Evaluating The Effectiveness Of Training System Approaches For Highly Complex Flight Training

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EVALUATING THE EFFECTIVENESS OF TRAINING SYSTEM APPROACHES FOR HIGHLY COMPLEX FLIGHT TRAINING

by

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ABSTRACT

This research investigates the Training Effectiveness of a low-cost, PC-based training system when compared with two modes (motion and no motion) of a cab training system with large screen for various aviation flying tasks. While much research on this topic has been done in the past, advances in technology have significantly altered what is considered a “low-cost” “simulator.” The technology advances have in effect increased the ability of a “low-cost” “simulator” to deliver desired experiences to the user. These “simulators” often are nothing more than PC training system, with only notional representations of the actual aircraft. This research considers the use of such training systems in training for a highly complex and dynamic task situation, that task being a search and rescue mission. A search and rescue mission is far more complex task than those studied for possible “low-cost” simulation substitution in the past. To address that aspect, one mode of the cab involves motion in two degrees of freedom. The results of this research advances the body of literature on the capability of “low-cost” simulation to deliver the experiences necessary to learn highly complex tasks associated with search and rescue as well as further clarify the extent to which a motion platform aides in flight training. This research utilizes available platforms provided by the US Army Research, Development and Engineering Command Simulation and Training Technology Center. Additionally, all the participants in the research are in training to be helicopter pilots. Participants were randomly assigned to one of three training configurations: a) Cab with motion turned ON, b) Cab with motion turned OFF and c) PC-based simulator. Training effectiveness is evaluated using measures for learning, task performance, and human

factors. Statistically significant results are shown for the Cab with Motion and the Cab with No Motion configurations.

Dedicated to the new generation of college students in the Casanova family:

Manuel, Ingrid, Carlos, and Lourdes.

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CHAPTER ONE
INTRODUCTION

Whether advanced training technology features (e.g., graphical quality, haptic quality, motion base, surrounding sound, large screens, head-mounted displays) are required for optimal training has been questioned by Waag (1981), O'Hare and Roscoe (cited in Roscoe, 1991) and Morris, Ganey, Ross, and Hancock (2002)

Morris et al. (2002) argue that "… while advanced simulations may "aid" in the process of human immersion, the variance associated with degree of immersion has repeatedly been shown to be predominantly a function of individual responsiveness to cues and characteristics of the environment, not associated with fidelity or replicated reality". Kantowitz (cited in Morris et al., 2002) specifies three main elements to an experimental situation as setting representation (the physical realism or immersive properties), subject (or person representation), and variable representation. He demonstrated that "setting representativeness" is exaggerated and that transfer of the behavior from the virtual reality to the real world is dependent more on the compatibility of psychological processes than in the technical improvements of the realism. Furthermore, Kalawsky (2001) suggests that improvements in technology can result in virtual reality systems that will be extremely difficult to use and completely ineffective.

Thus the research question remains, what level of replicated reality is necessary to support training? The number of potential dimensions to reality include all the human sensory dimensions. Technology has not yet been able to replicate all those dimensions. Further, replication approaches vary by task sufficiency, cost and availability. Depending on the training task, not all these dimensions need be modeled (Caro, 1976, Caro, 1977, Ellis, 1985, Roscoe, 1991).

According to Hays and Singer, fidelity is usually described as the degree of similarity between the simulated and operational environments (cited in Hays, Jacobs, Prince, & Salas, 1992). One report (Advisory Group for Aerospace Research and Development (AGARD), 1980) noted that a differentiation should be made between the real cues measured objectively and the cues the trainee subjectively perceives. The report identifies two types of fidelity. Objective fidelity is defined as "the degree to which a simulator would be observed to reproduce its real-life counterpart if its form, substance and behavior were sensed and recorded by non-physiological instrumentation system onboard the simulator". It includes both equipment and environmental cues. Equipment cues replicate the appearance and feel of the operational equipment, for example the shape, size, position, and color of controls and displays. Environmental cues replicate the environment and the motion through the environment, for example, motion from platforms or "g" seats and visual cues. The second type of fidelity, according to the report (AGARD, 1980), is perceptual fidelity. This is defined as "the degree to which the trainee subjectively perceives the simulator to reproduce its real-life counterpart…in the operational task situation."

The principal human sensory mechanisms relevant to motion fidelity are the semicircular canals, the otoliths, the pressure sensors, the proprioceptive and kinesthetic sensors, and the eyes (AGARD, 1980, AGARD 1988, Hall, 1989).

The semicircular canals together with the otoliths (described below), known as the "vestibular organ", form the balance mechanism located in the inner ear. They consist of three orthogonal ducts in each ear. They signal the angular velocity of the head about any axis. However, at frequencies slower than 0.1 Hz, the signals are misleading. These frequencies are usually sustained in man-made vehicles and airplanes. (AGARD, 1980, AGARD 1988, Hall, 1989, Sherman & Craig, 2003).

The otoliths act as the linear accelerometers in the human internal orientation system; one pair is oriented in the horizontal plane with the head in its normal position, the other pair is oriented primarily in the vertical plane. The otoliths are unable to distinguish between gravitational acceleration and linear acceleration with respect to inertial space (AGARD, 1980, AGARD 1988, Hall, 1989).

The proprioceptive and kinesthetic sensors signal the relative positions of parts of the body as well as their movements to the central nervous system. They are located in the muscles, tendons, and joints. These sensors provide information on the forces and therefore, the acceleration of the human body (AGARD, 1980, AGARD 1988, Hall, 1989).

The tactile or pressure sensors permit detection of a change in force or orientation in the body. An important feature with respect to simulation is that the output of these human sensors tends to return to a reference level during sustained uniform pressure application (AGARD, 1980, AGARD 1988, Hall, 1989).

The eyes make it possible to create self-motion sensations ("vection") by uniform motion of a wide visual field. This self-motion sensation is based on the motion detection capabilities of the peripheral retina (AGARD, 1980, AGARD 1988, Hall, 1989). Vection becomes effective when the Field of View is larger than 60 degrees and most effective with a Field of View of 180 degrees (AGARD 1988).

Motion cueing is achieved through the stimulation of the vestibular organ, tactile receptors, proprioceptive and kinesthetic sensors, and the eyes (AGARD, 1980, AGARD 1988, Hall, 1989, Sherman & Craig, 2003). Motion cueing systems aim to provide perceptual environmental fidelity (AGARD, 1980). For example, since the semicircular canals signal angular velocity over a limited frequency range, it is possible to "wash-out" platform motion at very low frequencies, so that motion cues are achieved while the actual space in which the platform rotates is limited; since the otoliths can not distinguish between linear acceleration and orientation with respect to the vertical, it is common practice to substitute a steady pitch or roll attitude for sustained linear acceleration (AGARD, 1980, AGARD 1988, Hall, 1989).

Lane and Alluisi (cited in Rehman, 1995) identified four fidelity drivers to be used to determine simulation requirements: mission to be simulated, objectives of the simulation, fidelity dimensions, and simulation components. The mission or mission segment to be simulated will determine the tasks to be performed and therefore the simulation components in which fidelity should be focused. The fidelity needed to meet specific objectives is based on the extent to which each of the tasks that occur within a mission segment should be supported by the simulation and in what detail. The fidelity dimensions are classified as the attributes of 1) the simulator, 2) the operator, 3) the processes and events external to the simulation. The importance of breaking down to the simulation components is that at this level fidelity decisions should be made.

Prasad, Schrage, Lewis, and Wolfe (cited in Rehman, 1995) performed a survey of simulation devices and existing technologies and determined that there are generally ten subsystems, shown in Table 1, which adequately describe a simulator. Table 2 describes fidelity characteristics.

Table 1. Simulator Subsystems

(1) Cockpit	(6) Environment
(2) Audio	(7) Ground Handling
(3) Motion	(8) Mission Equipment
(4) Control System	(9) System Latency
(5) Math Model	(10) Visual

Table 2. Levels of Fidelity Characteristics for Simulator Subsystems

SIMULATOR SUBSYSTEM	FIDELITY CHARACTERISTICS
(1) Cockpit/Crew Station	- none - simulated/generic type instruments - partially simulated cockpit - full up crew station
(2) Audio	- none - significant cockpit sounds - incidental sounds - realistic
(3) Motion	- none - 2DOF (pitch and roll) - 3DOF (pitch, roll, and yaw) - 6DOF
(4) Control System	- no force feel - constant force (spring/damper) - partial duplication of actual force - complete duplication
(5) Mathematical Model	- none - 3 DOF - 6 DOF - 6 DOF with rotor
(6) Environment	- clean air - discrete gusts - first order filtered turbulence - rotationally sampled turbulence
(7) Ground Handling	- no gear - rigid gear - simplified gear model - comprehensive
(8) Mission Equipment	Equipment - none - communication only - communication/navigation only - complete
(9) System Latency	- non real time (off line) - significant delay - minimal delay - real time
(10) Visual	field of view / dynamic range / detail workstation day low 75°horiz/35°vert dusk medium 90°horiz/40°vert haze/fog high wider night very high

Figure 1 (AGARD, 1980) indicates that, while it is usually expected that training simulators possess high equipment and environmental cue fidelity, there are also effective training devices that do not possess high fidelity in either dimension. At one extreme are cockpit familiarization and procedures trainers which have high equipment cue fidelity and low environmental cue fidelity. At the opposite extreme are research simulators having high environmental cue fidelity but low equipment cue fidelity. The conclusion from the AGARD report (1980) is that high fidelity (equipment or environmental) may not be needed for effective training. Instead, the critical dimension is whether or not the device capabilities will support specific training objectives. The key factor is that the training device simulates those cues that are necessary for effective learning of specific skills.

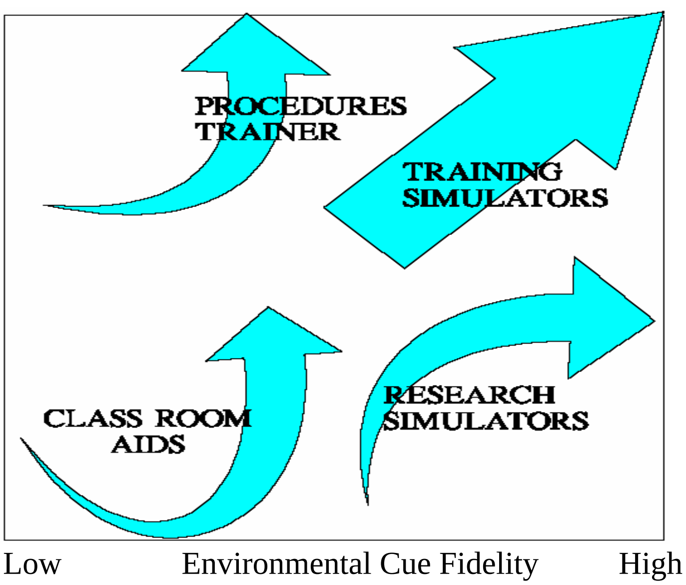


Figure 1. Tradeoff between Equipment and Environmental Cue Fidelity

CHAPTER TWO
LITERATURE REVIEW

The review below of the application area literature identifies limitations of current research in training effectiveness analysis and specifically states how this research will fill the void in the current state of flight simulation training. Eight successful experimental research efforts reported in the literature on the training effectiveness for different approaches for flight simulation training, three technical reports and one thesis are discussed. Presented next, is a discussion on the research gap between the current training effectiveness literature and the investigation necessary to optimize the tradeoffs between safety, affordability and effectiveness regarding future combat aviation training.

2.1 Army Research Institute Research

Stewart, Dohme and Nullmeyer (1989) reviewed the U.S. Army Initial Entry Rotary Wing (IERW) Program of Instruction and studied the existing literature on military transfer of training for aviation with the purpose of optimizing the use of simulation in IERW training. At that time, the U.S. Army only used simulation for IERW instrument training. The IERW Program of Instruction consisted of three main phases: Primary, Instrument and Combat Skills. Primary Aviation Training took place in the classroom and in the aircraft. The IERW program required only 30 hours of simulator training time that was limited to the instrument phase. In its conclusion, the paper recommended two follow up studies: Phase I that would focus on the instrument phase of IERW training. It would explore the effects of varying the mix of simulator and aircraft hours and would also analyze the effects of a low-cost simulator when compared with those of a full motion platform. Phase II would focus on the Primary Phase of training which, at that time, did not employ simulation.

In a follow-up study, Stewart, Barker, Weiler, Bonham, and Johnson (2001) compared a motion simulator, the 2B24 Synthetic Flight Training System, used for the IERW instrument training with a PC-based simulator, the Frasca 342 Primary Skills Trainer. Thirty-eight pilot students were assigned to experimental and control groups. Both groups completed 30 hours of simulator training and 20 hours in the TH-67 aircraft. Research indicated that, regardless of the simulator, students were able to complete instrument training successfully. The research did not demonstrate any clear advantage of the personal computer based system over the motion-based system. In their answers to the training exercise questionnaire, motion based students were more likely to denote that training in the simulation had obstructed their performance in the aircraft. This research demonstrated that students could learn IERW instrument skills in a less expensive, simpler simulator without a motion system.

Johnson and Stewart (2002) further investigated the use of simulation for IERW training. Research was performed to assess the effectiveness of Personal Computer Aviation Training Devices for primary and instrument flight training tasks. Seventy-one tasks were chosen from the IERW Program of Instruction. Sixteen pilots, chosen from experienced and student aviators, assessed the adequacy of personal computer to aid in IERW training. Both experienced and student pilots rated the personal computer as better able to support Instrument Flight Training than Primary Flight Training.

Boldovici (1992) examined the reasons for and against using motion effects in land vehicles and aircraft simulators. Research literature and opinions received from 24 authorities were reviewed. He concluded that: (1) No transfer of training experimental data supports using motion-based instead of fixed-base simulators; (2) The lack of supporting experimental data do not demonstrate that no differences exist. Finding no differences may be the result of inadequate statistical power and other deficiencies in the experiments instead of resulting from an absence of differences; (3) Reliable and safe tests should be developed to evaluate the performance of tasks that can not be safely performed in actual vehicles.

2.2 U.S. Air Force Human Resources Laboratory Research

Martin and Waag (1978) used a transfer of training design to analyze the effects of a six degrees of freedom motion platform on the learning of basic contact, approach and landing skills. Twenty-four students with no previous flying experience were divided into three groups: (1) Motion, (2) No-Motion, and (3) Control. The students in the control group received the standard pre-flight training. The students in the two experimental groups received the same training on basic contact tasks in the Advanced Simulator for Pilot Training (ASTP) with the exception of presence or absence of motion cueing. Transfer of training effects were measured by 1) performance on two specially designed rides in the T-37 aircraft for the students trained in the ASTP simulator, 2) data collected for selected tasks for students in the three groups during their pre-solo T-37 flights. The results indicated 1) no differences in performance in the simulator or in the two specially designed rides in the T-37 aircraft between the Motion and No-Motion groups, 2) no significant differences in the scores calculated from the T-37 pre-solo flight data between the Motion and No-Motion groups, although there was a trend for the Motion group to perform slightly better, and 3) the two groups trained in the ASTP simulator performed significantly better than the Control group in the more advanced tasks.

Since the Martin and Waag (1978) research utilized the entire ASTP field of view, (300 degrees horizontal by 150 degrees vertical), it was considered that peripheral cues might had been providing important motion information (Nataupsky, Waag, Weyer, McFadden, & McDowell, 1979). If that was the case, platform motion would be anticipated to have a greater effect for narrow field of view (FOV) systems. Nataupsky et al. (1979) experiment was designed to address this question. They studied the effects of platform motion, visual FOV and their interaction upon learning in the simulator and consequent transfer of training to the aircraft for basic contact maneuvers for the T-37 aircraft. A transfer of training study methodology was used in which thirty-two student pilots were initially trained in the ASTP and subsequently evaluated on their first flight in the T-37 aircraft. They were selected with the restriction of having had little prior flying experience: the range of previous flying experience was 25 to 64 hours. Each student received training under one of four simulator configurations: (1) full platform motion (six degrees of freedom), full FOV (300 degrees horizontal by 150 degrees vertical); (2) full platform motion, limited FOV (48 degrees horizontal by 36 degrees vertical); (3) no platform motion, full FOV; and (4) no platform motion, limited FOV. The resulting data provided no definitive evidence of differential transfer of training resulting from platform motion cueing, size of the visual FOV, or their interaction. These data supported previous findings that platform motion cueing does not significantly improved the transfer of training for basic contact maneuvers in the T-37 aircraft. No significant evidence was found indicating enhanced transfer of training using a platform motion with a narrow FOV visual scene.

Waag (1981) performed a literature review concerning the training effectiveness of visual and motion simulation. He reviewed data obtained from twenty-eight flight simulator transfer of training experiments. Fifteen of those experiments measured the contributions of the motion platform to the learning of flying tasks. His review showed that, although there exists much pilot opinion and in-simulator performance data, the benefits of platform motion have not been proven in the case of transfer of training to the airplane. In no instance was performance in the aircraft significantly improved as a result of simulator training with a motion platform.

2.3 Pilot's Perception and Control of Aircraft Motions (Hosman)

In his thesis, Hosman (1996) studied the influence of motion feedback on pilot's control behavior. Under the assumption that the ultimate solution for a flight simulator is to produce motion and visual cues that are perceived by the pilot as equal to those in the actual aircraft, he studied the visual-vestibular motion perception process. He investigated the contribution of the central and peripheral visual systems on the perception of the aircraft attitude and angular rate. The experimental results demonstrated that the perception of aircraft attitude from an artificial horizon is more accurate and faster than the perception of the aircraft angular rate from the artificial horizon or the peripheral visual field. He also investigated the differences between speed and accuracy of motion perception with the visual and/or vestibular system. His research demonstrated that the perception accuracy is independent of the senses but the reaction time is significantly reduced when the vestibular system is involved. Hosman performed an additional experiment on tracking tasks, he found only a small effect of motion on performance. Pilots provided with motion cues showed slightly less roll angle error than pilots without. Moreover, control behavior was affected by motion cues only with unstable aircraft. In that case, there was an increase in stability for pilots with motion, but there was an associated loss in gain. Hosman's conclusion was that both the visual system and the vestibular system have their own particular contribution to the pilot's control behavior.

2.4 Federal Aviation Administration (FAA) Research

Taylor et al. (1997) studied the training effectiveness of Personal Computer-Based Aviation Training Devices for instrument flight training. To evaluate transfer of training, the performance of a group of students trained in a flight-training device and later trained to criterion in the aircraft were compared with the performance of a control group who had been trained only in the airplane. The one hundred and forty-four students were enrolled in instrument flight instruction at the University of Illinois and were randomly assigned to the computer-based simulator group or the airplane group. The experimental data demonstrated that the levels of savings in airplane time varied from 15% to over 40% according to the instrument tasks tested. As a general rule, transfer savings were positive and substantial for the training of new tasks.

A research performed by Go, Burki-Cohen and Soja, (2000) addressed the question of the need for simulator motion for commuter airline pilot's recurrent training and evaluation. The experiment used an FAA qualified Level C simulator with a six degrees of freedom motion platform and a wide angle, high-quality visual system. The research used forty-two experienced regional airline pilots in recurrent training. Two experiments were performed, the first evaluated the level to which a pilot's flying skills transferred from the aircraft to the simulator. The second experiment assessed the effect of the simulator as a training tool for skill acquisition and, subsequently, the transfer of training of those skills to the aircraft. Half of the pilots were trained with and the other half without motion. The transfer of skill was evaluated in the simulator with the motion system turned on as a stand-in for the aircraft.

Two pilot tasks that satisfied the criteria described in the literature as diagnostic for the detection of a motion requirement were chosen, they were: engine failures on take-off with either rejected take off or continued take-off. The criteria included: 1) closed loop to permit motion to be part of the control feedback loop to the pilot; 2) high thrust and high gain to emphasize motion effects; 3) unpredictable and asymmetric disturbance to emphasize an early altering function of motion; 4) short duration to avoid pilots from adjusting to the lack of cues; and 5) high workload with low visibility and crosswind, to increase the need for redundant cues as provided by instruments, sound, motion and the outside visual scene.

The results indicated that motion did not significantly affect the operational performance of the tasks evaluated. The report provided two caveats at the end. First, that the simulator used in the study might have not provided enough motion to be effective (measurements indicated that the flight simulator used might have failed to provide lateral acceleration motion representative of the aircraft for the tasks selected). The second caveat was that the research used the simulator with motion as the equivalent of the airplane.

Taylor et al. (2003) investigated the effectiveness of Personal Computer-Based Aviation Training Devices and Flight Training Devices to meet the FAA instrument currency requirements (Rehmann, 1995, defines three categories of aviation training devices: 1) Airplane Simulator, 2) Airplane Flight Training Device and 3) Computer-Based Simulator). After receiving an Instrument Proficiency Check in the aircraft, one hundred and six instrument pilots were randomly assigned to one of four groups: the computer-based simulator, the Flight Training Device, the aircraft, or the control group. During the six-month period, performance on an Instrument Proficiency Check in the aircraft evaluated pilots that received instrument currency experience in the training devices to the control group and to the aircraft group. The control group received no training. The experimental results demonstrated that training in either the computer-based simulator or the Flight Training Devices resulted in better performance than the control group. Training in the computer-based simulator and the Flight Training Devices was considered to be at least as effective as training in the aircraft.

