Learning Objective requirements.

A. ENABLING LEARNING OBJECTIVE (ELO) #1:

ACTION: Explanation of ELO flight maneuvers and brief review of orientation senses.

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, enroute to the flight training area.

STANDARD: In accordance with FM 1-301.

Learning Step/Activity: Explain individual roles during ELO flight maneuvers and provide a brief review of orientation senses.

Method of Instruction: CO. Instructor to student ratio is 1:3.

Time of instruction: 0003 minutes.

Media: None.

NOTE: Provide general assurance that no violent maneuvers will be performed and that no maneuvers will exceed the aircraft's limitations per Technical Manual (TM) 55-1520-210-10 (Operator's Manual, Army Model, UH-1H/V Helicopters).

a. Explanation of ELO flight maneuvers.

(1) Prior to the commencement of each ELO flight maneuver, one of the students will be identified as the "subject student." (Each student will be a subject student during at least one high level ELO flight maneuver and one hover ELO flight maneuver.) The subject student will sit free of all airframe structures other than the seat. He or she will lower his/her dark visor and note the aircraft's initial parameters (airspeed, altitude and heading) as provided by the flight surgeon/facilitator. The subject student will then close his/her eyes and provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading. **The IP will instruct the student to maintain a head position oriented as if flying the aircraft.**

(2) The other students will observe, but not comment, until after the ELO flight maneuver is terminated.

(3) At the completion of each ELO flight maneuver, the subject student will be instructed when to open his/her eyes. An observing student will be asked to tell the subject student what actually happened and all observing students will be asked for their comments.

b. The flight surgeon/facilitator will briefly review orientation senses.

Three sensory systems are especially important in maintaining equilibrium, orientation, and balance. They are the proprioceptive system, the vestibular system, and the visual system. Normally, the combined functioning of these senses maintains equilibrium and spatial orientation.

NOTE: The contribution of hearing to orientation is small and variable; e.g., changes in the sound of rotor blade rotation caused by angles of bank. It cannot be relied upon until you have had a great deal of experience in that type of aircraft, and so will not be mentioned further.

(1) Visual sense. Of the three sensory systems, the visual system is the most important in maintaining equilibrium and spatial orientation. (Stress the overwhelming contribution of vision to orientation and that spatial disorientation is primarily a problem associated with poor external visual conditions. Explain that it is due to the importance of vision that the subject student will be deprived of his/her vision during the subsequent ELO flight maneuvers.)

(2) Vestibular system. This system is the motion- and gravity-detecting organ located in the inner ear. The vestibular apparatus consists of two distinct structures: the semicircular canals (sense angular accelerations) and the otolith organs (sense linear accelerations).

(3) Proprioceptive system. This system reacts to the sensations resulting from pressures on joints, muscles, and skin and also from slight changes in the position of internal organs.

NOTE: Conduct a check on learning and summarize the learning step/activity.

B. ENABLING LEARNING OBJECTIVE (ELO) #2:

ACTION: Demonstrate the limitations of performance of the semicircular canals (ELO Flight Maneuver #1).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of performance of the semicircular canals.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #1.

(1) The flight surgeon/facilitator will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #1.

(1) Ten seconds after the subject student announces eyes closed, the PIC will initiate a gently increasing, yet detectable, left or right roll (3 degrees/second) until the aircraft achieves a turn of standard rate. The turn is continued for 360 degrees. The aircraft is then rolled wings-level at a rate

that will be easily detected by the subject student. (The rate of roll-out should be approximately twice as fast as the rate of entry or 6 degrees/second.)

NOTE: The initial roll is normally detected, but as the semicircular canal response decays, a false sensation of a return to straight and level flight is perceived. As the roll-out to level flight is made, a sensation of turning in the opposite direction is perceived.

(2) After the roll-out, the student is instructed to open his/her eyes once straight and level flight is again perceived.

c. After completion of ELO Flight Maneuver #1.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then remind the students of the limitations of the physiology of semicircular canal performance.

NOTE: Conduct a check on learning and summarize the learning step/activity, stressing how easy it is to detect roll by vision, but how difficult it can be when deprived of it.

C. ENABLING LEARNING OBJECTIVE (ELO) #3:

ACTION: Demonstrate the limitations and illusions of the proprioceptive system and vestibular apparatus (ELO Flight Maneuver #2).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations and illusions of the proprioceptive system and the vestibular apparatus.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #2.

(1) The flight surgeon/facilitator will assign a different student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #2.

(1) Following the subject student's announcement of "eyes closed," the aircraft will be flown with no alteration of airspeed, altitude, or heading.

NOTE: Because of small aircraft movements from turbulence and the aerodynamic response of the helicopter which stimulate the proprioceptive system and/or the vestibular apparatus, students should perceive climbs, descents, or turns in unpredictable and varying amounts.

NOTE: On particularly calm days, minor pilot-induced turbulence may be necessary.

(2) After approximately 90 seconds, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #2.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss the erroneous sensations produced by brief stimulation of the proprioceptive system and vestibular apparatus.

NOTE: Conduct a check on learning and summarize the learning step/activity.

D. ENABLING LEARNING OBJECTIVE (ELO) #4:

ACTION: Demonstrate the limitations of the otolith organs (ELO Flight Maneuver #3).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of the otolith organs.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #3.

(1) The flight surgeon/facilitator will assign the third student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and a heading which is ideally into the wind.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #3.

(1) Following the subject student's announcement of "eyes closed," the PIC will initiate a deceleration which will result in a free air hover in 30-40 seconds. There will be no change of heading or altitude.

NOTE: Both the deceleration and the final nose-up pitch associated with the attitude change when slowing the aircraft usually convinces the student that a climb is taking place. In addition, a turn is often falsely perceived when balance variations are made to maintain straight and level flight.

(2) After establishment of the free air hover, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #3.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss the physiological limitations of the otolith organs and the somatogravic illusion.

NOTE: Conduct a check on learning and summarize the learning step/activity.

E. ENABLING LEARNING OBJECTIVE (ELO) #5:

ACTION: Demonstrate physiological limitations of detecting inadvertent descents. (ELO Flight Maneuver #4).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the physiological limitations of detecting inadvertent descents.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #4.

(1) The flight surgeon/facilitator will assign a subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

NOTE: This flight maneuver will terminate at terrain flight altitudes, therefore, the PIC will ensure that a safe descent can be made within the training area. Additionally, the PIC should plan the descent so as to terminate the flight maneuver in close proximity to a predetermined stagefield or LZ within which the next three enabling learning objectives will be performed.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #4.

(1) After the subject student announces "eyes closed," the PIC will initiate a detectable left or right turn while gently entering an undetectable descent (less than 500 feet per minute). During the descent, it is acceptable for the PIC to perform variable right and left turns. Upon reaching a safe terrain flight altitude, ideally, in close proximity of a predetermined stagefield or LZ, the PIC will establish straight and level flight.

NOTE: The student, remembering ELO Flight Maneuver #2, usually states that he/she has rolled out straight and level, unaware of the change in altitude.

(2) After establishment of straight and level terrain flight, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #4.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss how easily a pilot can become unaware of an inadvertent descent in restricted visibility (fog, dust, snow, and night operations).

NOTE: Conduct a check on learning and summarize the learning step/activity.

WARNING: The following ELO Fight Maneuvers (ELO's #6 through #8) are performed in a landing zone or at a stagefield, therefore, it is imperative that a comprehensive assessment of the hazards be conducted. The terrain should be familiar to the crew, and they and the observing students must maintain good airspace surveillance.

NOTE: During this series of hovering maneuvers, each student will experience being a subject student.

F. ENABLING LEARNING OBJECTIVE (ELO) #6:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #5).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #5.

(1) The flight surgeon/facilitator will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude, heading and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #5.

(1) After the subject student announces "eyes closed," the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with the establishment of a backward climb at 10-15 knots.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the backward climb is established, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #5 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

G. ENABLING LEARNING OBJECTIVE (ELO) #7:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #6).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #6.

(1) The flight surgeon/facilitator will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #6.

(1) After the subject student announces "eyes closed," the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will very gently land the aircraft without the subject student realizing it. After landing, the IP may continue minor cyclic inputs to simulate hovering flight.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the aircraft is gently landed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #6 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

H. ENABLING LEARNING OBJECTIVE (ELO) #8:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #7).

CONDITION: In a UH-1 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-211.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #7.

(1) The flight surgeon/facilitator will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 5 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #7.

(1) After the subject student announces “eyes closed,” the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to “hide” various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with a gentle transition to forward flight.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the transition to forward flight is completed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #7 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

SECTION IV. - SUMMARY

Method of Instruction: CO. Instructor to student ratio is 1:3.

Time of Instruction: 0003 minutes.