2.5 Flight Simulator Training Effectiveness: A Meta-Analysis

Hays, Jacobs, Prince, and Salas (1992) performed a "meta-analysis" of flight simulation training research in order to identify significant characteristics that have an impact in training effectiveness. According to Hays et al. (1990), meta-analysis employs quantitative review techniques as an alternative to the narrative review method. Meta-analysis attempts to aggregate individual research results into a common effect size metric, it then computes a mean value across experiments to obtain a good estimate of the population value. A total of two hundred and forty-seven technical reports and journal articles were found from which twenty-six experiments (nineteen involved aircraft pilot training and seven involved helicopter pilot training) were identified as having enough information for statistical meta-analysis. This research demonstrated that simulation consistently produced improvements in training for jet pilots compared with training in the aircraft only. Since the study included such a small number of helicopter experiments, no conclusion could be made about the simulator effectiveness for helicopter training. For aircraft training, it was found that motion cues add little to the training environment. The cumulative effect value across the five motion versus no-motion experiments included in the meta-analysis was negative in value indicating that motion might detract from training for some tasks. The study states that this conclusion can not be considered definitive because of two reasons: lack of periodic calibration of the motion systems and the inclusion of several training tasks in each experiment. The study states that, since reports often collapse across task boundaries when making between-group comparisons, the positive effects of platform motion for one task might have been masked by the negative effect of motion for another task. The analysis recommends that future research should address the issue of task-specific motion effects to verify what tasks or group of tasks benefit from motion cues.

2.6 Department of the Navy Training Analysis and Evaluation Group Research

McDaniel, Scott and Browning (1983) used a transfer of training design to compare the performance of a group of pilots trained with the Device 2F64C SH-3 helicopter simulator with motion cues to that of the control group trained under the same conditions but without motion. Twenty-six student pilots were randomly assigned to the motion and no-motion groups. The students were all graduates of the US Navy Undergraduate Pilot Training program. The motion system platform was instrumented and tested by engineers during the transfer of training experiment. Nine tasks were selected for analysis. The flight tasks chosen were basic and advanced contact and mission oriented tasks (which are usually conducted under instrument flight rules). Performance was measured by 1) the hours required in the aircraft to complete training and 2) aircraft trails to achieve proficiency in selected tasks. Positive training results (the motion group performed better than the no-motion group) were achieved in three tasks: Aircraft Stabilization Equipment off, freestream recovery and coupled hover departure procedures. Motion cueing was associated with negative training results for five of the remaining six tasks including landings, approaches and takeoff.

2.7 Summary of Literature Review

A search of the literature produced numerous articles on flight simulation. Some of the articles on training effectiveness have been based on pilot's and/or researcher's opinion (Boldovici, 1992; Waag, 1981) or analysis of the dynamic fidelity of the simulation in comparison with the aircraft (Hosman, 1996). These do not provide an indication of training effectiveness based on tangible metrics.

A very limited number of research experiments have attempted to objectively determine simulator effectiveness. Only two of those experiments addressed the contribution of motion simulation to the training of helicopter pilots.

Table 3 below summarizes notable flight simulation experimental evaluations, the type of aircraft studied and the transfer of training methodology used.

Table 3. Summary of Literature Review

Authors	Type of Aircraft	Methodology
Stewart et al. (2001)	Rotary wing	Simulator Performance Improvement Model
Johnson and Stewart (2002)	Rotary wing	Opinion Survey Model
Boldovici (1992)	N/A	Opinion Survey and Literature Review
Martin and Waag (1978)	Fixed wing	Transfer of Training Model
Nataupsky et al. (1979).	Fixed wing	Transfer of Training Model
Waag (1981)	Fixed and rotary wing	Literature Review
Taylor et al. (1997)	Fixed wing	Transfer of Training Model
Go et al. (2000)	Fixed wing	Backward Transfer Model and Simulator-to-Simulator Transfer Model
Taylor et al. (2003)	Fixed wing	Transfer of Training Model
Hays et al. (1992)	Fixed wing	Literature Review
McDaniel et al. (1983)	Rotary wing	Transfer of Training Model

2.8 Research Gap

While numerous studies have been conducted in the past to investigate the contribution of motion simulation to training transfer for fixed wing aircraft, few studies have addressed the training of helicopter pilots. Furthermore, while helicopter transfer of training studies have yielded no significant differences in performance between the group trained with motion from that of the group trained without motion, some positive outcomes have been identified when results are analyzed on a task by task basis. Additional task specific motion research is necessary to determine which helicopter flying tasks benefit from motion cueing. In this research, the training effectiveness of a cab with a large screen and 2DoF-Motion platform will be compared with that same training system with the motion turned off and a low-cost PC-based simulator for a highly complex joint search and rescue task.

CHAPTER THREE
METHODOLOGY

3.1 Research Approach

The objective of this research considers three relatively low cost training systems in the role of a training simulator. Specifically the research investigates the effectiveness of learning and performing helicopter control using a low-cost, PC-based training system when compared with a cab with a large screen and 2DoF-Motion platform with motion on and motion off. Helicopter control is defined in more detail below but entails conditions with and without atmospheric turbulence.

The research methodology entails the development and implementation of an experiment involving student helicopter pilots. As such, training transfer to a real environment is not the objective of this research. Rather, the objective of this research is simply to measure the degree to which control of a simulated helicopter is enhanced over the course of instruction given the previously stated modes and atmospheric conditions. The particular task chosen to facilitate turbulence is a Combat Search and Rescue mission. Criteria used to measure learning and performance is based on military references and military subject matter experts as cited below.

The foundation for the training methodology is described in TRADOC Regulation 350-70 “Training Development management, Processes and Products” and MIL-HDBK-29612-2 “Instructional Systems Development/Systems Approach to Training and Education (Part 2 of 4 Parts)”. The Instructional Systems Design/Systems Approach to

Training model is the recognized standard governing the instructional process in the Department of Defense.

3.2 Systems Approach to Training (SAT) Methodology

The Systems Approach to Training process is an adaptation of the systems engineering process. “It is a systematic approach to developing instructional materials by integrating the process of analysis, design, development, implementation and evaluation” (Department of Defense, 1999). The Systems Approach to Training process is made up of five different phases. They are Analyze, Design, Develop, Implement, and Evaluate. During the Analyze Phase of Systems Approach to Training, a particular area of specialty is analyzed to determine what job holders perform on the job, the order in which they perform it, and the standard of performance necessary to adequately perform the job. The results or outcomes of the Analyze Phase are selected for instruction. During the Design Phase of Systems Approach to Training, learning objectives, learning steps, performance tests, and the sequence of instruction are created. The Develop Phase of Systems Approach to Training builds on the outcomes of the Analyze and Design Phases. A program of instruction is developed providing a description of the learning objectives and evaluation procedures for a specific educational program. The next phase is the Implement Phase in which the instruction is delivered to promote student understanding of material to demonstrate professional competence in the learning objectives. This will ensure the transfer of knowledge from the instructional setting to the job. The last phase of the Systems Approach to Training process is the Evaluate Phase, which measures instructional program effectiveness and efficiency.

3.2.1 Phase I: Analysis

Analysis is the building block of a training program. The purpose of this phase is to identify critical tasks and the standards, conditions, and performance criteria to perform each task. The results of the analysis are the foundation for all subsequent development activities. Some of the required products, such as Job or Task Lists may have already been produced by other departments within the organization.

The analysis phase includes the following:

- Analysis of the Mission/Job performance requirements
- Task Analysis
- Selection of tasks to be trained
- Identification of the Knowledge, Skills and Abilities required to perform the Mission/Job.

The Mission/Job Analysis is provided in Appendix A. It was performed by analyzing the Combat Search and Rescue mission descriptions provided in Joint (Joint Chiefs of Staff, 2002; Joint Chiefs of Staff, 1998) and US Army (Department of the Army, 2003) publications.

The task analysis and identification of the required Knowledge, Skills and Abilities are presented in Appendix B. A top-down analysis of the tasks that comprise the Combat Search and Rescue mission at different echelons (Theater, Service, Brigade, Battalion, Company, individual) was performed using the information provided in several Joint and US Army publications (Department of the Army, 2001; Department of the Army, 2000a; Department of the Army, 2000b; Department of the Army, 2002; Joint Chiefs of Staff, 2002; USA Combined Arms Center, 2002; US Army Training and

Doctrine Command, n.d.). In order to select the tasks to be trained, the results of a study on the cues and conditions for the UH-60 flight and mission tasks (Humanalysis, Inc., 1994) and the US Army Training Circular 1-237 “Aircrew Training Manual Utility Helicopter, UH-60/EH-60” were utilized.

3.2.2 Phase II: Design

In the design phase, the information from the analysis is translated into a plan for the training program. Using the list of tasks to be trained from the previous phase, the instructional designers identify specific learning objectives, develop tests and design the instruction. During this phase, the instructional designer also selects the instructional methods and media.

3.2.2.1 Learning Objectives

Action: Plan and conduct UH-60 pilot slice of a Search and Rescue Mission.

Conditions: The individual is in a simulated environment. He has received orders to participate in a Search and Rescue. The first segment of the mission is performed under fair environmental conditions, the second segment is performed under severe environmental conditions. A map of the area is available.

Standard: The Search and Rescue mission was performed within the time constraints specified in the commander’s orders. Mission accomplishment was enhanced by careful planning and the use of proper techniques and procedures. Department of the Army (2000b) Aircrew Training Manual Utility Helicopter, UH-60/EH-60 (TC 1-237).

Military references and subject matter experts identified the attributes with respective go/no-go as well as variable criteria for helicopter control indicated below.

3.2.2.1.1. GO/NO GO Performance Measures

	GO	NO GO
The designated aircraft flew the designated route corridor	______	______
Arrived at the pickup zone within 8 minutes from takeoff	______	_______
Arrived safely at the landing zone	______	_______
Overall mission was accomplished within 20 minutes	______	_______

(US Army Combined Arms Center, 2002)

3.2.2.1.2 Variable Performance Measures

During flight:

- Heading was maintained within +/- 10 degrees
- Airspeed was maintained +/-10 knots (except for takeoff, hovering, landing, climbing, and descending, the pilot will be asked to maintain an airspeed of 100 KIAS for both route segments)
- Altitude was maintained +/- 100 feet
    - Altitude will be analyzed using the following segments:
        - Non- turbulence (from assembly area to pickup zone):
            - Level flight over mountain terrain (altitude required: 1,000 ft. starting 60 seconds after takeoff until 1 mile before the pickup zone).

- Microburst/Severe turbulence (from pickup zone to landing zone)
    - Level flight over mountain terrain (altitude required: 2,000 ft. starting 60 seconds after takeoff until 1 mile before the landing zone).
- The pilot will be asked to hover for 30 seconds at 50 feet after takeoff from both the assembly area and the pickup zone. During hover the pilot will be required to:
- Maintain heading +/- 10 degrees
- Maintain altitude +/- 3 feet
- Do not allow drift to exceed 3 feet
- Maintain a constant rate of movement for existing conditions
- Maintain a constant rate of turn not to exceed 30 degrees per second.

(Department of the Army, 200b)

3.2.2.2 Training Program Outline

- Background Questionnaire
- Immersive Tendencies Questionnaire
- Familiarization Training (0.5 hour)
- Break
- Practice trials in the simulator (3 trials, first will be used as baseline)
- Break
- Perform CSAR mission
- Feedback Questionnaire

Table 4. CSAR Mission Sequence of Events

Event	Action	Time Required
1	Individual receives order to conduct CSAR mission	0.25 hour
2	Plan operation	0.5 hour
3	Individual executes the mission	0.1667 hr (10 min.)

3.2.2.3 Instructional Media

The instructional media chosen is a helicopter simulator based at the US Army Research, Development and Engineering Command, in Orlando, Florida (refer to Figure 2). The simulator consists of a 2DoF electro-mechanical motion system (pitch: +43/-67, roll: +43/-43), the Capsule and the Display Case. The Capsule includes two seats (pilot and co-pilot), two joysticks, a pilot collective and two sets of rudder pedals. The Display Case provides a 60" (diagonal) rear-projection, 1024 x 768 resolution visual display system and houses the computer that operates the system. The main components of the computer system are: Intel Pentium 4 3.06 GHz CPU, 1GB RAM, ATI Radeon 9700 Pro AGP Graphics Card, 40 GB IDE Hard Drive with 8MB Cache, Windows XP Operating System and SoundBlaster Audigy2 soundcard (Naval Air Warfare Center Training Systems Division, 2003). (Appendix D depicts the simulator architecture. The specification of the motion platform is presented in Appendix E.)

Figure 2. Motion Platform Simulator

A desktop trainer with the same computer configuration, and functionally identical collective, joystick, chair and pedals as the motion platform simulator will also be involved in the study. A picture of the joystick, collective and pedals is provided in Figure3. (http://www.flightlink.com/hardware/rotorwing/index.html). These interface components were employed directly out of the box without additional modification. The computer monitor is a 19" Dell Trinitron. The resolution of the monitor will be set to be identical to the Display Case in the motion simulator (1024 x 768). The brightness and contrast of the monitor will be calibrated to be roughly equivalent to the one of the Display Case.

Figure 3. Basic Rotor Wing Hardware Package

The center point for both displays will be set to be at eye-height, assumed to be at 48" above the ground. The computer monitor will be set at a comfortable distance of 24" from the user. The viewing distance for the Display Case is 88“.

X-Plane version 7.61 will be used to provide a consistent SNE between the three systems both in terms of the content of the visual display and turbulence model. No direct modifications to the code will be made, though input variables will be modified for this research. X-Plane is a commercial flight simulation software implemented in OpenGL by Laminar Research. It contains 40 aircraft models and 18,000 airports across the United States and overseas (http://www.x-plane.com/descrip.html). X-Plane received United States Federal Aviation Administration (FAA) approval for use in flight training towards a professional Airline Transport Pilot Certificate, when conducted in an approved full-motion simulator (http://www.x-plane.com/FTD.html). X-Plane includes special effects such as day/night, wind and other weather conditions (http://www.x-plane.com/realweather.html). The Data Input & Output Window on the Settings Menu will be used to identify the output data. The data requested will be logged by X-Plane into the “Data.out” file which can be viewed after the flight using Microsoft Excel.

The research participants will be students and instructors from Helicopter Adventures, a helicopter flight school in Titusville, Florida

3.2.3. Phase III: Development

During the development phase, the lessons and other instructional materials are developed. The last step in this phase is the validation of the material by using representative samples of the target population and then revising the program as needed.

The motion platform simulator set up instructions can be found in Appendix F. There are no set up instructions for the Desktop configuration. A software driver that was received with the Basic Rotor Wing Hardware Package (refer to Figure 3 above) has been installed. To run the Desktop Configuration, it is only necessary to turn on the computer and start X-Plane.

The Background Questionnaire for the research participants is provided in Figure 4. The Combat Search and Rescue exercise is presented in paragraph 3.2.3.1. The scenario used in the Combat Search and Rescue lesson is part of a large international command and control research scenario generated by The Technical Cooperation Program. The author of the original citation for this scenario (Rathmell, 1999). as well as the Principal Investigator for a follow on project (Allsopp, Beautement, Bradshaw, Durfee, Kirton, Knoblock, Suri, Tate & Thompson) were contacted on December 10th and 11th, 2003 to request permission to use the scenario in this experiment.

The original scenery file (geographical properties and obstacle data) was edited using the World Maker software provided with X-Plane 7.61. Mountains, crops, villages, swamps, forests, and a river were added to the Northeast Africa area where the exercise will take place (X-plane environment file: N10E30) to make it consistent with the storyline of the Binni Scenario.

Please, provide the following information:
1.- a. How many flight hours do you have?
b. How many hours do you have in rotary wing aircraft?
2.- a. What helicopter pilot certification course are you currently taking?
b. In which stage of the certification course you are currently in?
3.- Do you hold any previous flight certificate? If yes, please indicate year you earned the certification(s).
4. Do you have any military flight experience? If so, what is it?
5. Do you have search and rescue (SAR) experience?
(If you don't have SAR experience, please, go to question #6)
a) In what aircraft?
b) How many SAR missions have you participated in?
c). Do you have any formal SAR training?
d) How many SAR training missions have you participated in?
e) Were you the pilot/co-pilot or some other crewmember?
h) What type of terrain were the SAR missions conducted in? (ex. mountainous, desert, wooded, over water)
i)What type of search patterns were used?
6. How much experience (hours) do you have flying in marginal weather? Please, describe your experience. (If you don't have experience flying in marginal weather, please, go to question #7)
a) Was this in helicopters or fixed wing aircraft?
b) What percent of your marginal weather experience is in precipitation?
c) What percent of your marginal weather experience is in fog or low visibility conditions?
7. Do you have experience in high steady state winds? Please, describe your experience.
8. What is your experience with turbulence? If so, what is it?
9. Have you used a flight simulator?
a) What was the total simulator time?
b) Was it a rotary wing flight simulator?

Figure 4. Background Questionnaire

3.2.3.1 UH-60 Simulator Scenario

The instructions and flight plan below will be provided to the participants after the second break and before the CSAR mission (refer to paragraph 3.2.2.3).

3.2.3.1.1 Introduction

Figure 5. Binni Map

In 2010, the change to a more humid climate in East Africa had allowed the population of Gao and Agadez to produce large quantities of wheat. A strong export market had developed. The only way to transport this large amount of food to the European market was by sea, either through the Gulf of Suez or around Cape of Good Hope. However, Gao was blocked by Agadez as it contained the only deep-water ports, at Sikasso and Costa del Maria.

Gao initiated a pre-emptive attack to open up a corridor to the sea. This attack caught Agadez by surprise and succeeded with little local resistance. Immediately after the borders had been created, Gao declared the annexed area to be the independent country of Binni. This infuriated the people of Agadez who launched repeated guerrilla activities to remove the Gao forces from Binni. The Provisional Government of Binni asked from protection from the UN in order to secure its stability. Gao agreed to retreat from Binni provided that it could have access to the Ports of Sikasso and Costa del Maria.

Following the declaration of Binni as a separate state and the request for UN support, terrorist elements believed to belong to the Agadez guerrilla force launched an attack to the Alexandria hotel in the Laki Safari Park to retaliate for the UN intervention. During the confrontation, twelve armed Binni militia and twenty-three visitors were murdered. Twenty-one people were taken hostage including the two teenage daughters of Joshua Ubngli, the newly elected Prime Minister of Binni.

As a result of this dangerously unstable situation, the UN passed Resolution 955 to create and deploy a UN War Avoidance Force for Binni (UNWAFB). This is composed of the military resources from five UN member nations (Australia, Gao, Netherlands, USA and the UK) and supplemented by advisors and personnel from the international community. The immediate issue for the UNWAFB is the safe recovery of hostages. This is of personal interest to Mr. Ubngli the Prime Minister of Binni who feels a grave concern for the welfare of his two daughters.

3.2.3.1.2 Execution

You are a UH-60 pilot who has been assigned the following mission:

Liftoff in 10 minutes and hover at 50 ft until told to depart from Runway 18 of your assembly area located at N19.5764E37.2159.

Fly to the pickup zone, located at N19.5004E37.1872 to rescue Mr. Ubngli's daughters from the Agadez terrorist forces. Arrive at the pickup zone no later than 8 minutes after departing.

Liftoff from the pickup zone and hover at 50 ft until told to depart for landing zone. Arrive to the landing zone located at N19.4337E37.2337 no later than 12 minutes after rescuing the hostages. Land up to the south (Runway 170) abeam a red/white antenna.

The mission should not deviate from the corridor provided. During flight, you should maintain heading +/- 10 degrees.

You should maintain an airspeed of 100 KIAS (+/- 10 knots) for both route segments (except for takeoff, landing, climbing, and descending).

You should maintain an altitude (+/- 100 feet) of 1,000 ft during the first segment (from assembly area to pickup zone). The required altitude will be measured starting 60 seconds after takeoff until 1 mile before the pickup zone.

You should maintain an altitude (+/- 100 feet) of 2,000 ft during the second segment (from pickup zone to landing zone). The required altitude will be measured starting 60 seconds after takeoff until 1 mile before the landing zone.

During hovering, you should maintain heading +/- 10 degrees, altitude +/- 3 feet, do not allow drift to exceed 3 feet, maintain a constant rate of movement for existing conditions, and maintain a constant rate of turn not to exceed 30 degrees per second.

All systems are operational and the aircraft has been refueled.