Media: None.

1. REVIEW/SUMMARIZE

a. On the return flight to the basefield, the flight surgeon/facilitator will discuss the Spatial Disorientation Demonstration Flight. He/she will make particular reference to the significance of undetectable maneuvers and erroneous sensory information cues.

b. The students are reassured that they are all physiologically normal, but that humans are just not "designed" for flight. The objective of the demonstration flight is to provide them with an idea of the limitations of the own physiology in the environment in which they operate and the phases of flight commonly associated with spatial disorientation.

c. Advise the students that the best way to avoid and counter the effects of spatial disorientation is to achieve a working knowledge of the limitations of the orientation senses and to maintain proficiency at instrument flying.

2. CHECK ON LEARNING.

a. Solicit student questions and explanations.

b. Questions and answers.

NOTE: No specific questions are required. The flight surgeon/facilitator can quiz any demonstrated weak areas.

c. Correct students misunderstandings.

3. TRANSITION TO NEXT LESSON. N/A.

SECTION V. - STUDENT EVALUATION

1. TESTING REQUIREMENTS: None.

2. FEEDBACK REQUIREMENTS: None.

Appendix C.

Spatial disorientation demonstration flight (UH-60 lesson plan).

DECEMBER 1999

SPATIAL DISORIENTATION DEMONSTRATION FLIGHT (UH-60 Lesson Plan)

TABLE OF CONTENTS

SECTION I. - ADMINISTRATIVE DATA

1. TASK(S) TAUGHT OR SUPPORTED:

TASK NUMBER	TASK TITLE
N/A	N/A

2. TASK(S) REINFORCED:

TASK NUMBER	TASK TITLE
N/A	N/A

3. ACADEMIC/FLIGHT HOURS:

	PEACETIME HOURS/TYPE	MOBILIZATION HOURS/TYPE
ACADEMIC	0.1/CO	0.1/CO
FLIGHT	0.4/PE	0.4/PE
TEST	.0	.0
TEST REVIEW	.0	.0
TOTAL HOURS	0.5	0.5

4. LIST THE LESSON NUMBER IN WHICH THE TERMINAL LEARNING OBJECTIVE/ENABLING LEARNING OBJECTIVE IS TESTED AND THE TEST RESULTS ARE REVIEWED: See above.

	HOURS	LESSON NO
TESTING:	N/A	N/A
REVIEW OF THE TEST RESULTS:	N/A	N/A

5. PREREQUISITE LESSON: Spatial Disorientation and Sensory Illusions of Flight, File 2/5/9/9E/UEA/UEC/UEE/4505-3, PFN# 4505.

6. CLEARANCE AND ACCESS: Unclassified; foreign students may attend this class.

7. REFERENCE:

NUMBER	TITLE	PAGES	ADDITIONAL INFORMATION
FM 1-301	AEROMEDICAL TRAINING FOR FLIGHT PERSONNEL	8-1 - 8-13	Chapter 8

8. STUDENT STUDY ASSIGNMENT: None.

9. INSTRUCTOR REQUIREMENTS: One flight surgeon or facilitator (primary instructor), one UH-60 pilot-in-command (to perform flight maneuvers), and one UH-60 pilot. (A UH-60 instructor pilot is desirable, but not necessary.) The flight surgeon/facilitator will be seated in a crewchief/gunner's seat in the passenger compartment with the students.

10. ADDITIONAL SUPPORT PERSONNEL REQUIREMENTS: None.

11. EQUIPMENT REQUIRED FOR THE INSTRUCTION: One UH-60 helicopter with 3 forward-facing passenger seats, one crewchief/gunner's seat, an intercom system which accommodates all crew and passengers, and flight protective clothing and equipment per AR 95-1 (dark visor on helmet).

12. MATERIALS REQUIRED FOR THE INSTRUCTION:

INSTRUCTOR MATERIALS: Spatial Disorientation Demonstration Flight (UH-60 Lesson Plan).
STUDENT MATERIALS: None.

13. CLASSROOM, TRAINING AREA, AND/OR RANGE REQUIREMENTS: A flight training area and stagefield or landing zone (LZ) with low aviation activity is desirable.

14. AMMUNITION REQUIREMENT: None.

15. INSTRUCTIONAL GUIDANCE: The UH-60 pilot-in-command (PIC) will be proficient in the required enabling learning objective (ELO) flight maneuvers and will perform all ELO flight maneuvers within the standards established in Training Circular (TC) 1-212 (Aircrew Training Manual, Utility Helicopter, UH-60).