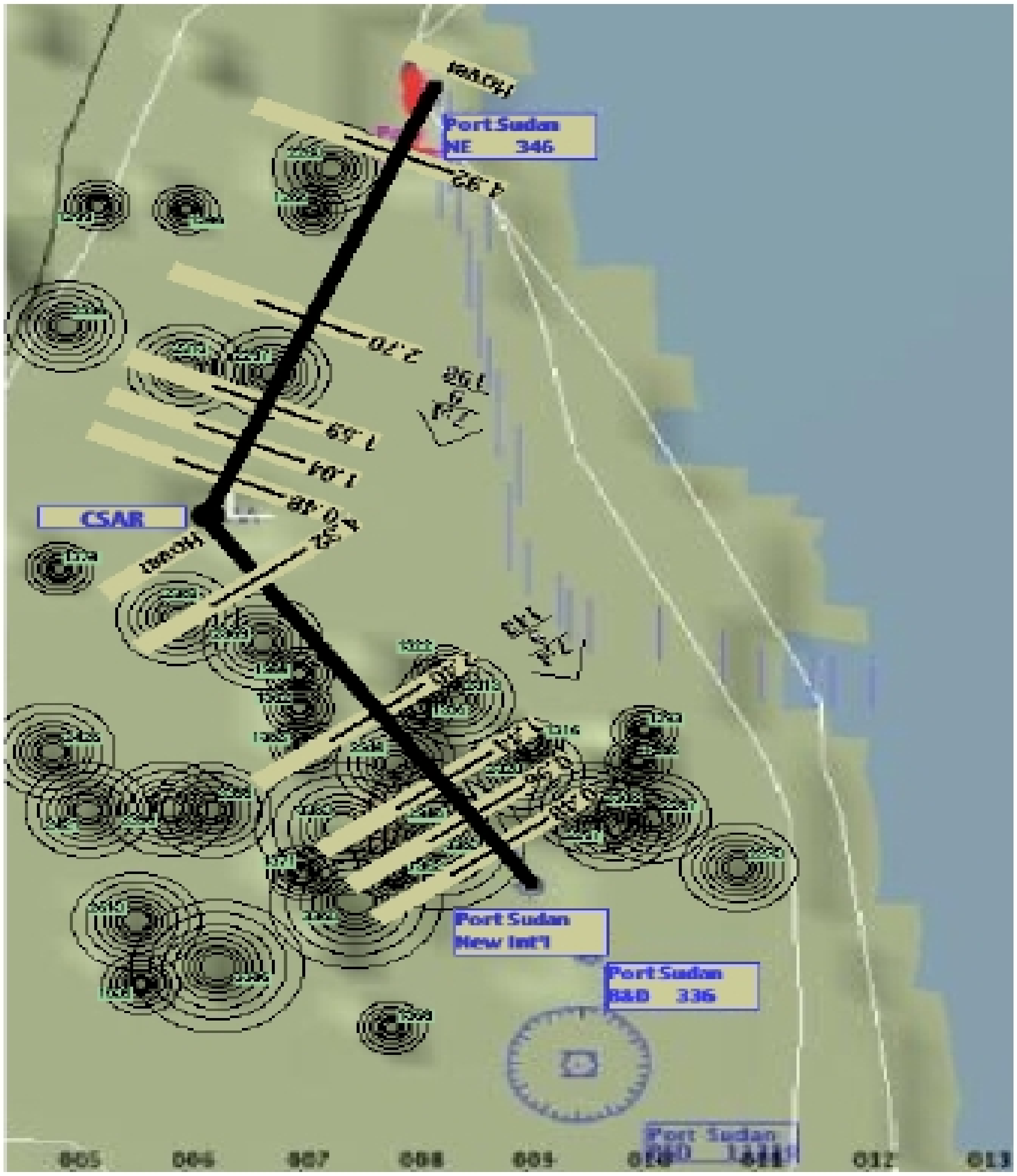


Figure 6. CSAR Flight Route

Operational Conditions: The current date is Monday 19th December 2011, it is therefore early winter and storms are forecast for the next two weeks. There has been considerable rain in the region of conflict and the terrain is becoming increasingly difficult. Low level flying and high level reconnaissance missions will be limited especially in the mid-afternoon period when Gao and Agadez forces are likely to be moving. There is a significant threat of the side effects to ‘la Nina’ storms in the region of the Red Sea which will make operations from the UNWAFB Fleet difficult over the next ten days.

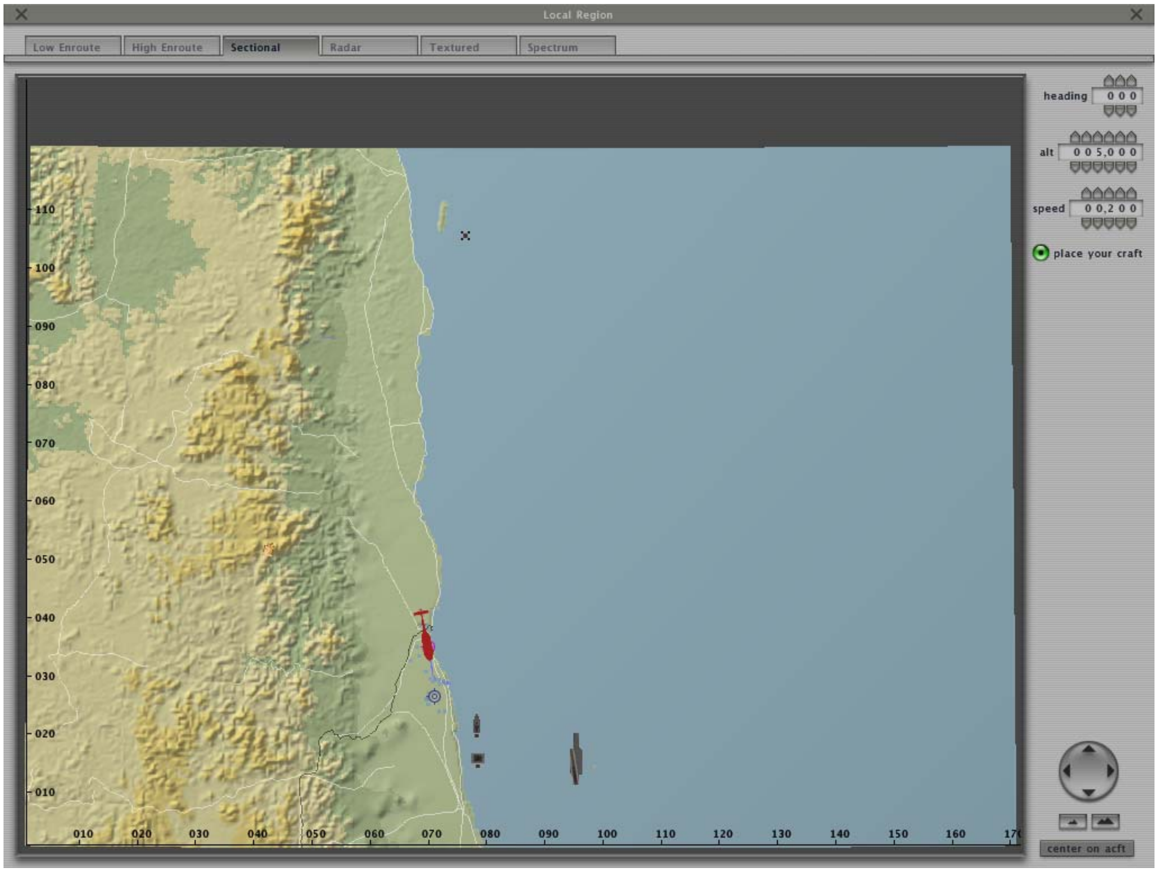


Figure 7. CSAR Mission Terrain

3.2.3.2 Trial Scenario

A scenario similar to the one developed for the CSAR mission was created for the practice trials. The instructions and flight plan below will be provided to the participants after the first break and before the practice trials in the simulator (refer to paragraph 3.2.2.3).

3.2.3.2.1 Execution

You are a UH-60 pilot who has been assigned the following mission:

Liftoff in 10 minutes and hover at 50 ft until told to depart from Runway 06 of your assembly area located at N44.8687W63.52492.

Fly to the pickup zone, located at N44.4804W63.3524 to rescue the downed crew. Arrive at the pickup zone no later than 8 minutes after departing.

Arrive to the landing zone located at N44.25W63.2930 no later than 12 minutes after rescuing the crew. Land on Runway 18.

The mission should not deviate from the corridor provided. During flight, you should maintain heading +/- 10 degrees.

You should maintain airspeed of 100 KIAS (+/- 10 knots) for both route segments (except for takeoff, landing, climbing, and descending).

You should maintain an altitude (+/- 100 feet) of 1,000 ft during the first segment (from assembly area to pickup zone). The required altitude will be measured starting 60 seconds after takeoff until 1 mile before the pickup zone.

You should maintain an altitude (+/- 100 feet) of 2,000 ft during the second segment (from pickup zone to landing zone). The required altitude will be measured starting 60 seconds after takeoff until 1 mile before the landing zone.

During hovering, you should maintain heading +/- 10 degrees, altitude +/- 3 feet, do not allow drift to exceed 3 feet, maintain a constant rate of movement for existing conditions, and maintain a constant rate of turn not to exceed 30 degrees per second.

All systems are operational and the aircraft has been refueled.

Figure 8. Trial Scenario Flight Route

3.2.3.3 Immersive Tendencies Questionnaire (ITQ)

The ITQ will be provided to the participants at the beginning of the training program in order to measure possible individual differences in the tendencies of subjects to immerse themselves in different environmental situations. This questionnaire is provided in Appendix G.

3.2.3.4 Instructional Materials Validation

The validation of the instructional materials was conducted during the September-October 2004 timeframe. Two current US Army pilots, a former US Army UH-60 instructor, and the Chief Flight Instructors for Air Orlando-Helicopters and Tropical Helicopter reviewed the set-up in X-Plane of the data outputs, the scenario weather and time of day, and the helicopter model parameters, as well as the CSAR scenario. All the inputs from these Subject Matter Expert (SME) pilots were incorporated, many of them in "real time" while the SMEs were still in the RDECOM-STTC high bay area (where the training program was being developed). After their comments were incorporated, the changes were shown to the SMEs for final feedback. There was no manpower available to document the SME inputs at the same time.

3.2.4. Phase IV: Implementation

During this phase, a training plan is prepared and the training is conducted. A three-group experimental design will be used to investigate the Training Effectiveness of a low-cost, PC-based simulator when compared with two different treatments of a 2DoF training system. Forty five participants will be assigned to one of three training configurations: a) Cab simulator with motion turned ON, b) Cab simulator with motion turned OFF and c) PC-based simulator. The three groups will have the same number of beginner, intermediate and advanced experience pilots.

The criteria to determine the pilot's level of experience is based on expert judgment as provided by US Army Captain Thomas Lucario, an UH-60 pilot, and the information contained in Federal Aviation Administration (2003) and is as follows:

- Beginner: At least 30 flight hours, Recreational (30 flight hours) or Private Pilot Certification (40 flight hours).
- Intermediate: Commercial (150 flight hours) Certification or Flight Instructor.
- Advanced: Airline Certification (1200 flight hours), Intermediate plus Search and Rescue experience, Intermediate plus UH-60 experience, Intermediate plus experience flying in turbulence, marginal weather or with high steady state winds.

To determine the sample size, the Power and Precision software package downloaded from http://www.power-analysis.com was used. The expected outcome input was based on the results of two previous studies (Nataupsky, Waag, Weyer, McFadden, & McDowell, 1979 and Hosman, 1996).

The same trial and CSAR scenarios will be employed in the three simulator configurations.

The transfer of training methodology to be used will be the "Simulator Performance Improvement Model" (Advisory Group for Aerospace Research and Development, 1980). In an effective simulator training program, it is expected that the performance of the trainees in the simulator will improve as a result of training they receive in the simulator. If this does not happen, there is little expectation that subsequent operational performance will be improved as a result of simulator training. Therefore, improvement in performance in the simulator is frequently mentioned as evidence that simulator training is effective. This method is usually employed when circumstances prevent the employment of a transfer model to determine simulator training effectiveness. It must be noted that this model provides only indirect proof of simulator effectiveness. It can demonstrate that a necessary condition has been met, but it does not justify the conclusion that the improved performance in the simulator will result in improved operational performance. This model, therefore, is most useful in a negative way: if no improvement occurs in the simulator, none should be expected operationally.

3.2.4.1 Assessing Learning Aircraft Control

The first null hypothesis tests equivalence in helicopter control between the first run and the last run. Learning for the purposes of this experiment will be experiential in nature and be defined as the improvement in task performance for the tasks identified above across four runs from the first run to the last run. If the null hypothesis is not rejected, then no difference in helicopter control occurred and therefore no learning. If the null hypothesis is rejected, then a difference in helicopter control occurred between the first run and the final run. The direction of the change will indicate whether or not an improvement occurred.

Learning aircraft control in each training configuration will be assessed from three perspectives yielding twelve measures:

1. Analyzing, using the Wilcoxon Signed Ranks Test, how the pilot complied with four Go/No Go performance measures (delineated in paragraph 3.2.2.1.1) during the CSAR mission when compared against the baseline trial in the instructional phase (refer to 3.2.2.2 Training Program Outline).
2. Comparing, using the Chi-Square Test, the number of crashes and timeouts (pilots will be "timed-out" if more than 8 minutes have passed after takeoff without arriving to the pickup zone) in the CSAR mission against observations during the baseline trial of the instructional phase.

3. Analyzing, using the Wilcoxon Signed Ranks test, how the pilot complied with heading, speed, altitude for level flight for each flight segment in the initial run compared to the last run with respect to the ranges described in paragraph 3.2.2.1.2.

3.2.4.2 Assessing Performance Differences between a Turbulent and a Non-turbulent Environment

The second null hypothesis tests the hypothesis that performance in the turbulent flight segment was equivalent to performance in the non-turbulent flight segment. Using the Wilcoxon Signed Ranks Test, the outputs of the CSAR mission during the Non-Turbulence segment will be compared against the ones of the same mission during the Microburst/ Moderate Turbulence segment (refer to paragraph 3.2.2.1.2) to determine the impact of turbulence on pilots performance for each of the three training configurations.

3.2.5. Phase V: Evaluation

Evaluation is performed during the analysis, design, development and implementation phases. The goal of this phase is to allow for continuous improvement of the training program. A Feedback Questionnaire will be provided to the research participants at the end of their session. The questionnaire includes a request for improvement suggestions and is provided below in Figure 9. The feedback from the research participants can be applied by the US Army Research, Development and Engineering Command Simulation and Training Technology Center to future research studies.

1. - Please, mark the training system configuration you were trained in:

Motion Platform Simulator with Motion Turned ON: _____

Motion Platform Simulator with Motion Turned OFF: _____

Desktop simulator: _____

2.- What were the features of the training system that were most effective with regards to practicing helicopter flight skills? What were the least effective?

3.- Do you believe it will be of value to use this training system in flight schools? Why or why not?

4.- Please, provide any suggestions you might have concerning improvements to this research study.

Thanks in advance for your feedback.

Figure 9. Feedback Questionnaire

CHAPTER FOUR
EXPERIMENT RESULTS

4.1 Data Collection and Analysis

The experiment was conducted from December 21st, 2004 to January 19th 2005 at Helicopter Adventures in Titusville, Florida. Forty five subjects participated in the study. All subjects were helicopter pilots. They were assigned to one of the training configurations Cab with Motion, Cab with No Motion and Desktop. The three groups had the same number of beginner, intermediate and advanced level pilots.

Visual Basic macros were developed to perform the data reduction of the X-Plane output files. Analyse-it, an Excel add-in (downloaded from www.mbaware.com/analyseit.html), was used as the statistical software package.

4.2 Learning: CSAR GO/NO GO Results

Pilot's learning over the three experiential trials was measured with respect to compliance with the CSAR GO/NO GO performance measures is summarized in Table 5. The Wilcoxon Signed Ranks Test was used to compare the results of the baseline run with the observations during the CSAR mission.

Table 5. Learning from Initial Trial to CSAR: GO/NO GO Measures

	Arrived at pickup zone within 8 minutes	Arrived safely at the landing zone
Cab Motion	0.0273	0.0313
Cab No Motion	0.0273	0.0002
Desktop	0.125	0.0625
	Overall mission accomplished within 20 minutes	Followed corridor
Cab Motion	0.0313	0.0078
Cab No Motion	0.0002	0.0137
Desktop	0.0625	0.0313

At the .05 level of significance, there were statistical differences in the performance of participants in all categories for all simulator modes except for the desktop simulator. For the "arrived at pickup zone within 8 minutes," "arrived safely at the landing zone," and "overall mission accomplished within 20 minutes" measures, the training improvement is significant for both the Cab with Motion and the Cab with No Motion configurations. For the "followed corridor" measure, the three configurations showed significant improvement. Statistical significance, for both the Cab with Motion and Cab with No Motion configurations in the four measures and for the Desktop configuration in the “followed corridor” measure, does not support the null hypothesis that there was no difference in helicopter control. Therefore learning occurred between the first and the last run where a statistical significant difference occurred.

4.3 Learning: Crashes and Timeouts

Pilot's learning with respect to avoiding crashes and timeouts was analyzed using the Chi-Square statistic. The number of crashes and timeouts in the first run was compared with the number of crashes and timeouts during the CSAR mission. Results are shown in Table 6 (pilots were "timed-out" if more than 8 minutes had passed after takeoff without arriving to the pickup zone).

Table 6. Learning from Initial Trial to CSAR Mission: Crashes and Timeouts

	Crashes/Timeouts	
	No Turbulence	Turbulence
Cab Motion	0.0528	0.0271
Cab No Motion	0.0067	<0.0001
Desktop	0.2636	0.2723

At the .05 level of significance, there were statistically significant improvements in the performance of participants in both the Motion and the No Motion configurations for the Turbulence segment and for the No Motion configuration in the Non Turbulence segment. Statistical significance on these measures does not support the null hypothesis that there is no difference in helicopter control. Therefore learning occurred between the first and the last run for both the Cab with Motion (during Turbulence) and Cab with No Motion (for both the Non Turbulence and the Turbulence segments) simulators.

4.4 Learning from Initial Trial to CSAR: Heading, Velocity and Altitude Flight Segment Analysis

Pilot's learning from the initial run to the last run was analyzed for each flight segment with respect to the ranges described in paragraph 3.2.2.1.2 for heading, speed and altitude for level flight using the Wilcoxon Signed Ranks Test. A Visual Basic macro was developed to calculate the amount of time during level flight (for both the Turbulence and the Non Turbulence segments) that the pilot was out of the established ranges for heading, speed and altitude. The results are summarized in Tables 7, 8, and 9 below.

Table 7. Learning Heading Control

Configuration	Heading Non Turbulence	Heading Turbulence
Cab Motion	0.0039	0.0313
Cab No Motion	0.0391	0.0020
Desktop	0.0625	0.0625

Table 8. Learning Speed Control

Configuration	Speed Non Turbulence	Speed Turbulence
Cab Motion	0.3028	0.1272
Cab No Motion	0.2293	0.0040
Desktop	0.0906	0.3203

Table 9. Learning Altitude Control

Configuration	Alt. Non Turbulence	Altitude Turbulence
Cab Motion	0.1514	0.6250
Cab No Motion	0.0730	0.4238
Desktop	0.0054	0.4648

At the .05 level of significance, the null hypothesis of equivalence in Heading Control was rejected for both the Cab with Motion and the Cab with No-Motion simulators for both the turbulent and non-turbulent flight segments. Therefore the alternate hypothesis of learning heading control is accepted and an improvement in maintaining the heading is shown in the Cab with Motion and the Cab with No Motion training configurations during both the Non Turbulence and the Turbulence flight segments. The null hypothesis could not be rejected for all other simulator, turbulence, and control combinations except for two. During the Turbulence segment, significant improvement in maintaining speed is shown in the Cab with No Motion configuration. During the Non Turbulence segment, a significant improvement in maintaining altitude is shown in the Desktop configuration.

4.5 Performance Differences: Non-turbulence vs Turbulence

The impact of turbulence in the pilot's performance was analyzed by comparing the performance in the non turbulence segment against the turbulence segment during the CSAR mission using the Wilcoxon Signed Ranks Test. The results are shown in Table 10 below.

Table 10. Effects of Turbulence on Pilot's Performance

Configuration	Heading	Velocity	Altitude
Cab Motion	0.5000	0.0002	0.0001
Cab No Motion	0.5000	0.0026	0.0001
Desktop	0.2500	0.0001	0.0001

The null hypothesis of equivalence was rejected for both velocity and altitude in all three simulator configurations. The null hypothesis of equivalence for heading could not be rejected. The participant's performance in the three training configurations was negatively affected by turbulence with respect to the velocity and altitude parameters. This was not unexpected as learning control of the helicopter in turbulence was expected to be more difficult than under conditions other than turbulence.

4.6 Immersive Tendencies Questionnaire

An Immersive Tendencies Questionnaire (ITQ) was provided to all the participants at the beginning of the training program. Some of the beginner participants that received high scores in the ITQ questionnaire were more successful than intermediate or advanced participants in avoiding crashes and timeouts. However, none of the statistical tests performed relating the ITQ scores (total score, Focus, Involvement, Games) to the pilots' performance produced a statistically significant result.

4.7 Feedback Questionnaire

The feedback questionnaire was provided to all forty-five participants at the end of the training session. Feedback comments that were common to at least three participants in any given column are summarized in Table 11 below. Comments from three participants represent 20% of the fifteen participants that responded in any given column.