16. LESSON PLAN WRITTEN BY:

NAME	RANK	POSITION	DATE
_____ ARTHUR ESTRADA III	DAC	RESEARCH HELICOPTER PILOT, FSB, USAARL	15 DEC 99

17. PROPONENT LESSON PLAN APPROVAL AUTHORITY:

NAME	RANK	POSITION	DATE
_____ PATRICIA A. LEDUC	DAC	C, SPATIAL DIS-ORIENTATION TEAM, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ CORINA VANDEPOL	MAJ	DIRECTOR, AHPD, USAARL	15 DEC 99

NAME	RANK	POSITION	DATE
_____ JOHN A. POWELL	COL	COMMANDER, USAARL	15 DEC 99

18. BRANCH SAFETY OFFICER APPROVAL:

NAME	RANK	POSITION	DATE
_____			

ANNUAL REVIEW

_____
PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

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PRINTED NAME OF PERSON REVIEWING LESSON DATE REVIEWED

SECTION II. - INTRODUCTION

Method of Instruction: PE. Instructor to student ratio is 1:3.

Time of Instruction: 0029 minutes.

Media: None.

MOTIVATOR:

NOTE: The flight surgeon/facilitator will begin the introduction phase immediately following the passenger safety briefing conducted by the PIC.

NOTE: The flight surgeon/facilitator may use a motivator of his or her choice; however, he or she must ensure that it gains the students' attention, states the need for this training, and explains the terminal learning objective (TLO). A suggested motivator follows:

"There appears to be a killer stalking Army aviation. When it strikes, pilots are unable to see, believe, interpret, or process the information on their flight instruments. Instead, they rely on false information their senses provide, becoming victims of spatial disorientation (FLIGHTFAX, February 1997). Our goal today is to reinforce the academic instruction you've already received and to allow you to experience the physiological limitations of your orientation senses during actual flight. This training will enhance your awareness of potentially disorienting situations, allowing you to recognize what is happening, and how best to prevent it from happening."

TERMINAL LEARNING OBJECTIVE (TLO):

NOTE: Read the TLO requirements to the students.

At the completion of this lesson the student will:

ACTION: Be aware of the physiological limitations of the orientation senses and how to best prevent spatial disorientation.

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat.

STANDARD: In accordance with (IAW) FM 1-301, Aeromedical Training For Flight Personnel.

SAFETY REQUIREMENTS: The PIC will ensure that the students receive a full passenger safety briefing IAW TM 1-1520-237-10 prior to the flight.

NOTE: During the conduct of the various ELO flight maneuvers, there will be periods of reduced intercommunications with regards to direction of turns and their magnitudes. Therefore, the observing students will be instructed to assist with airspace surveillance and to feel free to verbalize their concerns whenever safety appears to be compromised.

RISK ASSESSMENT LEVEL: Low.

ENVIRONMENTAL CONSIDERATIONS:

1. This demonstration flight will be conducted under visual flight rules (VFR) only. Since the training requires flight at altitudes of at least 500 feet above ground level (AGL), the worst weather should be forecast to be equal to or greater than 1000 feet ceilings and 3 miles visibility during the demonstration flight .

2. Wind speed should not exceed 20 knots. Greater wind speeds will require a reevaluation of the risk assessment level.

EVALUATION: Because this training reinforces material already academically taught and evaluated, there is no formal evaluation. The flight surgeon will provide oral quizzing relating to the physiological senses and spatial disorientation prior to, during and after the flight to ensure continuity of the academic and flight training.

INSTRUCTIONAL LEAD IN:

NOTE: The flight surgeon may use an instructional lead in of his or her choice. A suggested instructional lead-in follows:

"The academic classes you attended at the School of Aviation Medicine provided the knowledge necessary to understand your orientation senses and the effects of spatial disorientation. This flight will reinforce that knowledge and provide you with a flight experience which will demonstrate your physiological limitations with regards to spatial orientation."

SECTION III. - PRESENTATION

WARNING: Because the ELO flight maneuvers require short periods during which the verbalization of direction of turns and their magnitudes would defeat the purpose of the training, the flight crew and flight surgeon/facilitator will be especially alert to obstacle and collision avoidance. The flight crew will be thoroughly familiar with each ELO flight maneuver, the sequence in which they will be performed, and the flight training areas in which they will be flown. (This coordination will be conducted during the crew mission briefing prior to the arrival of the students.) During the conduct of the ELO flight maneuvers, the PIC will modify standard terminology. For example, instead of "Clear right?" or "Clear down?", he will request, "Clear to continue the maneuver?." The flight crew, knowing the maneuver, will respond, "Clear to continue." If safety is ever compromised, standard terminology will be used to clearly state the situation and the flight maneuver will be immediately terminated.

NOTE: The flight surgeon/facilitator will begin the presentation phase after takeoff and during the flight to the training area.

NOTE: Inform the students of the Enabling Learning Objective requirements.

A. ENABLING LEARNING OBJECTIVE (ELO) #1:

ACTION: Explanation of ELO flight maneuvers and brief review of orientation senses.

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, enroute to the flight training area.

STANDARD: In accordance with FM 1-301.

Learning Step/Activity: Explain individual roles during ELO flight maneuvers and provide a brief review of orientation senses.

Method of Instruction: CO. Instructor to student ratio is 1:3.

Time of instruction: 0003 minutes.

Media: None.

NOTE: Provide general assurance that no violent maneuvers will be performed and that no maneuvers will exceed the aircraft's limitations per Technical Manual (TM) 1-1520-237-10 (Operator's Manual, H-60 Helicopters).

a. Explanation of ELO flight maneuvers.

(1) Prior to the commencement of each ELO flight maneuver, one of the students will be identified as the "subject student." (Each student will be a subject student during at least one high level ELO flight maneuver and one hover ELO flight maneuver.) The subject student will sit free of all airframe structures other than the seat. He or she will lower his/her dark visor and note the aircraft's initial parameters (airspeed, altitude and heading) as provided by the flight surgeon/facilitator. The subject student will then close his/her eyes and provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading. **The IP will instruct the student to maintain a head position oriented as if flying the aircraft.**

(2) The other students will observe, but not comment, until after the ELO flight maneuver is terminated.

(3) At the completion of each ELO flight maneuver, the subject student will be instructed when to open his/her eyes. An observing student will be asked to tell the subject student what actually happened and all observing students will be asked for their comments.

b. The flight surgeon/facilitator will briefly review orientation senses.

Three sensory systems are especially important in maintaining equilibrium, orientation, and balance. They are the proprioceptive system, the vestibular system, and the visual system. Normally, the combined functioning of these senses maintains equilibrium and spatial orientation.

NOTE: The contribution of hearing to orientation is small and variable; e.g., changes in the sound of rotor blade rotation caused by angles of bank. It cannot be relied upon until you have had a great deal of experience in that type of aircraft, and so will not be mentioned further.

(1) Visual sense. Of the three sensory systems, the visual system is the most important in maintaining equilibrium and spatial orientation. (Stress the overwhelming contribution of vision to orientation and that spatial disorientation is primarily a problem associated with poor external visual conditions. Explain that it is due to the importance of vision that the subject student will be deprived of his/her vision during the subsequent ELO flight maneuvers.)

(2) Vestibular system. This system is the motion- and gravity-detecting organ located in the inner ear. The vestibular apparatus consists of two distinct structures: the semicircular canals (sense angular accelerations) and the otolith organs (sense linear accelerations).

(3) Proprioceptive system. This system reacts to the sensations resulting from pressures on joints, muscles, and skin and also from slight changes in the position of internal organs.

NOTE: Conduct a check on learning and summarize the learning step/activity.

B. ENABLING LEARNING OBJECTIVE (ELO) #2:

ACTION: Demonstrate the limitations of performance of the semicircular canals (ELO Flight Maneuver #1).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of performance of the semicircular canals.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #1.

(1) The flight surgeon/facilitator will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #1.

(1) Ten seconds after the subject student announces eyes closed, the PIC will initiate a gently increasing, yet detectable, left or right roll (3 degrees/second) until the aircraft achieves a turn of

standard rate. The turn is continued for 360 degrees. The aircraft is then rolled wings-level at a rate that will be easily detected by the subject student. (The rate of roll-out should be approximately twice as fast as the rate of entry or 6 degrees/second).

NOTE: The initial roll is normally detected, but as the semicircular canal response decays, a false sensation of a return to straight and level flight is perceived. As the roll-out to level flight is made, a sensation of turning in the opposite direction is perceived.

(2) After the roll-out, the student is instructed to open his/her eyes once straight and level flight is again perceived.

c. After completion of ELO Flight Maneuver #1.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then remind the students of the limitations of the physiology of semicircular canal performance.