Table 11. Common Themes in Responses to Feedback Questionnaire

	Cab Motion	Cab No Motion	Desktop	Chi--square Test
Needs motion		4		0.0163
Controls				
Slow response	4	1	1	0.1431
Lack of control feedback		6	3	0.301
Pedals heavy/not good	4	1	3	0.3006
Get controls mounted			4	0.0104
Display				
Not enough detail in the terrain, outside references needed	7	3	5	0.2881
Peripheral vision needed	2	1	4	0.2712
Could not see well the control panel	2	3		0.2275
Better if simulator had sound	2	1	2	0.7589

Table 12. Comparison against Null Hypothesis of No Problem with Training System Feature

	Cab Motion	Cab No Motion	Desktop
Needs motion		0.1071	
Controls			
Slow response	0.1052		
Lack of control feedback		0.0225	0.2217
Pedals heavy/not good	0.1052		0.2217
Get controls mounted			0.1052
Display			
Not enough detail in the terrain, outside references needed	0.0088	0.2235	0.0484
Peripheral vision needed	0.4631		0.1052
Could not see well the control panel	0.4631	0.2235	
Better if simulator had sound	0.4631		0.4631

Table 13. Motion versus No Motion Analysis

	Chi-Square Test
Needs motion	0.1230
Controls	
Slow response	0.2853
Lack of control feedback	0.0279
Pedals heavy/not good	0.2853
Display	
Not enough detail in the terrain, outside references needed	0.1910
Peripheral vision needed	0.9497
Could not see well the control panel	0.9324
Better if simulator had sound	0.9497

Table 11 shows statistical differences between training systems modes when taken together. Two attributes were statistically different between systems. First, participants in the large screen, cab simulator with motion turned off indicated that the motion needed to be turned on. This indicates different expectations from this group from either of the other two groups. We believe that the desktop group did not express a need for motion as it was expected that motion could not be provided. The cab with motion group had motion, although there is evidence to be explained later that some of them were not satisfied with the quality of that experience. The cab without motion group expressed a need for motion.

When addressing the least effective features of the training system as well as the areas that needed improvement, the majority of the participant's comments focused in two areas: training system controls and the display system.

With respect to the training system controls, participants in the three configurations stated that the pedals "did not feel good" (three in the Motion Configuration, one in the No Motion Configuration and two in the Desktop Configuration) or were too heavy (one in the Motion system and one in the Desktop). Four participants in the Motion system, one in the No Motion and one in the Desktop considered that the software response to the control inputs was too slow.

Four participants in the No Motion configuration and two in the Desktop considered that the lack of control feedback was the least effective element of the training system. Refer to Table 12, when compared with the null hypothesis of no problem with this feature and using a 95 % confidence interval, the result of the Chi-square test is significant for the No Motion configuration ($p=0.0225$). The Chi-square test result is also statistically significant ($p= 0.0279$), with respect to this response, when the Motion and No Motion configurations are compared at the .05 level of significance (refer to Table

13). Two No Motion and one Desktop participant suggested that control feedback had to be included as part of future system improvements.

Four Desktop participants stated that the training system controls needed to be firmly mounted. Refer to the Chi-square test results shown in Table 11 above, using a 95% confidence interval, this response was statistically significant (p=0.0104). Four No Motion participants commented that the system needed motion to be "realistic." Refer to Table 11, using a 95% confidence interval, this result was also statistically significant (p=0.0163).

Participants from the three training configurations (seven from the Motion, three from the No Motion and five from the Desktop) commented that the terrain needed additional ground features in order to be able to judge speed and distance. Refer to Table 12, when compared with the null hypothesis of no problem with this training system feature and using a 95 % confidence interval, the result of the Chi-square test is significant for both the Motion (p=0.0088) and the Desktop configurations (p=0.0484) .

It was also expressed by participants from the three training configurations (two from the Motion, one from the No Motion and four from the Desktop) that the lack of peripheral vision made hovering and approaches difficult. Participants from both the Motion (two) and the No Motion (three) configurations stated that they could not see the control panel well.

CHAPTER FIVE
CONCLUSIONS

5.1 Summary of Findings

Investigating the training effectiveness of three different training configurations (a Cab with motion turned ON, a Cab with motion turned OFF, and a PC-based simulator) for a highly complex task, a Search and Rescue mission, was the purpose of this study. The complexity involved maintaining helicopter control in terms of a number of attributes to include heading, velocity and altitude under both non-turbulent and turbulent atmospheric conditions.

Table 14. Learning Summary

Simulator	Number of Objective Measures that Support Learning	Number of Objective Measures that Do Not Support Learning
Cab with Motion	7	5
Cab with No Motion	9	3
Desktop	2	10

For the Cab with Motion configuration, all learning measures are supported except speed and altitude control (in both turbulence and no turbulence environments) and crashes in non-turbulent environment. For the Cab with No Motion configuration, all measures are supported except speed control in no turbulence environment and altitude control (in both turbulence and no turbulence environments). For the Desktop configuration, only two measures are supported, the "Followed Corridor" GO/NO GO measure and altitude control in non-turbulence environment.

Table 15. Learning Summary: Non Turbulence Conditions

Simulator	Number of Objective Measures that Support Learning under Non Turbulence	Number of Objective Measures that Do Not Support Learning under Non Turbulence
Cab with Motion	2	3
Cab with No Motion	3	2
Desktop	1	4

Under non-turbulent conditions, participants trained in the Cab with Motion configuration showed statistically significant learning for the "arrived at pickup zone within 8 minutes" GO/NO GO measure and in heading control during the Non Turbulence segment. The pilots trained in the Cab with No Motion configuration demonstrated statistically significant learning for the GO/NO GO performance measure related to the Non Turbulence segment, heading control, and in avoiding crashes and timeouts.

The pilots trained in the PC-based simulator showed significant learning for only one measure, altitude control.

Table 16. Learning Summary: Turbulence Conditions

Simulator	Number of Objective Measures that Support Learning under Turbulence	Number of Objective Measures that Do Not Support Learning under Turbulence
Cab with Motion	3	2
Cab with No Motion	4	1
Desktop	0	5

Under turbulent conditions, participants trained in the Cab with Motion configuration showed statistically significant learning for the "arrived safely at the landing zone" " GO/NO GO performance measure, in heading control and in avoiding crashes and timeouts. The pilots trained in the Cab with No Motion configuration demonstrated statistically significant learning for all measures supported except altitude control. The pilots trained in the PC-based simulator did not show significant learning with respect to the objectives measures that support learning under Turbulence conditions.

The GO/NO GO performance measures “Overall mission accomplished within 20 minutes” and “Followed corridor” involve both the Non Turbulence and the Turbulence segments therefore, these two measures were not included in either Table 15 or 16 above.

Table 17. Comparison against Null Hypothesis of No Learning for Each Training Configuration

	Chi-Square Test Result
Cab with Motion	0.0070
Cab with No Motion	0.0007
Desktop	0.4602

To gain an overall assessment of each configuration, Chi Square Tests were performed to compare the total number of objective measures that supported learning in each training configuration against the null hypothesis of no learning. Using a 95% confidence interval, the results were statistically significant for the Cab with Motion (p= 0.0070) and the Cab with No Motion (p= 0.0007) configurations. The null hypothesis of no learning is therefore rejected and alternative hypothesis that learning occurred in these two configurations is accepted. Overall the null hypothesis of no learning can not be rejected for the Desktop model.

Table 18. Objective Measures that Support Learning: Statistical Comparison of Two Training Configurations

	Chi-Square Test Result
Cab with Motion vs. Cab with No Motion	0.665
Cab with Motion vs. Desktop	0.0917
Cab with No Motion vs. Desktop	0.0140

A Chi Square Test was performed to compare the number of objective measures that supported learning in the Cab with Motion configuration against the ones that supported learning in the Cab with No Motion configuration. Using a 95% confidence interval, the result was not statistically significant (p= 0.665).

A Chi Square Test was used to compare the number of objective measures that supported learning in the Cab with Motion configuration versus the ones that supported learning in the Desktop configuration. Using a 95% confidence interval, the result was not statistically significant (p= 0.0917).

A Chi Square Test was also performed to analyze the number of objectives measures that supported learning for the Cab with No Motion configuration when compared with the ones that supported learning for the Desktop configuration. Using a 95% confidence interval, the result was statistically significant (p= 0.0140).

Each of the three configurations, beginning with the Cab with No Motion, will be discussed in turn.

In the responses to the Feedback Questionnaire (refer to Table 11), four Cab No Motion participants commented that the system needed motion to be "realistic." At the .05 level of significance, this response was statistically significant (p=0.0163). Despite this finding, the objective data still supported the alternative of learning without the presence of motion. The experiment was conducted in an open area, a hangar at Helicopter Adventures in Titusville, Florida. It is likely that many of the Cab with No Motion research participants saw the 2DoF training system running with the motion turned on. That might have influenced their perception that something was "missing" from the No Motion configuration they were assigned to participate in.

Previous research supports the argument that the learning that occurred in both Cab configurations may have been due largely to the large screen systems that both systems have. As stated in paragraph 3.2.2.4, the Cab configurations used a 60" (diagonal) rear-projection (30^0 horizontal x 30^0 vertical field of view, 1024 x 768 resolution) visual display system while the Desktop configuration used a 19" diagonal monitor (40^0 horizontal x 40^0 vertical field of view, 1024 x 768 resolution). In their study, Reeves and Naas (1998) concluded that images on a large screen (90" versus 22" diagonal) are remembered more than those in a smaller screen. Tan (2004) used two monitors of different size, with the same field of view, he concluded that "physical display size seems to immerse users more within virtual environments and bias users into egocentric strategies." Furthermore, he concluded that "egocentric strategies only aid performance on tasks which benefit from having users imagine their bodies within the problem space."

The limited learning that occurred in the desktop system needs to be further addressed beyond the lack of a large screen. Another factor that likely affected the learning in the Desktop configuration was the fact that the controls (joystick, collective and pedals) were not mounted to the floor. This issue was identified in the Feedback Questionnaire by four of the Desktop participants. These controls had been tested, before the experiment, in the high bay area of the RDECOM-STTC which has a carpet floor and where no problems with the controls were identified. The Helicopter Adventures hangar has a concrete floor. These four participants felt the controls were sliding. Refer to Table 11, using the Chi-square test and a 95% confidence interval, it was found that this response was statistically significant (p= 0.0104). It should be noted that mounting the controls to the floor was not required by the installation instructions provided by the Basic Rotor Wing Hardware Package (Figure 3) vendor. Clearly, this particular desktop simulator suffered from the lack of a fixed base or means to affix the controls to the floor.

Both the Cab with Motion and the Desktop configurations may have been adversely affected by terrain fidelity. Specifically, participants from the three training configurations (a total of 15 out of the 43 pilots that responded to the Feedback Questionnaire) commented (refer to Table 11) that the terrain needed additional ground features in order to be able to judge speed and distance. Refer to Table 12, when compared with the null hypothesis of no problem with this training system feature and using a 95 % confidence interval, the result of the Chi-square test is significant for both the Motion (p=0.0088) and the Desktop configurations (p=0.0484). This comment is supported by US Army training documentation. According to Department of the Army (2000c), terrestrial associations comparing an object of known size against and object of unknown size can be used to determine the distance to the unknown object. The lack of the ability to clearly discern this distance would adversely affect depth perception and hence the judgment of distances and speed control.

Participants in the three configurations stated that the pedals "did not feel good" or were too heavy. Four participants in the Cab with Motion system, one in the Cab with No Motion and one in the Desktop considered that the software response to the control inputs was too slow. These training systems shortcomings likely contributed to the limited learning shown in this study in relationship to the speed and altitude control parameters.

Table 19. Turbulence Performance Summary

Simulator	Number of Objective Measures that support Performance Under Turbulence	Number of Objective Measures that do not support Performance Under Turbulence
Cab with Motion	1	2
Cab with No Motion	1	2
Desktop	1	2

Participant’s performance during the final CSAR run, in all three training configurations, was not affected by turbulence with respect to the heading parameter. It was affected negatively by turbulence with respect to the velocity and altitude parameters.

5.2 Experiment Limitations

Even with forty five participants and the time available, the experiment could not control for all factors. Time, money, and safety considerations limited this experiment to the above methodology. Experiment limitations are not believed to have been significant enough to undermine any of the conclusions cited above but are found in the following: scenario, equipment, facilities, and software. Each is discussed below.

Scenario: Event Sequence: Perhaps the biggest limitation was inability to control statistically for the sequence in which turbulence occurred. While the sequence of training in non-turbulence before training in turbulence is consistent with the crawl, walk, run instructional philosophy by putting the most difficult tasks at the end, the sequence may influence the findings. For example the sequence of having the non-turbulent flight segment before the turbulent flight segment may likely have contributed to the building of confidence in the pilots during the three instructional runs. However, it reduces the ability for the experiment to statistically discern between learning control in turbulence because there would be carry-over effects of learning from the Non-Turbulence segment. It also reduces the ability for the experiment to statistically discern between control performance between turbulent and non-turbulent flight segment because of the practice effect which can be positive (performance improvement due to familiarity) or negative (performance deterioration due to fatigue).

Equipment limitations: Motion Delay: Besides the lack of design that insures stability of the pedals in the desktop configuration, in order to use the latest X-Plane version at the time (version 7.61 which allowed a more detailed terrain and scenario modifications that facilitated the execution of the CSAR mission), an update of the software that controlled the motion platform was necessary. Given the STTC need to remove the 2DoF Motion Simulator from the building at that time, it was necessary to move the simulator to Helicopter Adventures and start the experiment before the software update was completely optimized. It was considered by the contractor, that the motion software running with X-Plane 7.61 was not as good as the previous version. The delay was estimated by Simulation Entertainment Group, Inc. to be about 100 milliseconds which, according to McDaniel et al. (1983), is consistent with most trainer standards. This may have contributed to the some of the complaints associated with the quality of the motion system controls.

Facilities limitations: Environmental Distractions: The experiment was conducted in the hangar of Helicopter Adventures. Participants were subjected to the normal airport noise and the relatively cold temperatures of a Florida winter.

Software limitations: Hovering: The scenario should have included an additional parameter change besides altitude (heading, for example) at the time of performing the hovering (refer to paragraph 3.2.2.2.2). After takeoff, pilots did not achieve the required 50 ft. of altitude and started hovering at the same time. The X-Plane output files did not provide a clear indication of when the hovering had occurred, therefore that data was not part of the statistical analysis.

Software limitations: Lack of adequate X-Plane software support and documentation: The X-Plane 7.61 documentation is very limited. The User's Manual provides only basic information. It does not explain many of the capabilities that X-Plane has which have the potential of use for training, for example, a description of each field of the "data.out" file, how to correctly insert custom objects, how to manipulate the airplane controls before and during flight, what some of the information that appears in the World Maker screen when zooming to insert and object or change the texture mean, etc.

Software limitations: Support: Additionally, X-Plane is not supported by dedicated customer service personnel. Its author, Austin Meyer, personally responds to questions when available.

Software limitations: Feature limitations: The scenarios creation and the data analysis required extensive searching into different locations in the World Wide Web (including some user's bulletin boards) that refer to or are dedicated to X-Plane as well as a lot of trial and error. The limited X-Plane documentation and the lack of adequate customer support resulted in long scenario development and data analysis time periods and in the use of several manual workarounds while conducting the experiment.

5.3 Lessons Learned

A few lessons were learned that might improve follow-on experimentations. These include improvements to the feedback questionnaire, additional pre-test, and restarting a pilot who may have crashed. None of these lessons learned are believed to have been serious enough to have undermined the conclusions cited above.

Though the feedback questionnaire provided useful information, the questions needed to be improved. Specifically, the questions were too general and relied too much on the participants to explain their remarks. For example, in some instances some remarks by participants about the controls could not be discerned if the remark was directed at the joystick, the collective or the pedals.

While pre-tests were done on all three configurations, the actual test occurred in another area in which a pre-test had not been conducted. The controls had been tested, before the experiment, in the high bay area of the RDECOM-STTC which has a carpet floor and where no problems with the controls were detected. The Helicopter Adventures hangar has a concrete floor. Four participants felt the controls were sliding on the floor. Had a pre-test been conducted on the concrete floors, this shortcoming in the equipment might have been detected and the equipment manufacturer notified so that an approved solutions might have been created. As it was the experiment was conducted in accordance with the existing equipment limitations. If the simulator equipment needs to be relocated, the experiment schedule needs to include a Pre-Test phase at the new location to verify that the equipment move has not affected system performance and that the differences in site conditions do not call for changes to the hardware, software or training program.

During the experiment, if a pilot crashed or was timed out during the first segment, that particular run was stopped. After that, the pilot started in the first segment of the next run (refer to the Training Program Outline delineated in paragraph 3.2.2.2, there were a total of four runs: three trial ones and the CSAR mission). When calculating the amount of time, for the second segment, that these pilots (who had crashed or been “timed-out” during the first segment) were out of the established ranges for heading, speed and altitude, a default value corresponding to the maximum time out of range was used. A better measure of pilot’s improvement in heading, speed and altitude could have been obtained if, instead of using default values for the second segment, X-Plane had been restarted and the pilot had actually “flown” that segment.

5.4 General Conclusions and Future Research

As seen in Table 19, turbulence produced degradation in performance with respect to speed and altitude control when compared to the non-turbulence segment of the CSAR run. The training program used for this research involved a total of only four runs (three practice trials and the CSAR mission). Given that flying the helicopter during turbulence is assumed to be more difficult, more practices runs may have resulted in learning to control the aircraft under those conditions. Future research should increase the number of practice trials to train helicopter pilots on speed and altitude control under severe weather conditions to determine if level of practice effects performance.

The transfer of training methodology used for this study was the "Simulator Performance Improvement Model" (Advisory Group for Aerospace Research and Development, 1980). With this methodology, learning in the simulator is used as evidence that simulator training is effective. In this case, pilot's learning was analyzed by comparing the results of the baseline run with the ones of the CSAR mission in the same simulator configuration. Refer to Table 17, when the objectives measures that support learning were compared for each configuration with the null hypothesis of no learning, statistically significant results were detected for both the Cab with Motion and the Cab with No Motion configurations. Overall the statistics did not reject the hypothesis of no learning in the Desktop configuration and only supported the alternative hypothesis of learning for two of the twelve objective measures.

The "Simulator Performance Improvement Model" is usually employed when research conditions prevent the employment of a transfer model to determine simulator training effectiveness. Direct transfer could not be tested during this experiment due to the expense and safety considerations. The methodology used shows only "indirect evidence of simulator effectiveness" (Caro, 1977). In order to provide direct evidence of simulator effectiveness, future task-based motion studies should use the Transfer of Training Model (Advisory Group for Aerospace Research and Development, 1980). This model is considered the study method that is most appropriate to determine whether simulator training has improved subsequent operational performance (Caro, 1977). In its simplest form, it consists of two groups of participants, an experimental group which receives simulator training prior to further training in the aircraft and a control group which receives all the training in the aircraft. Using this design, difference in task performance in the aircraft between the experimental and control groups is attributed to the influence of training received by the experimental group. The two groups must be equivalent, of course, with respect to prior training and experience.

In their study, Hays, Jacobs, Prince, and Salas (1992) stated that, since reports often collapse across task boundaries when making between-group comparisons, the positive effects of platform motion for one task might have been masked in the past by the negative effect of motion for another task. The analysis recommended that future research addressed the issue of task-specific motion effects to verify what tasks or group of tasks benefit from motion cues.

Even when the recommendations by Hays, et al. (1992) were followed, the results of this research did not demonstrate there was an advantage with respect to learning when using the Motion versus the No Motion configuration (refer to Table 18, the result of a Chi-square test comparing the number of objective measures that supported learning for the Motion versus the No Motion configuration was not statistically significant). This is consistent with the findings of previous studies which did not detect significant training benefits due to adding motion to flight simulator training (in this particular case, for the Combat Search and Rescue task). However, to at the same time it does not rule out the contribution of motion to aircraft control. A statistically significant number of respondents in the no motion configuration indicated a need for motion. This indicates a lack of confidence in the effectiveness of the no motion platform to train a pilot for actual conditions under which motion will be experienced. Additionally, the more difficult task of control when the cab is in motion than when the cab is not in motion may simply require more training time in order to achieve a performance improvement. Finally, to discern the level of contribution of motion through actual experimentation may require a transfer experiment involving actual aircraft under turbulent conditions.

According to Hosman (1996), aircraft control behavior is affected by motion cues only with unstable aircraft. This research incorporated Turbulence in the second segment of the Combat Search and Rescue mission to maximize satisfaction of criteria for a motion requirement. In the future, additional maneuvers that involve an unstable helicopter (for example, certain malfunctions like engine failure) should be tested as well.

As shown in Table 18, the Chi-square test comparing the number of objectives measures that supported learning in the No Motion versus the Desktop configurations detected a statistically significant effect. The difference in learning can be explained in part by the difference in display size. According to Reeves and Nass (1998), larger screens mean more excitement, stronger memories, and more positive evaluations of the content display. However, additional research in this area is needed. Reeves and Nass warned that viewers may be over stimulated by large images to the point where they may not attend to the instructional message. Tang (2004) stated that, even though large displays generally evoke a greater level of attention and memory, this attention and memory could be easily misdirected and that care had to be taken when designing large display systems and content. Future research should focus also on the appropriate image content and display size for flight simulation training.

APPENDIX A
MISSION/JOB ANALYSIS

This appendix contains excerpts from the following Joint and US Army publications:

Joint Chiefs of Staff. (1998, March). Doctrine for Joint Combat Search and Rescue (Joint Publication 3-50.2)

Joint Chiefs of Staff (2002, July) Universal Joint Task List (CJSCM 3500.04C).

Department of the Army (2003). Aviation Brigades (FM 3-04.111) Retrieved March 25, 2004 from http://www.adtdl.army.mil

A.1 Mission Description

Combat Search and Rescue is described as "a specific task performed by rescue forces to effect the recovery of distressed personnel during war or military operations other than war. Each service and USSOCOM is responsible for conducting CSAR in support of their own operations, consistent with their assigned functions. Joint CSAR operations are those that have exceeded the capabilities of the component commanders in their own operations, and require the efforts of two or more components of the joint force to accomplish the operation" (Joint Chiefs of Staff , 2002)

A.2 Typical Joint Combat Search and Rescue Incident Sequence of Events

(Joint Chiefs of Staff , 1998)

a. Distress Indicator. A distress indicator may be received in the form of the following:

• Mayday.

• Non-return from a mission.

• Overdue contact.

• Receipt of emergency beacon transmission.

• Sighting of aircraft or vessel going down.

• Report of personnel being isolated by enemy activity.

• Receipt of ground emergency codes used by survivors of downed aircraft.

b. Unit Requesting Combat Search and Rescue Support. The unit requesting Combat Search and Rescue (CSAR) support should notify the component Rescue Coordination Center (RCC), which should notify the Joint Search and Rescue Center (JSRC).

c. Component Rescue Coordination Center

• Assumes duties as CSAR mission coordinator initially and reports the incident to the JSRC.

• Initiates CSAR planning.

• Receives intelligence briefing to determine area threat.

• Designates an ISOPREP control point and obtains ISOPREP data and Evasion Plan of Action (EPA) from units.

• Tasks subordinate CSAR-capable forces and coordinates with the JSRC and the requesting unit.

• Requests additional recovery forces through the JSRC if component CSAR resources are inadequate or insufficient.

• Informs the JSRC if component resources execute the CSAR mission.

d. Joint Search and Rescue Center

• Coordinates JFC tasking of other component RCCs to execute CSAR missions when notified that a component RCC is unable to do so or requires support.

- Coordinates with component commands for use of non-dedicated CSAR resources when appropriate.
- Coordinates for use of special operations forces (SOF) with the operations directorate or section (J-3) and the JFSOC component as appropriate.
- Coordinates development of a CSAR task force with component CSAR controllers when appropriate.
- Coordinates with the intelligence directorate or section (J-2) and/or the special operations component to alert E&R nets, where established and activated, to assist isolated personnel.
- Alerts all forces operating in the area of the CSAR incident to report any evidence of isolated personnel.
- Determines if current operations will provide temporary air superiority in the vicinity of the isolated personnel, resulting in collateral support of the CSAR effort.

e. Assignment of Combat Search and Rescue Mission Coordinator.

After coordination with component RCCs, the JSRC assigns a CSAR mission coordinator and provides all available data to the person or organization so designated. Normally, component RCCs represent the first line of response for SAR and CSAR incidents. However, the JSRC may assume the role of CSAR mission coordinator when the following conditions apply:

- RCCs are not established.
- The JSRC receives initial notification.
- The event is sufficiently complex to require response and/or tasking of several component commanders.

• The CSAR mission is beyond the capabilities of conventional CSAR forces and requires SOF response.

• The RCC providing the initial response requests additional assistance and for the JSRC to assume CSAR mission coordinator.

• Current operations or nonavailability of CSAR-capable resources preclude the component commander from initiating or continuing a CSAR response.

f. Combat Search and Rescue Mission Coordinator. The CSAR mission coordinator confirms the distress call, isolated personnel authentication data, and assists in planning the CSAR mission.

g. Isolated Personnel. Isolated personnel confirm distress and authenticate.

h. Evaluation. Recovery forces evaluate the probability of success and execute the CSAR mission.

i. Debriefing. Intelligence personnel debrief recovered personnel in accordance with Joint Pub 3-50.3, "Joint Doctrine for Evasion and Recovery."

A.3 CSAR Mission Responsibilities

A.3.1 CSAR Commander

(Department of the Army, 2003)

The commander of the Army Force has primary authority and responsibility to plan and conduct CSAR in support of his own forces. To plan such operations, he will consider the capability of his own forces as well as those of other service components, if available. He will execute his CSAR responsibilities through the following actions:

a. Rescue Coordination Center (RCC). Establish an RCC to

(1) Coordinate/monitor all subordinate unit CSAR activities.

(2) Coordinate all Army-external CSAR requirements as necessary with the Joint Search and Rescue Center.

b. Intra-Service Support. Ensure that—

(1) Army forces (ground and aviation) are aware of existing CSAR capabilities within the total force structure.

(2) Subordinate Army unit commanders understand the parameters within which CSAR forces will operate; i.e., factors based on mission, enemy, terrain, troops, and time available; available assets; weather; etc.

(3) Army forces are knowledgeable of the procedures for requesting CSAR.

(4) Both command and coordination channels are actively involved in the execution of intra-service CSAR operations.

c. Signal. Ensure that—

(1) Subordinate units equipped with survival radios are provided signal operating instructions.

(2) Deconfliction of frequency usage is enforced throughout the command.

(3) CSAR-only code words and radio frequencies are established for common usage across the component, if not provided by Joint headquarters; for example, frequency modulation (FM), ultra high frequency (UHF), very high frequency (VHF), and satellite communications (SATCOM).

(4) If the Joint headquarters does provide CSAR-only code words and frequencies, information is disseminated to subordinate commands.

d. Joint Support.

(1) Provide mutual CSAR support to other service components when tasked through the joint search and rescue center.

(2) Ensure that both the command and coordination channels are actively involved in the inter-service planning and execution of Joint CSAR operations, and that unity of effort is maintained throughout.

(3) In the same context, ensure that interoperability requirements—such as communications compatibility, fuel types/standards, refueling equipment, and map series—are consistent with Joint requirements.

e. Augmentation Personnel.

(1) Provide personnel as tasked from the Joint Search and Rescue Center to support Joint Search and Rescue Center operations. The number of personnel provided will be based, preferably, upon an equal percentage of personnel provided from other service components.

(2) Ensure that augmentation personnel are familiar with Joint Publications 3-50.2 and 3-50.21.

f. Aircraft Destruction Authority. Establish a policy designating aircraft destruction authority in the event of probable enemy retrieval.

g. Training.

(1) Task organize combined-arms forces to develop and promote habitual CSAR relationships and an understanding of CSAR tactics, techniques, and procedures.

(2) Request and coordinate Joint level training to prepare for CSAR contingency operations.

A.3.2 Unit Commander

(Department of the Army, 2003)

Unit commanders must—

a. Conduct CSAR operations to support their own operations.

b. Provide mutual CSAR support at both the intra- and inter-service levels.

c. Ensure CSAR contingencies are incorporated into all mission plans; be prepared to generate CSAR support requests as required.

d. Complete the following actions before or immediately after deployment:

(1) Standard Operating Procedures. Develop Standard Operating Procedures including tactics, techniques, and procedures to be used to conduct CSAR operations; ensure unit personnel are familiar with associated CSAR publications.

(2) Signal. Ensure that personnel who may be operating search and rescue/survival equipment—

(a) Are technically proficient (for example, that certain aviation personnel know how to operate the Global Positioning System (GPS), the Personnel Locator System (PLS), and crew survival radios).

(b) Are knowledgeable of the SOI procedures that support those technical systems.

(3) Training.

(a) Task organize unit forces to develop and promote habitual CSAR relationships and an understanding of CSAR TTPs.

(b) Request and coordinate combined arms training to prepare for CSAR contingencies.

A.3.3 On-site Commander

(Department of the Army, 2003)

The on-site commander is the person in charge of executing a mission in a given area when an isolated personnel situation develops in that same area. He may not be the unit commander, as elements of a given unit may not be operating within the unit commander's immediate sphere of influence. He must—

a. Make a rapid assessment of the situation to determine his actions.

b. Report the isolated personnel's situation as soon as possible to the next higher command. With information that may not be readily available to the on-site commander, the next higher command can influence the on-site commander's decision to execute the recovery. This information may include other friendly forces operating in the same area, or a new development in the tactical situation requiring immediate action which may or may not support immediate recovery.

A.3.4 Rescue Coordination Center

(Department of the Army, 2003)

The RCC is the hub of a deployed Army force CSAR operation. Preparing to conduct CSAR operations requires the execution of certain organizational, operational, and administrative procedures. Persons assigned to the RCC should be trained to plan and coordinate CSAR missions at the appropriate command level; i.e., the command level responsible for RCC operations. These persons should be trained before they arrive at the RCC, but they may receive on-the-job training. In addition, they must be trained and ready to interface with the JSRC. This means they must study applicable reference material. They should have a working knowledge of service-unique doctrines such as the Navy's "strike rescue" or the Marine's tactical recovery of aircraft and personnel (TRAP). A sufficient number of personnel should be assigned to the RCC to conduct/monitor 24-hour operations.

A.3.5 CSAR Resources

(Department of the Army, 2003)

Any or all of these Army forces may be available to the COMARFOR for the conduct of CSAR operations:

a. Rotary-wing aviation units.

b. Special operations forces (SOF).

c. Long-range surveillance units (LRSU).

d. Ground maneuver forces.

e. Army watercraft units.

Resources are formed into a CSAR task force. This task force will search for and recover isolated personnel and/or equipment. In addition, the CSAR task force must be able to provide organizational security while en route to the isolated personnel's area, and maintain security during the recovery and return to assembly area phases of the operation.

Task organization. The factors that make up a CSAR operation preclude a standard CSAR task force organization. Commanders must look at the requirements of the mission, assess their own unit's capabilities, and request external support as necessary. The table below illustrates an example of an aviation task force organized with assets from several different type units. This organization is assuming the mission of personnel rescue at a downed aircraft site with the additional intent of airframe recovery. The terrain is rugged and sparsely vegetated. The enemy situation is some lightly armored vehicles and tanks operating within the area. Crew personnel at the downed aircraft site have been injured and are unable to execute an EPA.

After assessing all the factors involved, the aviation task force commander decides to task organize according to the following justifications:

ASSETS	QTY	JUSTIFICATION
UH-60	1	Command and control
UH-60	1	Security force lift
AH-64	5	Antiarmor
UH-60	1	Personnel recovery
CH-47D	1	Airframe recovery
Troops	11	Ground security

A.4 Job Analysis

This research will focus on the CSAR tasks that will need to be performed by the UH-60 pilot assigned to personnel recovery. The scenario that will be used will assume that the location of the isolated personnel is known. According to the Department of the Army (2003), "…search procedures then become a matter of tactical extraction procedures used by the type unit involved. For example, an air assault aviation unit might conduct this extraction as a one or two ship mission, using the same tactics, techniques, and procedures as any other given air assault mission under the same tactical circumstances."

APPENDIX B
TASK ANALYSIS

This appendix contains excerpts from the following Joint and US Army publications:

Department of the Army (2001). Mission Training Plan for Aviation Brigades (ARTEP 1-111-MTP). Washington, DC.

Department of the Army (2000a) Mission Training Plan for the Utility Helicopter Battalion (ARTEP 1-113-MTP). Washington, DC.

Department of the Army (2000b) Aircrew Training Manual Utility Helicopter, UH-60/EH-60. (TC 1-237).

Department of the Army (2002). Soldier's Manual and Trainer's Guide MOS 93P Aviation Operations Specialist Skill Level (STP 1-93P1-SM-TG). Washington, DC.

Joint Chiefs of Staff (2002, July) Universal Joint Task List (CJSCM 3500.04C).

USA Combined Arms Center. (2002, December). Army Universal Task List (FM 7-15). Ft. Leavenworth, KS.

US Army Training and Doctrine Command (n.d.). Command Aviation Company (CATS 01108A000). Retrieved March 25, 2004 from http://www.adtdl.army.mil

B.1 Joint Services

(Joint Chiefs of Staff, 2002)

ST 6.2.7.3 Coordinate Combat Search and Rescue

Measures of Performance:

M2	Percent	Actions taken must be appropriate to the situation and consistent with US objectives. They must be permissible under the law of armed conflict, consistent with applicable domestic and international law, and in accordance with applicable rules of engagement.
M3	Percent	Identified processes have fully integrated all available capabilities to ensure a defense in depth. Should be integrated in all military operations, to include activities by other government and non-government agencies or organizations.
M4	Percent	Of friendly operations delayed, disrupted, or degraded due to ineffective tactical information operations.

Service Tasks:

AFT 3.1.1.1.6	Perform Information Transmission and Storage
ART 5.3.7	Conduct Defensive Information Operations
NTA 5.1.1	Communicate Information
NTA 5.5	Conduct Information Warfare (IW)

B.2 Service

(Army)

(USA Combined Arms Center, 2002)

ART 8.5

Conduct Tactical Mission Tasks

8-85. Tactical mission tasks describe the results or effects the commander wants to achieve—the what or why of a mission statement. These tasks have specific military definitions that are different from those found in a dictionary. The tasks in this section are often given to small units as the tasks or purpose parts of their mission statement. (FM 3-90) (USACAC)

ART 8.5.29 CONDUCT COMBAT SEARCH AND RESCUE

8-114. Locate and extract distressed personnel (military, civilian, or foreign nationals) and sensitive equipment from enemy controlled or contested areas during wartime or contingency operations to prevent capture. This task includes peacetime search and rescue and the conduct of unconventional assisted recovery. (FM 3-05) (USAJFKSWCS)

B.3 Brigade

(Department of the Army, 2001)

TASK: CONDUCT COMBAT SEARCH AND RESCUE (CSAR) OPERATIONS (01-6-2045.01- 0111)

(FM 1-111) (JOINT PUB 3-50.21)

CONDITIONS: The brigade is in a simulated (live, virtual, or constructive) combat environment. The staff has received an OPORD/FRAGO and the commander's guidance.

The main CP is operational and the staff sections are functioning. Reports are being received through normal channels. The unit is preparing to conduct missions throughout the area of operations.

TASK STANDARDS: CSAR plans employed all joint CSAR resources and operations were performed IAW unit SOP.

1. S3 assumes responsibility for the rescue coordination center (RCC) when brigade is directed by the Commander of the Army Force (COMARFOR). a. Established the RCC within the aviation brigade operations center. b. Assigned personnel knowledgeable in CSAR planning and coordination requirements. c. Assigned personnel knowledgeable in joint search and rescue center (JSRC) capabilities. 2. S6 section establishes communications with all elements involved in CSAR operations. a. Established radio communications as required. b. Established landline communications as required. c. Established computer network communications as required. 3. RCC coordinates with JSRC. a. Alerted JSRC whenever a CSAR mission had been planned, executed, or was ongoing. b. Received and logged all information transmitted by the JSRC. c. Received all Army CSAR taskings from the JSRC. 4. RCC monitors all air tasking orders (ATOs). a. Monitored all subordinate unit missions that may have placed personnel in an isolated position. b. Ensured that every ATO provided enough reserve transponder codes for an Army aviation CSAR task force. 5. RCC coordinates all airspace usage requirements with the Airspace Control Authority (ACA). 6. Brigade conducts CSAR operations. a. Prepared for intra-service support. (1) Ensured that unit was aware of all CSAR capabilities, both air and ground. (2) Ensured that unit was knowledgeable of parameters within which CSAR forces would operate, IAW RCC guidance. (3) Ensured that unit personnel were knowledgeable of procedures for requesting CSAR. b. Prepared for joint CSAR operations. (1) Provided mutual support to other services when tasked by the		

JSRC. (2) Ensured that unit personnel augmenting joint CSAR operations were familiar with Joint Publications 3-50.2 and 3-50.21. * 7. S3 identifies and controls hazards IAW risk management procedures (see app C).		

TASK PERFORMANCE / EVALUATION SUMMARY BLOCK

ITERATION 1 2 3 4 5 M TOTAL

TOTAL TASK STEPS EVALUATED

TOTAL TASK STEPS “GO”

TRAINING STATUS “GO”/“NO-GO”

“*” indicates a leader task step.

SUPPORTING INDIVIDUAL Task Number Task Title

References

011-420-0026 Coordinate Combat Search and Rescue MOS W 152H 3

(CSAR) Procedures MOS W 153D 3

011-510-0011 Implement Fundamentals of Air-Ground

Operations

011-510-0014 Employ Aviation Command, Control, and

Communications (C3) Operations

011-510-0018 Plan Army Airspace Command and Control

011-510-0024 Conduct Forward Arming and Refueling Point

(FARP) Operations

011-510-1302 Employ Downed Aircraft Recovery Team

Operations

SUPPORTING COLLECTIVE TASKS

Task Number Task Title

01-6-0003.01-0111 Produce Intelligence Products

01-6-0008.01-0111 Establish and maintain the Administrative and Logistics Operations Center (ALOC) in coordination with the S1

01-6-0029.01-0111 Maintain the current situation

01-6-0030.01-0111 Conduct battle tracking

01-6-0066.01-0111 Sustain the brigade

01-6-7102.01-0111 Support the Tactical Operations Center (TOC) and the Administrative and Logistics Operation Center (ALOC)

01-6-7726.01-0111 Conduct Forward Arming and Refueling Point (FARP) operations

OPFOR TASKS AND STANDARDS: NONE

B.4 Battalion

(Department of the Army, 2000a)

MISSION: PROVIDE COMBAT SEARCH AND RESCUE

Collective Task(s) (01-1-1020.01-0NRC) COORDINATE DOWNED AIRCREW RECOVERY OPERATIONS

(01-2-0108.01-0NRC)CONDUCT DOWNED AIRCREW RECOVERY OPERATIONS

Reference(s) FM 1-111 Aviation Brigades

Joint Pub 3-50.21 Joint Tactics, Techniques, and Procedures for Combat Search and Rescue

B.5 Company

(US Army Training and Doctrine Command, n.d.)

Task: CONDUCT DOWN HELICOPTER CREW RESCUE OPERATIONS (01-TS-2046)

Supporting Task(s):

01-2-0108.01-0NRC	CONDUCT DOWNED AIRCREW RECOVERY OPERATIONS
01-2-2047.01-0NRC	CONDUCT TROOP LEADING PROCEDURES
01-2-7105.01-0NRC	PERFORM AERIAL PASSAGE OF LINES
01-2-7707.01-0NRC	EVACUATE CASUALTIES

Frequency: Quarterly (4)

Types of Events: STX

Supported Mission(s):

MISSION SUPPORT

PROVIDE SEARCH AND RESCUE

B.5.1 Conduct Downed Aircrew Recovery Operations

(01-2-0108.01-0NRC) (Department of the Army, 2000a)

References: FM 3-04.111(FM 1-111)(JOINT PUB 3-50.21)

CONDITIONS: The battalion/squadron is in a simulated—live, virtual, or constructive—combat environment. The staff has received an OPORD/FRAGO and the commander's guidance. Some iterations of this task should be performed in MOPP4.

TASK STANDARDS: The unit performed recovery procedures according to the unit SOP and FM 3-04.111(FM 1-111). Search did not compromise the location of isolated personnel.

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
1. +Unit aircraft reports it is down, or another aircraft is down. a. Downed aircrew initiated distress call. (1) Initiated precontact transmission sequence followed by a listening period. (2) Did not divulge exact location, condition, or number in party unless certain of authenticity of friendly forces, and then only if requested. b. Other unit aircrew relayed distress. (1) Reported call sign of downed aircraft. (2) Reported location of downed aircraft. (3) Reported whether downed airmen were alive and under surveillance or in radio contact. (4) Reported physical condition of downed airmen. (5) Reported status of air and ground activity. 2. +Unit notifies higher headquarter of downed aircraft. a. Included information that would not be readily available to the on-site commander b. Included other friendly forces operating in area, or new developments in tactical situation. c. Forwarded information from ISOPREP packets (DD Form 1833), type and amount of survival equipment, and evasion plan of action. * 3. +Unit commander decides if, when, and how to execute recovery. 4. +Unit conducts recovery mission. a. Requested outside resources, as required. b. Organized task force of recovery aircraft, armed aircraft, and security force. c. Disseminated ISOPREP information. d. Conducted search. (1) Selected aerial or ground search procedure for isolated personnel (location unknown). (2) Selected method of search procedure for isolated personnel. (3) Contacted isolated personnel. (a) Authenticated personal identification, ISOPREP information, and CSAR code words according to unit CSAR SOP. (b) Established 360 degrees of security. (c) Ensured elements of the task force did not mass, encroach upon, overfly, or continue to circle the recovery site.		