NOTE: Conduct a check on learning and summarize the learning step/activity, stressing how easy it is to detect roll by vision, but how difficult it can be when deprived of it.

C. ENABLING LEARNING OBJECTIVE (ELO) #3:

ACTION: Demonstrate the limitations and illusions of the proprioceptive system and vestibular apparatus (ELO Flight Maneuver #2).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations and illusions of the proprioceptive system and the vestibular apparatus.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #2.

(1) The flight surgeon/facilitator will assign a different student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #2.

(1) Following the subject student's announcement of "eyes closed," the aircraft will be flown with no alteration of airspeed, altitude, or heading.

NOTE: Because of small aircraft movements from turbulence and the aerodynamic response of the helicopter which stimulate the proprioceptive system and/or the vestibular apparatus, students should perceive climbs, descents, or turns in unpredictable and varying amounts.

NOTE: On particularly calm days, minor pilot-induced turbulence may be necessary.

(2) After approximately 90 seconds, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #2.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss the erroneous sensations produced by brief stimulation of the proprioceptive system and vestibular apparatus.

NOTE: Conduct a check on learning and summarize the learning step/activity.

D. ENABLING LEARNING OBJECTIVE (ELO) #4:

ACTION: Demonstrate the limitations of the otolith organs (ELO Flight Maneuver #3).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the limitations of the otolith organs.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #3.

(1) The flight surgeon/facilitator will assign the third student to be the subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and a heading which is ideally into the wind.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #3.

(1) Following the subject student's announcement of “eyes closed,” the PIC will initiate a deceleration which will result in a free air hover in 30-40 seconds. There will be no change of heading or altitude.

NOTE: Both the deceleration and the final nose-up pitch associated with the attitude change when slowing the aircraft usually convinces the student that a climb is taking place. In addition, a turn is often falsely perceived when balance variations are made to maintain straight and level flight.

(2) After establishment of the free air hover, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #3.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss the physiological limitations of the otolith organs and the somatogravic illusion.

NOTE: Conduct a check on learning and summarize the learning step/activity.

E. ENABLING LEARNING OBJECTIVE (ELO) #5:

ACTION: Demonstrate physiological limitations of detecting inadvertent descents. (ELO Flight Maneuver #4).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in the flight training area.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the physiological limitations of detecting inadvertent descents.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0004 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #4.

(1) The flight surgeon/facilitator will assign a subject student who will then lower his/her dark visor.

(2) The PIC will establish straight and level flight at 90 KIAS, an MSL altitude which results in at least 500 feet AGL and an appropriate heading for the training area.

NOTE: This flight maneuver will terminate at terrain flight altitudes, therefore, the PIC will ensure that a safe descent can be made within the training area. Additionally, the PIC should plan the

descent so as to terminate the flight maneuver in close proximity to a predetermined stagefield or LZ within which the next three enabling learning objectives will be performed.

(3) The flight surgeon/facilitator will announce the aircraft's airspeed, pressure altitude, and heading. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of ELO Flight Maneuver #4.

(1) After the subject student announces "eyes closed", the PIC will initiate a detectable left or right turn while gently entering an undetectable descent (less than 500 feet per minute). During the descent, it is acceptable for the PIC to perform variable right and left turns. Upon reaching a safe terrain flight altitude, ideally, in close proximity of a predetermined stagefield or LZ, the PIC will establish straight and level flight.

NOTE: The student, remembering ELO Flight Maneuver #2, usually states that he/she has rolled out straight and level, unaware of the change in altitude.

(2) After establishment of straight and level terrain flight, the student is instructed to open his/her eyes.

c. After completion of ELO Flight Maneuver #4.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will then discuss how easily a pilot can become unaware of an inadvertent descent in restricted visibility (fog, dust, snow, and night operations).

NOTE: Conduct a check on learning and summarize the learning step/activity.

WARNING: The following ELO Fight Maneuvers (ELO's #6 through #8) are performed in a landing zone or at a stagefield, therefore, it is imperative that a comprehensive assessment of the hazards be conducted. The terrain should be familiar to the flight crew, and they and the observing students must maintain good airspace surveillance.

NOTE: During this series of hovering maneuvers, each student will experience being a subject student.

F. ENABLING LEARNING OBJECTIVE (ELO) #6:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #5).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #5.