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
(4) Conducted extraction of personnel, followed by recovery of equipment. (5) Remained in contact with higher headquarters, immediately alerted higher commander of successful/unsuccessful extraction. * 6. +Commander/Leader performs, or delegates performance of, the steps in the risk management process for each step in troop leading procedures (see Appendix C).		

TASK PERFORMANCE/EVALUATION SUMMARY BLOCK							
ITERATION	1	2	3	4	5	M	TOTAL
TOTAL TASK STEPS EVALUATED							
TOTAL TASK STEPS "GO"							
TRAINING STATUS "GO"/"NO-GO"							

"*" indicates a leader task step.

SUPPORTING INDIVIDUAL TASKS

References	Task Number	Task Title
STP 1-93P1-SM	011-141-0001	Locate a Geographic Coordinate on a Sectional, JOG-A or TPC
STP 1-93P1-SM	011-141-1046	Initiate Overdue Aircraft Procedures
STP 1-93P1-SM	011-141-1047	Process Information During Tactical Operations
STP 1-93P1-SM	011-141-1059	Operate the Aviation Mission Planning System (AMPS)
No STP and No MOS	011-420-0018	Implement Army Airspace Command and Control (A2C2)
No STP and No MOS	011-420-0026	Coordinate Combat Search and Rescue (CSAR) Procedures
No STP and No MOS	011-510-0308	Conduct Intelligence Preparation of the Battlefield (IPB)
No STP and No MOS	011-510-1302	Employ Downed Aircraft Recovery Team Operations
No STP and No MOS	011-540-0035	Supervise Aircraft Battle Damage Assessment and Repair
No STP and No MOS	301-371-1052	Protect Classified Information and Material

OPFOR TASKS AND STANDARDS

(None)

B.5.2 Conduct Troop Leading Procedures

(01-2-2047.01-0NRC) (Department of the Army, 2000a)

References: FM 3-04.100(FM 1-100), FM 3-100.14(FM 100-14), FM 5-0(FM 101-5)

CONDITIONS: The battalion/squadron is in a simulated—live, virtual, or constructive—combat environment. The company/troop has received an OPORD/FRAGO and the commander's guidance. The main CP is operational and the staff sections are functioning. Some iterations of this task should be performed in MOPP4.

TASK STANDARDS: Mission preparation was enhanced as a result of proper troop leading procedures. Sufficient time was allocated to allow subordinate elements to conduct their preparations.

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
* 1. +The company/troop commander receives a mission. a. Determined assets required based on METT-TC. b. Identified supplies and equipment required. c. Identified personnel required. d. Designated an AMC, if required. NOTE: AMCs for battalion/squadron, company/troop, and platoon-sized operations will usually be the respective commander. The commander will designate AMCs for operations below platoon level. * 2. +The company/troop commander issues the WARNORD to subordinate leaders, first sergeant, and the attached elements. 3. +The company/troop commander continues planning while the unit prepares for operations. a. Based the execution plan on the factors of METT-TC. b. Conducted a map reconnaissance. c. Used reverse planning to optimize time available. 4. The unit continues AA activities and maintains security. * 5. +The company/troop commander ensures that coordination with supported unit is conducted and/or— a. Attended initial planning conference—for battalion/squadron or higher operations. b. Coordinated with the battalion/squadron S3 and the supported unit S3 to ensure that all aspects of the air movement portion of the operation had been addressed. c. Coordinated, as necessary, with supporting units.		

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
* 6. +The company/troop commander issues an OPORD/FRAGO and ensures an aircrew briefing is conducted. * 7. +Platoon leaders conduct precombat checks according to the unit SOP. * 8. +The company/troop commander conducts rehearsals—map exercise or sand table exercise. * 9. +Commander/Leader performs, or delegates performance of, the steps in the risk management process for each step in troop leading procedures (see Appendix C)..		

TASK PERFORMANCE/EVALUATION SUMMARY BLOCK							
ITERATION	1	2	3	4	5	M	TOTAL
TOTAL TASK STEPS EVALUATED							
TOTAL TASK STEPS “GO”							
TRAINING STATUS “GO”/“NO-GO”							

“*” indicates a leader task step.

SUPPORTING INDIVIDUAL TASKS

References	Task Number	Task Title
No STP and No MOS	011-510-0301	Participate in the Military Decision Making Process
No STP and No MOS	011-510-0303	Conduct Operations Missions Briefing/ Debriefing
No STP and No MOS	011-510-0308	Conduct Intelligence Preparation of the Battlefield (IPB)
No STP and No MOS	011-510-0311	Conduct Military Briefings
No STP and No MOS	011-510-0504	Prepare a Company-Level Operations Order (OPORD)
No STP and No MOS	011-510-0505	Conduct Company-Level Rehearsals/AAR's
STP 1-93P24-SM-TG	071-332-5002	Prepare a Fragmentary Order
STP 1-93P24-SM-TG	071-332-5004	Prepare a Warning Order
No STP and No MOS	154-385-6263	Conduct a Risk Assessment
No STP and No MOS	301-371-1100	Integrate Intelligence Preparation of the Battlefield (IPB) Process Into Mission Planning

OPFOR TASKS AND STANDARDS

(None)

B.5.3 Perform Aerial Passage of Lines

(01-2-7105.01-0NRC) (Department of the Army, 2000a)

References: FM 3-04.111(FM 1-111), FM 3-04.112(FM 1-112), FM 3-04.113(FM 1-113) FM 3-04.114 (FM 1-114)

CONDITIONS: The battalion/squadron is in a simulated—live, virtual, or constructive—combat environment. The main CP is operational and the staff sections are functioning. Reports are being received through normal channels. The company/troop has received OPORD/FRAGO and the commander's guidance. The tactical situation dictates that operations be conducted forward of friendly units. Some iterations of this task should be performed in MOPP4.

TASK STANDARDS: The unit was not engaged by friendly units as a result of improper or inadequate coordination. The aerial passage of lines was conducted at the specified time and place.

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
* 1. +The commander conducts troop leading procedures.		
* 2. +The commander or designated AMC conducts special coordination.		
a. Selected ingress and egress routes if not provided by higher headquarters.		
b. Selected RPs forward of the FLOT.		
c. Exchanged information concerning signal operation instructions, number and type of aircraft, passage times, routes, and electronic attack and electronic protection measures to be employed with friendly unit.		
d. Established and coordinated recognition signals.		
3. +The designated aircraft pass through friendly airspace.		
a. Gave proper recognition signal at the prescribed time to the ground unit.		
b. Flew the designated route.		
c. Arrived and departed the designated contact and RPs at the assigned times.		

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
* 4. +Commander/Leader performs, or delegates performance of, the steps in the risk management process for each step in troop leading procedures (see Appendix C).		

TASK PERFORMANCE/EVALUATION SUMMARY BLOCK							
ITERATION	1	2	3	4	5	M	TOTAL
TOTAL TASK STEPS EVALUATED							
TOTAL TASK STEPS “GO”							
TRAINING STATUS “GO”/“NO-GO”							

“*” indicates a leader task step.

SUPPORTING INDIVIDUAL TASKS

References	Task Number	Task Title
STP 1-93P1-SM No	011-141-0001	Locate a Geographic Coordinate on a Sectional, JOG-A or TPC
STP 1-93P1-SM	011-141-1047	Process Information During Tactical Operations
STP 1-93C24-SM-TG	011-143-5062	Determine Army Airspace Command and Control Procedures
STP 1-93C24-SM-TG	011-143-7005	Integrate Airspace Control Measures
No STP and No MOS	011-420-0006	Conduct Fire Support Planning and Coordination
No STP and No MOS	011-510-0006	Employ Fire Support
No STP and No MOS	011-510-0018	Plan Army Airspace Command and Control
No STP and No MOS	011-510-0021	Employ Fundamentals of Army Operations
No STP and No MOS	011-510-0310	Perform Duties of Aviation Liaison Officer

OPFOR TASKS AND STANDARDS

(None)

B.5.4 Evacuate Casualties

(01-2-7707.01-0NRC) (Department of the Army, 2000a)

References: FM 4-02.2(FM 8-10-6)

CONDITIONS: The battalion/squadron is in a simulated—live, virtual, or constructive—combat environment. The unit has incurred simulated casualties. The AA is secure and the main CP and the battalion/squadron aid station are operational. The medical team is available to provide emergency medical aid and evacuation of casualties. Some iterations of this task should be performed in MOPP4.

TASK STANDARDS: Casualties receive immediate first aid when brought to the casualty collection point. Casualties are evacuated by the most expeditious manner available. All classified/sensitive documents are removed from casualties and secured.

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
* 1. +The commander/first sergeant develops the casualty evacuation plan.		
a. Alerted the medical treatment team of impending casualties.		
b. Determined assets needed to evacuate casualties.		
c. Confirmed primary and alternate evacuation routes, if by vehicle.		
d. Coordinated air evacuation, if tactical situation permits.		
e. Designated separate holding areas for contaminated and uncontaminated killed in action personnel.		
f. Designated a holding area and security plan for EPW casualties.		
g. Provided vehicles and/or aircraft to battalion/squadron, as required.		
h. Coordinated with higher headquarters for S5 support in case of civilian casualties.		
2. +The medics process casualties.		
a. Assessed the condition of casualties and prioritized injuries.		
b. Separated NBC contaminated casualties from uncontaminated casualties.		
c. Treated the most seriously wounded patients first.		
d. Stabilized patients to prevent further injury.		
(1) Stopped the bleeding.		
(2) Prevented/treated shock.		

TASK STEPS AND PERFORMANCE MEASURES	GO	NO-GO
(3) Splinted broken bones. (4) Administered painkillers. 3. +The unit personnel search casualties for sensitive or confidential information or equipment and secure it. 4. +Company/troop personnel prepare for air evacuation, if tactical situation permits. a. Reported the number and status of casualties. b. Secured LZs. c. Guided inbound aircraft to the PZ. d. Assisted in loading casualties. e. Evacuated casualties with appropriate personal NBC equipment. 5. The unit forwards DA Forms1155 and 1156 to battalion S1. * 6. +Commander/Leader performs, or delegates performance of, the steps in the risk management process for each step in troop leading procedures (see Appendix C).		

TASK PERFORMANCE/EVALUATION SUMMARY BLOCK							
ITERATION	1	2	3	4	5	M	TOTAL
TOTAL TASK STEPS EVALUATED							
TOTAL TASK STEPS "GO"							
TRAINING STATUS "GO"/"NO-GO"							

"*" indicates a leader task step.

SUPPORTING INDIVIDUAL TASKS

References	Task Number	Task Title
No STP and No MOS	011-510-0301	Participate in the Military Decision Making Process
No STP and No MOS	011-510-0900	Implement the Principles of Medical Evacuation
No STP and No MOS	031-503-1015	Protect Yourself From NBC Injury/Contamination With the Appropriate Mission-Oriented Protective Posture (MOPP) Gear
STP 21-24-SMCT	081-831-0101	Request Medical Evacuation
STP 21-1-SMCT	081-831-1003	Perform First Aid to Clear an Object Stuck in the Throat of a Conscious Casualty
STP 21-1-SMCT	081-831-1005	Perform First Aid to Prevent or Control Shock
STP 21-1-SMCT	081-831-1007	Perform First Aid for Burns
STP 21-1-SMCT	081-831-1008	Perform First Aid for Heat Injuries
STP 21-1-SMCT	081-831-1009	Give First Aid for Frostbite

SUPPORTING INDIVIDUAL TASKS

References	Task Number	Task Title
STP 21-1-SMCT	081-831-1016	Put on a Field or Pressure Dressing
STP 21-1-SMCT	081-831-1017	Put on a Tourniquet
STP 21-1-SMCT	081-831-1025	Perform First Aid for an Open Abdominal Wound
STP 21-1-SMCT	081-831-1026	Perform First Aid for an Open Chest Wound
No STP and No MOS	081-831-1032	Perform First Aid for Bleeding of an Extremity
STP 21-1-SMCT	081-831-1033	Perform First Aid for an Open Head Wound
STP 21-1-SMCT	081-831-1034	Perform First Aid for a Suspected Fracture
STP 21-1-SMCT	081-831-1042	Perform Mouth to Mouth Resuscitation
No STP and No MOS	081-831-1044	Perform First Aid for Nerve Agent Injury
No STP and No MOS	081-831-1045	Perform First Aid for Cold Injuries
No STP and No MOS	081-831-1046	Transport a Casualty
No STP and No MOS	121-010-8001	Report Casualties
STP 21-1-SMCT	081-831-1000	Evaluate a Casualty

OPFOR TASKS AND STANDARDS

(None)

B.6 Individual

Two company tasks, CONDUCT DOWNED AIRCREW RECOVERY OPERATIONS (01-2-0108.01-0NRC) and PERFORM AERIAL PASSAGE OF LINES (01-2-7105.01-0NRC) will be further analyzed.

B.6.1 Perform Aerial Passage of Lines

(01-2-7105.01-0NRC)

Several supporting individual tasks will not be further analyzed. Two of those tasks are not applicable to this research. For the rest, further information is not currently available. Those tasks are:

Task 011-143-5062: “Determine Army Airspace Command and Control Procedures” (Reference: STP 1-93C24-SM-TG, MOS 93C: Air Traffic Control). Air Traffic Controller job will not be analyzed for this research.

Task 011-143-7005: “Integrate Airspace Control Measures” (Reference: STP 1-93C24-SM-TG, MOS 93C: Air Traffic Control). Air Traffic Controller job will not be analyzed for this research.

Task 011-420-0006: “Conduct Fire Support Planning and Coordination” (Reference: No STP and no MOS)

Task 011-510-0006: “Employ Fire Support” (Reference: No STP and no MOS)

Task 011-510-0018: “Plan Army Airspace Command and Control” (Reference: No STP and no MOS)

Task 011-510-0021: “Employ Fundamentals of Army Operations” (Reference: No STP and no MOS)

Task 011-510-0310: “Perform Duties of Aviation Liaison Officer” (Reference: No STP and no MOS)

B.6.1.1 Task 011-141-0001

“ Locate a Geographic Coordinate on a Sectional, JOG-A or TPC” (Reference: STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Conditions: While performing duties as an aviation operations specialist, you are given an aeronautical chart, JOG-A, or TPC and FM 3-25.26 and five sets of geographic coordinates to properly locate.

Standards: According to FM 3-25.26.

Performance Steps

1. Locate Degrees and Minutes of Latitude.

a. The distance of a point north or south of the equator is known as its latitude. Lines of latitude run east and west and make parallel circles above and below the equator. Distances north and south are measured between these lines.

b. Geographic coordinates are expressed in angular measurements. Each circle is divided into 360 degrees; each degree, into 60 minutes. The degree is symbolized by °; the minute, by '. Starting with 0° at the equator, the parallels of latitude are numbered to 90° both north and south. The extremities are the North Pole at 90° north latitude and the South Pole at 90° south latitude.

c. Latitude is measured on a north-south line. To find the latitude of an item on a sectional aeronautical chart, JOG-A, or TPC, move up the scale (see Figure 10), keeping track of the measurements until you are aligned with the item. Look back at the last major measurement of degrees and count the tick marks up to the point where you are aligned with the item. This is the measurement of latitude. The latitude of the point indicated by the "X" in (Figure 10) is 32°35'N.

2. Locate Degrees and Minutes of Longitude.

a. The meridians of longitude are a second set of rings around the globe at right angle to the lines of latitude and passing through the poles. One meridian is designated as the prime meridian. (The prime meridian of the system we use runs through Greenwich, England.) The distance east or west of the prime meridian to a point is known as its longitude. Lines of longitude run north and south and measure distances east and west between them.

b. Starting with 0 at the prime meridian, longitude is measured both east and west around the world. Lines east of the meridian are numbered to 180° and are identified as east longitude. Lines west of the meridian are numbered to 180° and are identified as west longitude. The direction east or west must always be given. The line directly opposite the prime meridian (180°) may be referred to as either east or west longitude.

c. Longitude is measured on an east-west line. To find the longitude of an item on a sectional aeronautical chart, JOG-A, or TPC, move left (right if you are in Europe) on the scale (Figure 11), keeping track of the measurements until you are aligned with the item. Look back at the last major measurement of degrees and count the tick marks to the point where you are aligned with the item. This is the measurement of longitude. The longitude of the point indicated by the "X" in Figure 11 is 86°22'W.

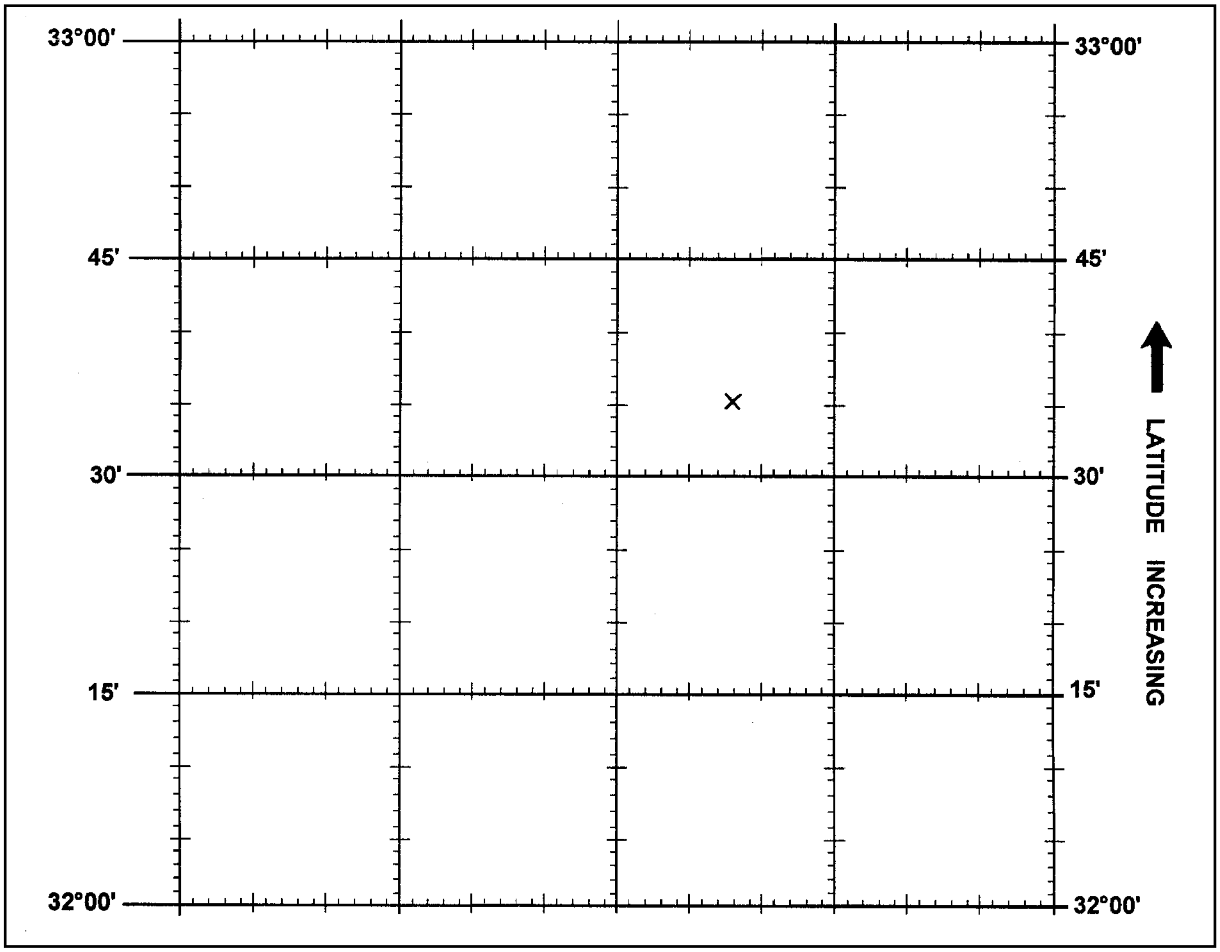


Figure 10. Degrees and Minutes of Latitude

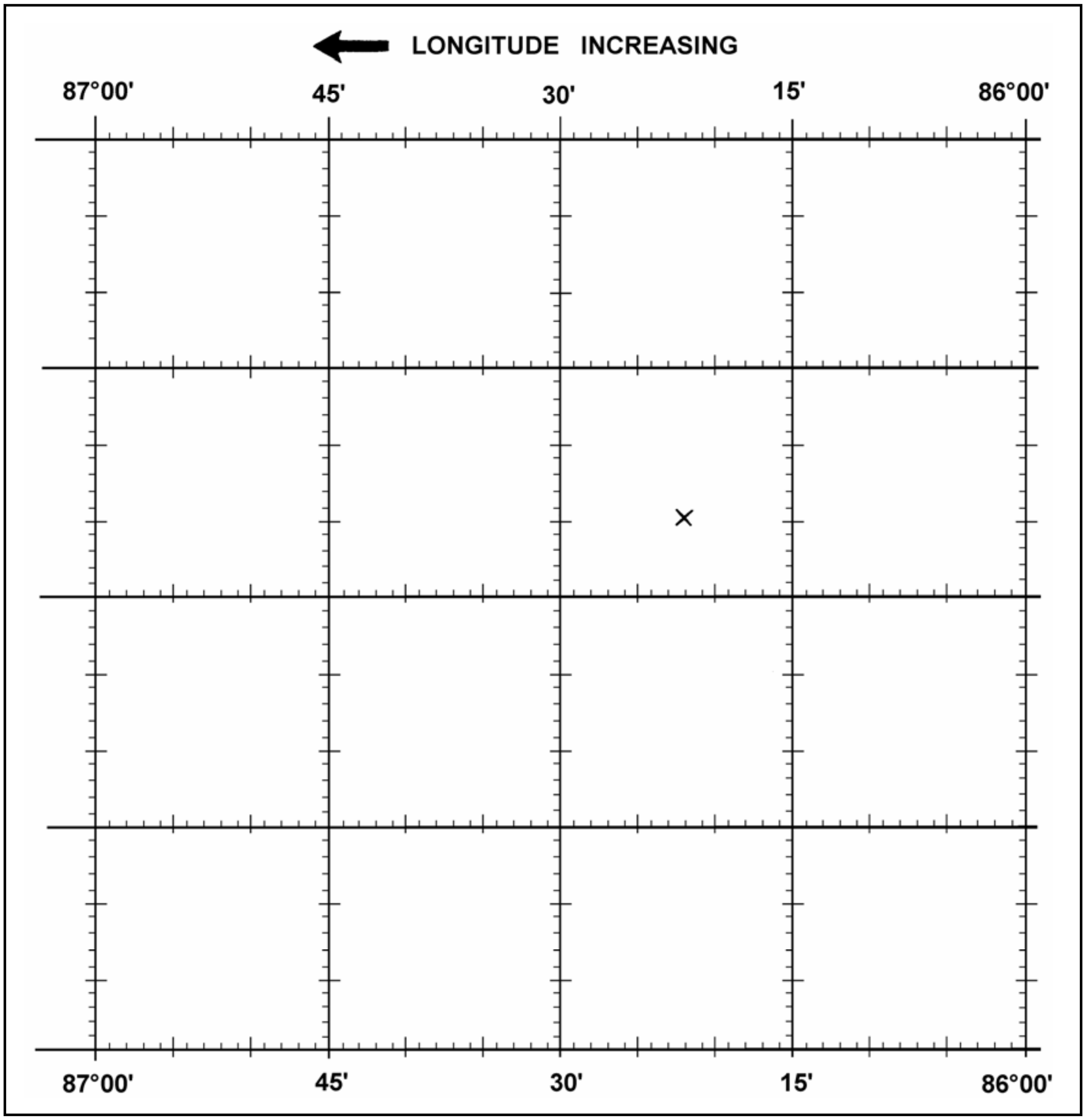


Figure 11. Degrees and Minutes of Longitude

3. Locate a 6-digit Grid on a JOG-A Map.

a. When plotting geographic coordinates, read latitude first; then read longitude. Read the coordinates in the direction in which the numbers are increasing. The coordinates of the point indicated by the "X" in Figure 12 are 32°35'N, 86°22'W.

b. When writing coordinates, write latitude first; then write longitude.