(1) The flight surgeon/facilitator will assign the subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 10 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude, heading and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #5.

(1) After the subject student announces “eyes closed,” the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to “hide” various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with the establishment of a backward climb at 10-15 knots.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the backward climb is established, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #5 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

G. ENABLING LEARNING OBJECTIVE (ELO) #7:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #6).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #6.

(1) The flight surgeon/facilitator will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 10 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #6.

(1) After the subject student announces "eyes closed," the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will very gently land, but not compress the aircraft struts, without the subject student realizing it. After landing, the IP may continue minor cyclic inputs to simulate hovering flight.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the aircraft is gently landed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #6 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/she will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

H. ENABLING LEARNING OBJECTIVE (ELO) #8:

ACTION: Demonstrate the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations (ELO Flight Maneuver #7).

CONDITION: In a UH-60 helicopter, secured in a forward-facing passenger seat, in a landing zone or at a stagefield.

STANDARD: In accordance with FM 1-301 and TC 1-212.

Learning Step/Activity: Demonstrate, through practical exercise, the ease of becoming spatially disoriented during hovering maneuvers when exposed to linear and rotational accelerations.

Method of Instruction: PE. Instructor to student ratio 1:3.

Time of instruction: 0003 minutes.

Media: None.

a. To prepare for ELO Flight Maneuver #7.

(1) The flight surgeon/facilitator will assign a different subject student who will then lower his/her dark visor.

(2) The PIC will establish the aircraft in a stable 10 feet hover.

(3) The flight surgeon/facilitator will announce the aircraft altitude and heading, and make reference to landmarks to the front and sides. The subject student will then close his/her eyes. (If necessary, under very sunny conditions, the subject students may need to cover their eyes with their hands.)

(4) The flight surgeon/facilitator will remind and prompt the subject student to provide a running commentary of his/her perception of orientation with particular reference to airspeed, altitude, attitude, and heading.

b. Performance of an ELO Flight Maneuver #7.

(1) After the subject student announces "eyes closed," the PIC will initiate a variety of hovering, rotating, and translating maneuvers which will provide linear and/or rotational accelerations. During these maneuvers, it is possible to "hide" various maneuvers so as to surprise the subject student with the final orientation of the aircraft. After approximately 45 seconds of the hovering maneuvers, the PIC will end the exercise with a gentle transition to forward flight.

(2) During the hovering maneuvers, the flight surgeon/facilitator will keep prompting the subject student for a running commentary (to occupy channels of attention) and thus, precipitate the onset of spatial disorientation.

NOTE: Most students are able to maintain their orientation for 10 to 15 seconds before losing it.

(3) After the transition to forward flight is completed, the subject student is instructed to open his/her eyes.

c. After completion of an ELO Flight Maneuver #7 exercise.

(1) An observing student will be asked to tell the subject student what actually happened and then all observing students will be asked for their comments.

(2) The flight surgeon/facilitator will discuss the ease in which spatial orientation is lost, particularly in the context of snow, dust, sand and night operations. He/She will also discuss how angular accelerations are detected fairly well, but how linear accelerations are not.

NOTE: Conduct a check on learning and summarize the learning step/activity.

SECTION IV. - SUMMARY

Method of Instruction: CO. Instructor to student ratio is 1:3.

Time of Instruction: 0003 minutes.

Media: None.

1. REVIEW/SUMMARIZE

a. On the return flight to the basefield, the flight surgeon/facilitator will discuss the Spatial Disorientation Demonstration Flight. He/she will make particular reference to the significance of undetectable maneuvers and erroneous sensory information cues.

b. The students are reassured that they are all physiologically normal, but that humans are just not "designed" for flight. The objective of the demonstration flight is to provide them with an idea of the limitations of the own physiology in the environment in which they operate and the phases of flight commonly associated with spatial disorientation.

c. Advise the students that the best way to avoid and counter the effects of spatial disorientation is to achieve a working knowledge of the limitations of the orientation senses and to maintain proficiency at instrument flying.

2. CHECK ON LEARNING.

a. Solicit student questions and explanations.

b. Questions and answers.

NOTE: No specific questions are required. The flight surgeon/facilitator can quiz any demonstrated weak areas.

c. Correct students misunderstandings.

3. TRANSITION TO NEXT LESSON. N/A.

SECTION V. - STUDENT EVALUATION

1. TESTING REQUIREMENTS: None.

2. FEEDBACK REQUIREMENTS: None.