Evaluation Preparation: Setup: In a suitable training environment. Provide the solider with five sets of geographic coordinates to properly locate and all items in the conditions statement.

Brief Soldier: Tell the soldier to plot the designated point on the map from the given coordinates. Go over the materials needed to perform the task.

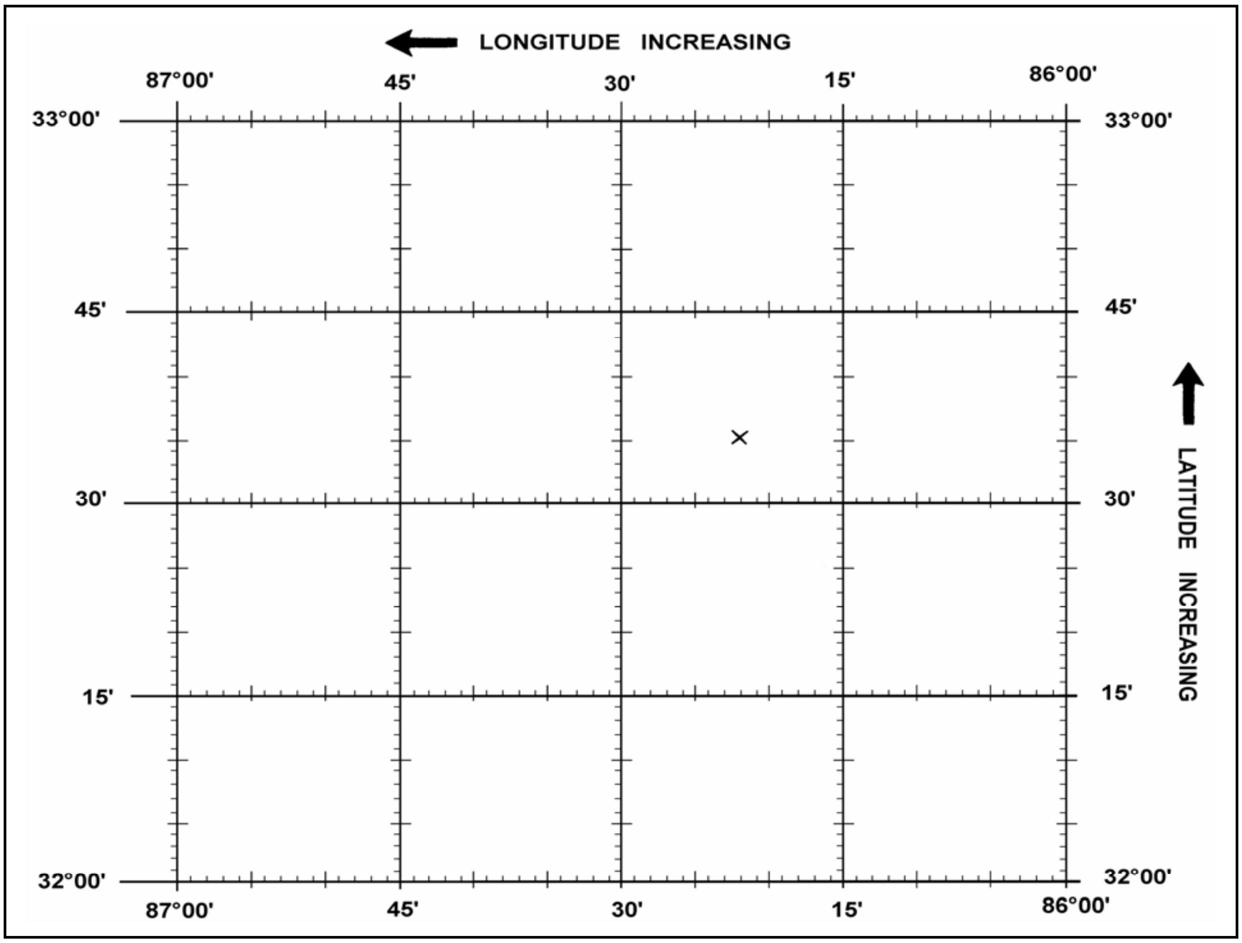


Figure 12. Plotting Geographic Coordinates

Performance Measures	GO	NOGO
1. Located degrees and minutes of latitude.	____	____
2. Located degrees and minutes of longitude.	____	____
3. Located a 6-digit grid on a JOG-A map.	____	____

Evaluation Guidance: Score the soldier GO if all performance steps are passed. Score the soldier NO-GO if any performance steps are failed. In case of a NO-GO, brief the soldier on the deficiency, retrain the soldier to perform the step correctly, and reevaluate the task.

References

Required	Related
FM 3-25.26	None

B.6.1.2 Task 011-141-1047

"Process Information During Tactical Operations" (STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Conditions: While performing duties as an aviation operations specialist, you are given FM 3-04.111(FM 1-111), FM 5-0(FM 101-5), FM 1-02(FM 101-5-1), FM 3-04.300(FM 1-300), and tactical standing operating procedures.

Standards: According to FM 3-04.111(FM 1-111), FM 5-0(FM 101-5), FM 1-02(FM 101-5-1), FM 3-04.300(FM 1-300), and TACSOP.

Performance Steps

1. Process any required operation reports from TACSOP by recording the information received and the disposition for the reports on DA Form 1594 (Daily Staff Journal or Duty Officer's Log).

2. Maintain DA Form 1594 of all TOC activities.

3. Processes required information for the operation of a TOC according to TACSOP.

Evaluation Preparation: Setup: In a TOC. Provide the soldier with selected reports to process and all items listed in the conditions statement.

Brief Soldier: Tell the soldier to process the given operational reports according to unit TACSOP. Go over the materials needed to perform the task.

Performance Measures	GO	NOGO
1. Processed required operation reports required by unit TACSOP.	——	——
2. Maintained DA Form 1594.	——	——
3. Processed information required by unit TACSOP.	——	——

Evaluation Guidance: Score the soldier GO if all performance steps are passed. Score the soldier NO-GO if any performance steps are failed. In case of a NO-GO, brief the soldier on the deficiency, retrain the soldier to perform the step correctly, and reevaluate the task.

References

Required	Related
FM 5-0(FM 101-5)	AR 220-15
FM 1-02(FM 101-5-1)	
FM 3-04.111(FM 1-111)	

B.6.2 Conduct Downed Aircrew Recovery Operations

Several supporting individual tasks will not be further analyzed. Additional information is not currently available. Those tasks are:

1) Task 011-420-0018: “Implement Army Airspace Command and Control (A2C2)” (Reference: No STP and no MOS)

2) Task 011-420-0026: “Coordinate Combat Search and Rescue (CSAR) Procedures” (Reference: No STP and no MOS)

3) Task 011-510-0308: “Conduct Intelligence Preparation of the Battlefield (IPB)” (Reference: No STP and no MOS)

4) Task 011-540-0035: “Supervise Aircraft Battle Damage Assessment and Repair” (Reference: No STP and no MOS)

5) Task 301-371-1052: “Protect Classified Information and Material” (Reference: No STP and no MOS)

B.6.2.1 Task 011-141-0001

“Locate a Geographic Coordinate on a Sectional, JOG-A or TPC” (STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Refer to paragraph B.6.1.1

B.6.2.2 Task 011-141-1046

"Initiate Overdue Aircraft Procedures" (STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Conditions: While performing duties as an aviation operations specialist, you are given telephone communications or automated communications computer, approved flight plan, FAAO 7110.10, FM 3-04.300(FM 1-300), and AR 95-11.

Standards: According to FAAO 7110.10, FM 3-04.300(FM 1-300), and AR 95-11.

Performance Steps

1. Determine when an aircraft meets overdue aircraft procedures.
2. Initiate preliminary communication search actions on an overdue aircraft.
3. Provide information to the FSS on an overdue aircraft.

Evaluation Preparation: Setup: In a suitable training environment. Provide the soldier with a scenario that requires overdue aircraft procedures to be initiated and all items listed in the conditions statement.

Brief Soldier: Tell the soldier to determine if the aircraft is overdue and to take the appropriate actions according to the given publications. Go over the material needed to perform this task.

Performance Measures	GO	NOGO
1. Determined if aircraft met overdue aircraft procedures.	——	——
2. Initiated preliminary communication search actions on an overdue aircraft.	——	——
3. Provided information to the FSS on an overdue aircraft.	——	——

Evaluation Guidance: Score the soldier GO if all performance steps are passed. Score the soldier NO-GO if any performance steps are failed. In case of a NO-GO, brief the soldier on the deficiency, retrain the soldier to perform the step correctly, and reevaluate the task.

References

Required	Related
AR 95-1	AR 95-11
FAAO 7110.10	
FM 3-04.300(FM 1-300)	
DOD FLIP General Planning	

B.6.2.3 Task 011-141-1047

"Process Information During Tactical Operations" (STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Conditions: While performing duties as an aviation operations specialist, you are given FM 3-04.111(FM 1-111), FM 5-0(FM 101-5), FM 1-02(FM 101-5-1), FM 3-04.300(FM 1-300), and tactical standing operating procedures.

Standards: According to FM 3-04.111(FM 1-111), FM 5-0(FM 101-5), FM 1-02(FM 101-5-1), FM 3-04.300(FM 1-300), and TACSOP.

Performance Steps

1. Process any required operation reports from TACSOP by recording the information received and the disposition for the reports on DA Form 1594 (Daily Staff Journal or Duty Officer's Log).

2. Maintain DA Form 1594 of all TOC activities.

3. Processes required information for the operation of a TOC according to TACSOP.

Evaluation Preparation: Setup: In a TOC. Provide the soldier with selected reports to process and all items listed in the conditions statement.

Brief Soldier: Tell the soldier to process the given operational reports according to unit TACSOP. Go over the materials needed to perform the task.

Performance Measures	GO	NOGO
1. Processed required operation reports required by unit TACSOP.	——	——
2. Maintained DA Form 1594.	——	——
3. Processed information required by unit TACSOP.	——	——

Evaluation Guidance: Score the soldier GO if all performance steps are passed. Score the soldier NO-GO if any performance steps are failed. In case of a NO-GO, brief the soldier on the deficiency, retrain the soldier to perform the step correctly, and reevaluate the task.

References

Required	Related
FM 5-0(FM 101-5)	AR 220-15
FM 1-02(FM 101-5-1)	
FM 3-04.111(FM 1-111)	
FM 3-04.300(FM 1-300)	

B.6.2.4 Task 011-141-1059

"Operate the Aviation Mission Planning System (AMPS)" (STP 1-93P1-SM, MOS 93P: Aviation Operations Specialist)

Conditions: While performing duties as an aviation operations specialist, you are given AMPS software, AMPS system or personal computer, necessary peripheral devices, and User's Manual.

Standards: According to User's Manual.

Performance Steps

1. Perform startup and login procedures.
2. Operate input devices.
    a. Input information using the keyboard.
    b. Input information using the roller ball.
3. Perform input and output functions from the AMPS.
    a. Input selected information into the system.
    b. Output selected information to the printer.
    c. Transfer selected information electronically.
4. Perform teardown procedures.
    a. Properly power down the AMPS.
    b. Properly pack the AMPS.

Evaluation Preparation: Setup: In a suitable training environment. Provide the soldier with a list of items to be inputted and outputted from the system and all items listed in the conditions statement.

Brief Soldier: Tell the soldier that by using the AMPS, they are to ensure the system is properly setup, perform startup and login procedures, operate AMPS input devices, perform input/output of information from the list of information you provided and power down the AMPS. Go over the materials needed to perform the task.

Performance Measures	GO	NOGO
1. Performed startup and login procedures.	____	____
2. Operate input devices.	____	____
a. Inputted information using the keyboard.		
b. Inputted information using the roller ball.		
3. Performed input and output functions.	____	____
a. Inputted selected information into the system.		
b. Outputted selected information to the printer.		
c. Transferred selected information electronically.		
4. Performed teardown procedures.	____	____
a. Properly powered down the AMPS.		
b. Properly packed the AMPS.		

Evaluation Guidance: Score the soldier GO if all performance steps are passed. Score the soldier NO-GO if any performance steps are failed. In case of a NO-GO, brief the soldier on the deficiency, retrain the soldier to perform the step correctly, and reevaluate the task.

References

Required	Related
User's Manual	None

B.6.2.5 Task 011-510-1302

"Employ Downed Aircraft Recovery Team Operations"

No STP or MOS exists for this task. According to the Joint Chiefs of Staff (2002) and the Department of the Army (1997), the tasks that need to be accomplished for the movement to and from the evacuee's assembly areas in a SAR air operation are the same as in an Air Assault Mission.

The individual tasks that need to be performed during an Air Assault Mission by the UH-60 are (Department of the Army, 2000b):

Participate in a crew mission briefing

Operate aviation mission planning station (AMPS)

Prepare a performance-planning card

Verify aircraft weight and balance

Inspect/perform operational checks on ALSE

Perform internal load operations

Prepare aircraft for mission

Perform preflight inspection

Perform before-starting engine through before-leaving helicopter checks

Maintain airspace surveillance

Perform hover power check

Perform radio communication procedures

Perform ground taxi

Perform hovering flight

Perform VMC takeoff

Navigate by pilotage and dead reckoning

Perform electronically aided naviation

Perform fuel management procedures

Perform VMC flight maneuvers

Select landing zone/pickup zone

Perform VMC approach

Perform slope operations

Perform go-around

Perform tactical mission planning

Perform tactical communication procedures

Transmit tactical reports

Perform precision approach

Perform inadvertent IMC procedures

Operate aircraft survivability equipment

Perform hand and arm signals

Perform refueling operation

According to a study on the cues and conditions for the UH-60 flight and mission tasks (Humanalysis, Inc., 1994), the Air Assault Mission tasks listed below are impacted by visual, kinesthetic and tactile cues. (A matrix showing the UH-60 flight and mission tasks versus the relevant visual, kinesthetic and tactile cues is provided in Appendix B.)

Perform ground taxi

Perform hovering flight

Perform VMC takeoff

Perform VMC flight maneuvers

Perform VMC approach

Perform slope operations

Select landing/pickup zone

B.6.2.5.1 Task 1034

“Perform ground taxi” (Department of the Army, 2000b):

CONDITIONS: In a UH-60 helicopter or UH-60FS, with the before-taxi check completed, and the aircraft cleared.

STANDARDS: Appropriate common standards plus these additions/modifications:

Rated.

Maintain speed appropriate for conditions.

Maintain the desired ground track within ±3 feet.

Nonrated.

Immediately inform the RCMs of any observed discrepancy or malfunction.

Clears the aircraft.

Use hand-and-arm signals, if required, per FM 21-60.

DESCRIPTION:

Crew actions.

The P* will ensure that the parking brake is released and the tail wheel is locked or unlocked as required before starting the ground taxi. He will announce his intent to begin ground taxi operations, and the intended direction of any turns and that the aircraft is clear of all traffic and obstacles. He will remain focused primarily outside the aircraft.

The P and NCM will assist in clearing the aircraft and provide adequate warning of traffic and obstacles. They also will announce when their attention is focused inside the aircraft and again when attention is reestablished outside.

Procedures. Ensure the area is suitable for ground taxi operations. Initiate the taxi by centering the cyclic and increasing the collective slightly to start forward movement. If required, adjust lateral cyclic and/or pedals to release the tail wheel lockpin. Avoid droop-stop (pounding) contact by using proper cyclic and collective control applications. Ensure that both sets of brakes operate properly, conditions permitting. Use left or right pedal input to turn the aircraft and lateral cyclic as necessary to maintain a level fuselage attitude in the turns. To regulate the taxi speed, use a combination of collective, slight forward cyclic and brakes. Be aware that high gross weights, soft, rough, or sloping terrain may require the use of more than normal power.

During taxi with the tail wheel unlocked, fuselage roll attitude is controlled with the cyclic. The attitude indicator, inclinometer, as well as outside visual cues, may be used to reference fuselage roll attitude. The normal method for ground taxi is with the tail wheel in the unlocked position.

Excessive cyclic input and insufficient collective application may result in droop-stop pounding or main rotor contact with mission equipment. See Task 1058 for description of droop-stop pounding.

While ground taxiing minor heading changes may be made with the tailwheel locked. However, care should be taken not to break or bend the tail wheel-locking pin. A slight fuselage roll in the opposite direction may indicate excessive pedal input with the tail wheel locked. Excessive collective application may activate the drag beam switch.

Depending on ground velocity, emergency stops may be performed by lowering the collective and applying the wheel breaks or by bringing the aircraft to a hover.

NIGHT OR NVG CONSIDERATIONS: The landing light should be used for unaided ground taxi and the searchlight with installed IR by-pass filter when wearing NVGs. The use of proper scanning techniques will assist in detecting obstacles that must be avoided.

SNOW/SAND/DUST CONSIDERATIONS: If ground reference is lost because of blowing snow/sand/dust, lower the collective, neutralize the flight controls, and apply wheel breaks until visual reference is reestablished. When initiating ground taxi, apply pressure and counter pressure to the pedals to ensure the wheels/skis are not frozen to the ground, if appropriate. Use caution when taxiing near other maneuvering aircraft because of limited visual references and possible relative motion illusion.

Because of decreased visual references and relative motion illusions, limit ground speed to a safe rate.

At night, use of the landing, search, or anti-collision lights may cause spatial disorientation in blowing snow/sand/dust.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in the aircraft or simulator.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.2 Task 1038

Perform hovering flight (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter or a UH-60FS and aircraft cleared.

STANDARDS: Appropriate common standards plus these additions/modifications:

Perform a smooth, controlled ascent to hover.

Perform a smooth, controlled descent with minimal drift at touchdown.

DESCRIPTION:

Crew actions.

The P* will announce his intent to perform a specific hovering flight maneuver and will remain focused primarily outside the aircraft to monitor altitude and avoid obstacles. He will ensure and announce that the aircraft is cleared prior it turning or repositioning the aircraft. He will announce when he terminates the maneuver.

The P and NCM will assist in clearing the aircraft and provide adequate warning of obstacles, unannounced drift, or altitude changes. They will announce when their attention is focused inside the aircraft and again when attention is reestablished outside.

Procedures.

Takeoff to a hover. With the collective full down, place the cyclic in a neutral position. Increase the collective smoothly. Apply pedals to maintain heading, and coordinate the cyclic for a vertical ascent. As the aircraft leaves the ground, check for the proper control response and aircraft CG.

Hovering flight. Adjust the cyclic to maintain a stationary hover or to move in the desired direction. Control heading with the pedals, and maintain altitude with the collective. The rate of movement and altitude should be appropriate for existing conditions. To return to a stationary hover, apply cyclic in the opposite direction while maintaining altitude with the collective and heading with the pedals.

NOTE: Air Taxi is the preferred method for ground movements on airports provided ground operations and conditions permit. Unless otherwise requested or instructed, pilots are expected to remain below 100 feet AGL. However, if a higher than normal airspeed or altitude is desired, the request should be made prior to lift-off. The pilot is solely responsible for selecting a safe airspeed for the altitude/operation being conducted. Use of air taxi enables the pilot to proceed at an optimum airspeed/altitude, minimize down wash effect, conserve fuel, and expedite movement from one point to another.

Hovering turns. Apply pressure to the desired pedal to begin the turn. Use pressure and counter pressure on the pedals to maintain the desired rate of turn. Coordinate cyclic control to maintain position over the pivot point while maintaining altitude with the collective. Hovering turns can be made around any vertical axis; for example, the nose, mast, tail of the aircraft, or a point in front of the aircraft. However, turns other than about the center of the aircraft will increase the turn radius proportionately.

Landing from a hover. Lower the collective to effect a smooth descent to touchdown. Ensure the aircraft does not move laterally or aft. Make necessary corrections with the pedals and cyclic to maintain a constant heading and position. On ground contact, ensure that the aircraft remains stable. Continue lowering the collective smoothly and steadily while continuing to check aircraft stability. When the collective is fully down, neutralize the pedals and cyclic. If sloping conditions are suspected or anticipated, see Task 1062, Perform Slope Operations.

Cyclic turns should only be used when necessary.

When landing from a hover to an unimproved area, the crew must check for obstacles under the aircraft.

NIGHT OR NVG CONSIDERATIONS:

Movement over areas of limited contrast, such as tall grass, water, or desert, tends to cause spatial disorientation. Seek hover areas that provide adequate contrast and use proper scanning techniques. If disorientation occurs, apply sufficient power and execute a ITO, Task 1170. If a go around is not feasible, try to maneuver the aircraft forward and down to the ground to limit the possibility of touchdown with lateral or aft movement. When performing operations during unaided night flight, ensure that the searchlight or landing light (white light) is in the desired position. Use of the white light will impair night vision several minutes. Therefore, exercise added caution if resuming flight before reaching full dark adaptation.

SNOW/SAND/DUST CONSIDERATIONS: During ascent to a hover, if visual references do not deteriorate to an unacceptable level, continue ascent to the desired hover altitude.

10-foot hover taxi. During takeoff to a hover, simultaneously accelerate the aircraft to a ground speed that keeps the snow/sand/dust cloud just aft of the main rotor mast. Maintain optimum visibility by observing references close to the aircraft. Exercise caution when operating in close proximity to other aircraft or obstacles.

When visual references deteriorate making a 10-foot hover taxi unsafe, determine whether to abort the maneuver, ground taxi, air taxi, or perform a ITO Task 1170.

20- to 100-foot air taxi. Use this maneuver when it is necessary to move the aircraft over terrain that is unsuitable for hover taxi. Initiate air taxi the same as a 10-foot hover, but increase altitude to not more than 100 feet and accelerate to a safe airspeed above ETL.

Ensure that an area is available to safely decelerate and land the aircraft. Under certain conditions, such as adverse winds, it may be necessary to perform a traffic pattern to optimize conditions at the desired termination point.

Hovering OGE reduces available ground references and may increase the possibility of spatial disorientation. Be prepared to transition to instruments and execute an ITO or Unusual Attitude Recovery Task 1182 if ground reference is lost.

At night, use of landing, search, or anti-collision light may cause spatial disorientation while in blowing snow/sand/dust.

CONFINED AREA CONSIDERATIONS: Select good references to avoid unanticipated drift. All crewmembers must be focused primarily outside for obstacle avoidance.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in the aircraft or simulator.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.3 Task 1040

Perform VMC takeoff (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter or UH-60FS with the hover power and before-takeoff checks completed.

STANDARDS: Appropriate common standards plus these additions/modifications:

Maintain aircraft in trim above 50-feet AGL or as appropriate for transition to mission profile.

Maintain takeoff power 10 percent (+5%, -0% torque) above hover power until reaching minimum single engine airspeed, desired climb airspeed, or transition to mission profile.

DESCRIPTION:

Crew actions.

The PC will determine the direction of takeoff by analyzing the tactical situation, the wind, the long axis of the takeoff area, and the lowest obstacles and will confirm that required power is available by comparing the information from the PPC to the hover power check.

The P* will remain focused primarily outside the aircraft throughout the maneuver to provide obstacle clearance. He will announce whether the takeoff is from the ground or from a hover and his intent to abort or alter the takeoff. He will select reference points to assist in maintaining the takeoff flight path

The P and NCM will announce when ready for takeoff and will remain focused primarily outside the aircraft to assist in clearing and to provide adequate warning of obstacles. The P will monitor power requirements and advise the P* if power limits are being approached. The P and NCM will announce when their attention is focused inside the aircraft and again when attention is reestablished outside.

Procedures.

From the ground. Select reference points to maintain ground track. With the cyclic and pedals in the neutral position, increase power. Continue applying power until the aircraft is airborne and set power to 10% (+5%, -0% torque) above hover power or power as required to transition to mission profile. As the aircraft leaves the ground, maintain heading with pedals and apply forward cyclic as required to establish an accelerate attitude appropriate for the terrain and to avoid obstacles. Adjust the cyclic to continue the acceleration to the desired climb airspeed, and maintain the desired ground track. Make the required power adjustments to clear obstacles in the flight path, and obtain the desired rate of climb. Maintain heading with the pedals when below 50-feet AGL or until making the transition to terrain flight; then place the aircraft in trim. After obtaining the desired airspeed, adjust the cyclic as necessary to stop the acceleration and maintain desired climb airspeed. Maintain takeoff power until reaching minimum single engine airspeed and then adjust power as necessary to continue the desired rate of climb or transition to mission profile.

From a hover. Select reference points to maintain ground track. Apply forward cyclic to accelerate the aircraft while simultaneously applying power. Perform the rest of the maneuver as for a takeoff from the ground.

Avoid unnecessary nose-low accelerate attitudes; 5 degrees nose low is recommended for acceleration. However, 10 degrees nose low should not be exceeded.

Performing this maneuver in certain environments may require hover OGE power. Evaluate each situation for power required versus power available.

From the ground with less than OGE power. Select reference points to maintain ground track. With the cyclic and pedals in the neutral position, increase power until the aircraft becomes “light on the wheels”. Continue applying power until the aircraft is airborne. As the aircraft leaves the ground, apply forward cyclic as required to avoid obstacles and to accelerate smoothly through ETL at an altitude appropriate for the terrain. Adjust the cyclic to continue the acceleration to the desired climb airspeed and maintain the desired ground track. Make the required power adjustments to clear obstacles in the flight path and to obtain the desired rate of climb. Maintain heading with the pedals when below 50 feet AGL or until making the transition to mission profile; then place the aircraft in trim. After obtaining the desired airspeed, adjust the cyclic as necessary to stop the acceleration. Adjust power as necessary to continue or to stop the rate of climb.

From a hover with less than OGE power. Apply forward cyclic to accelerate the aircraft while applying power to maintain the desired hover altitude. Perform the rest of the maneuver as for a takeoff from the ground with less than OGE power.

NIGHT OR NVG CONSIDERATIONS:

If sufficient illumination exists to view obstacles, accomplish the takeoff in the same way as a VMC takeoff during the day. Visual obstacles, such as shadows, should be treated the same as physical obstacles. If sufficient illumination does not exist, perform an altitude-over-airspeed takeoff by applying takeoff power first followed by a slow acceleration to ensure obstacle clearance. The P* may perform the takeoff from a hover or from the ground.

Maintain the takeoff power setting until reaching climb airspeed. Adjust power as required to establish the desired rate of climb and cyclic to maintain the desired airspeed. Alternate attention between crosschecking instruments and assisting in obstacle avoidance. The P* and NCM should maintain orientation outside the aircraft and concentrate on obstacle avoidance. The P should make all internal checks.

Reduced visual references during the takeoff and throughout the ascent at night may make it difficult to maintain the desired ground track. Knowledge of the surface wind direction and velocity will assist in maintaining the desired ground track.

Use proper scanning techniques to avoid spatial disorientation.

When performing operations during unaided night flight, ensure that the searchlight or landing light (white light) is in the desired position. Use of the white light will impair night vision several minutes. Therefore, exercise added caution if resuming flight before reaching full dark adaptation.

SNOW/SAND/DUST CONSIDERATIONS: As the aircraft leaves the surface, maintain heading with the pedals and a level attitude with the cyclic. As the aircraft clears the snow/sand/dust cloud and clears the barriers, accelerate to climb airspeed and trim the aircraft.

In some cases, applying collective to blow away loose snow/sand/dust from around the aircraft is beneficial before performing this maneuver.

Be prepared to transition to instruments and execute an ITO if ground reference is lost.

At night, use of the landing, search, or anti-collision lights may cause spatial disorientation while in blowing snow/sand/dust.

CONFINED AREA CONSIDERATIONS: Before departure, confirm the takeoff plan. Perform a hover power check. Reposition the aircraft, if desired, to afford a shallower departure angle and minimize power requirements. During departure, adjust the cyclic and the collective as required to establish a constant departure angle to clear obstacles. All crewmembers must be focused primarily outside for obstacle avoidance.

MOUNTAIN/PINNACLE/RIDGELINE CONSIDERATIONS: Analyze winds, obstacles, and density altitude. Perform a hover power check. Determine the best takeoff direction and path for conditions. After clearing any obstacles accelerate the aircraft to the desired airspeed.

NOTE: Where drop-offs are located along the takeoff path, the aircraft may be maneuvered down slope to gain airspeed.

MUD/MUSKEG/TUNDRA CONSIDERATIONS: Perform one of the following takeoff techniques:

From dry muskeg/tundra areas. A vertical takeoff may be best in drier areas where the aircraft has not sunk into the muskeg/tundra or where obstacles prohibit motion. Smoothly increase the collective until the crew confirms that the wheels/skis are free. Adjust controls as necessary to perform a VMC takeoff.

From wet areas. In wet areas where the aircraft is likely to have sunk or is stuck in the mud/muskeg/tundra, the following technique may be best: With the cyclic in the neutral position, smoothly increase the collective. As hover power is approached, place the cyclic slightly forward of the neutral position and slowly move the pedals back and forth. Continue increasing the collective and "swim" the aircraft forward to break the suction of the wheels/skis. When free, adjust the controls as necessary to perform a VMC takeoff.

NOTE: Before performing operations in a mud/muskeg/tundra environment, it is important to understand dynamic rollover characteristics.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in the aircraft or simulator.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.4 Task 1052

Perform VMC flight maneuvers (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter or a UH-60FS.

STANDARDS: Appropriate common standards plus these additions/modifications:

Maneuver the aircraft to establish and maintain the desired airspeed, altitude, course, ground track, or heading, as appropriate.

Enter, operate in, and depart a traffic pattern.

DESCRIPTION:

Crew actions.

The P* will remain focused primarily outside the aircraft. He will announce and clear each turn, climb, and descent.

The P and NCM will assist in clearing the aircraft and will provide adequate warning of traffic and obstacles. They will announce when their attention is focused inside the aircraft and again when attention is reestablished outside.

Procedures. Adjust cyclic as required to maintain the desired airspeed, course, ground track, or heading as appropriate. Adjust collective as required to maintain the desired climb/descent rate or altitude and maintain aircraft in trim with the pedals. Perform traffic pattern operations per ATC directives, local SOP, and FM 1-203.

NIGHT OR NVG CONSIDERATIONS:

The P* will focus primarily outside the aircraft and should concentrate on obstacle avoidance and aircraft control. The P will make all internal cockpit checks.

For NVG training in the traffic pattern, the recommended maximum airspeed is 80 KIAS, and the recommended maximum bank angle is 30°.

TRAINING CONSIDERATIONS: For traffic pattern training, the recommended airspeed is 80 KIAS on crosswind and base legs and 100 KIAS on the downwind leg.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in aircraft or simulator.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.5 Task 1058

Perform VMC approach (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter or UH-60FS.

STANDARDS: Appropriate common standards plus these additions/modifications:

Select a suitable landing area (analyze suitability, barriers, wind, approach path, touchdown point, and takeoff direction).

Maintain a constant approach angle clear of obstacles to desired point of termination (hover) or touchdown (surface).

Maintain rate of closure appropriate for the conditions.

Maintain ground track alignment with the landing direction, as appropriate.

Align aircraft with landing direction below 50 feet or as appropriate for transition from terrain flight.

Perform a smooth and controlled termination to a hover or touchdown to the surface.

Select departure path for go-around during approach.

DESCRIPTION:

Crew actions.

The P* will focus primarily outside the aircraft to provide obstacle clearance throughout the maneuver. He will announce when he begins the approach and whether the approach will terminate to a hover or to the surface. The P* also will announce the intended point of landing and any deviation to the approach, if required.

The P and NCM will confirm the suitability of the area, assist in clearing the aircraft, and provide adequate warning of traffic and obstacles. The P and NCM will acknowledge any deviation during the approach. The P and NCM will announce when his attention is focused inside the aircraft and again when attention is reestablished outside.

Procedures. Evaluate winds. Select an approach angle that allows obstacle clearance while descending to the desired point of termination. Once the termination point is sighted and the approach angle is intercepted (on base or final), adjust the collective as necessary to establish and maintain a constant angle. Maintain entry airspeed until the rate of closure appears to be increasing. Above 50-feet AGL, maintain ground track alignment and the aircraft in trim. Below 50-feet AGL, align the aircraft with the landing direction. Progressively decrease the rate of descent and rate of closure until reaching the termination point (hover, touchdown), or until a decision is made to perform a go-around.

To a hover. The approach to a hover may terminate with a full stop over the planned termination point, or continue movement to transition to hovering flight. Progressively decrease the rate of descent and rate of closure until an appropriate hover is established over the intended termination point.

To the surface. Proceed as for an approach to a hover, except determine an approach angle that allows obstacle clearance while descending to the desired point of touchdown. (The decision to terminate to the surface with zero speed or with forward movement will depend on the aircraft's loading or environmental conditions.) Touchdown with minimum lateral movement. After surface contact, ensure that the aircraft remains stable until all movement stops. Smoothly lower the collective to the full down position and neutralize the pedals and cyclic. Apply breakes if required.

Go-around. The P* should perform a go-around if a successful landing is doubtful or if visual reference with the intended termination point is lost. Once climb is established, reassess the situation and develop a new course of action.

The P* should perform a go-around if a successful landing is doubtful or if he loses visual reference with the intended termination point. See Task 1068, Perform Go-Around.

If wind conditions will be a factor, a wind evaluation should be performed. Techniques for evaluating wind conditions are found in FM 1-202, Environmental Flight.

Steep approaches can place the aircraft in potential settling-with-power conditions.

Performing this maneuver in certain environments may require hover OGE power.

Evaluate each situation for power required versus power available.

DROOP STOP POUNDING (DSP)/AERODYNAMIC BRAKING. DSP is a phenomenon that can occur when there is excessive downward blade travel causing the blades to strike the droop stops when they are in the fly position. The conditions, which combine to induce this type DSP, include excessive aft cyclic, low collective, and all wheels on the ground. The maneuver that is most likely to produce DSP is the roll-on landing in conjunction with aerodynamic braking, however, DSP can also occur during taxi and down slope landings. Aerodynamic braking is a procedure that uses the aerodynamic forces of the rotor system to slow or stop the aircraft. Once the tail wheel is on the ground, aft cyclic used in conjunction with and increase in collective will slow or stop the aircraft. Aerodynamic braking is permissible while the tail wheel is on the ground before main gear contact. Once the main wheels contact the ground, the cyclic must be centered, collective lowered (center cyclic before lowering the collective), and brakes applied, only when collective is full down, as required. If a pilot attempts to slow the aircraft after main wheel contact by using aft cyclic as he lowers the collective he will hear an audible 4/Rev knocking. This is the first indication of DSP. With more rear cyclic applied DSP will become heavy (you may also feel the pounding in the airframe) and main rotor blade contact with the ALQ-144 and tail rotor drive shaft may result.

NIGHT OR NVG CONSIDERATIONS:

Altitude, apparent ground speed, and rate of closure are difficult to estimate at night. The rate of descent during the final 100 feet should be slightly less than during the day to avoid abrupt attitude changes at low altitudes. After establishing the descent during unaided flights, airspeed may be reduced to approximately 50 knots until apparent ground speed and rate of closure appear to be increasing. Progressively decrease the rate of decent and forward speed until termination of maneuver.

Surrounding terrain or vegetation may decrease contrast and cause degraded depth perception during the approach. Before descending below obstacles, determine the need for artificial lighting.

Use proper scanning techniques to avoid spatial disorientation.

When performing operations during unaided night flight, ensure that the searchlight or landing light (white light) is in the desired position. Use of the white light will impair night vision several minutes. Therefore, exercise added caution if resuming flight before reaching full dark adaptation.

SNOW/SAND/DUST CONSIDERATIONS:

Termination to a point OGE. This approach requires OGE power and may be used for most snow landings and some sand/dust landings. Make the approach to a hover OGE over the intended landing location. Slowly lower the collective and allow the aircraft to descend. The rate of descent will be determined by the rate in which the snow/sand/dust is blown from the intended landing point. Remain above the snow/sand/dust cloud until it dissipates and visual references can be seen for touch down. After ground contact, lower the collective to the full down position and neutralize the flight controls.

Termination to the surface with forward speed. This termination may be made to an improved landing surface or suitable area with minimal ground references. Once the appropriate approach angle is intercepted, adjust the collective as necessary to establish and maintain the angle. As the apparent rate of closure appears to increase, progressively reduce the rate of descent and closure to arrive at the touchdown area slightly above effective translational lift. At this point, maintain the minimum rate of closure that ensures that the snow/sand/dust cloud remains behind the pilot's station. When the wheels or heels of the skis contact the snow/ground, lower the collective and allow the aircraft to settle. Apply slight aft cyclic at touch down to prevent burying the wheels or toes of the skis. See note 5 above.

Termination to the surface with no forward speed. This termination should be made to landing areas where slopes, obstacles, or unfamiliar terrain precludes a landing with forward speed. It is not recommended when new or powder snow or fine dust is present because white/brown out conditions will occur. The termination is made directly to a reference point on the ground with no forward speed. After ground contact, lower the collective to the full down position and neutralize the flight controls.

When landing in deep snow, the aircraft wheels/skis may settle at different rates and the aircraft will normally terminate in a tail low attitude.

During sand/dust landings, all doors and windows should be closed and vent blowers turned off.

Hovering OGE reduces available ground references and may increase the possibility of spatial disorientation. Be prepared to transition to instruments and execute an instrument takeoff (ITO) if ground reference is lost.

At night, use of the landing, search, or anti-collision light may cause spatial disorientation while in blowing snow/sand/dust.

CONFINED AREA CONSIDERATIONS: An approach to the forward one-third of the useable area will reduce the approach angle and minimize power requirements. Prior to commencing the approach, the crew will determine and brief an escape route in case a go-around is necessary. During the approach, continue to determine the suitability of the area and the possible need for a go-around. If possible, make the decision to go-around before descending below the barriers or going below ETL. After touching down, check aircraft stability as the collective is lowered.

MOUNTAIN/PINNACLE/RIDGELINE CONSIDERATIONS: Select a shallow to steep approach angle, depending on the wind, density altitude, gross weight, and obstacles. During the approach, continue to determine the suitability of the intended landing point. Motion parallax may make the rate of closure difficult to determine until the aircraft is close to the landing area. Reduce airspeed to slightly above effective translational lift until the rate of closure can be determined. Before reaching the near edge of the landing area, the descent should be stopped and the rate of closure slowed. At this point, decide whether to continue the approach or make a go-around. If a go-around is required, it should be performed before decelerating below ETL. If the approach is continued, terminate in the landing area to a hover or to the surface. After touching down, check aircraft stability as the collective is lowered.

To successfully operate into small areas, it may be necessary to place the nose of the aircraft over the edge of the landing area. This may cause a loss of important visual references when on final approach. All crewmembers must assist in providing information on aircraft position in the landing area.

MUD/MUSKEG/TUNDRA CONSIDERATIONS: Select a suitable area and terminate the approach to a 10-foot hover over the intended touchdown point. Begin a vertical descent until the aircraft touches down. Check aircraft stability while lowering the collective. If the area is suitable, lower the collective to the full down position and neutralize the cyclic and pedals.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in the aircraft or simulator.

Evaluation. The evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.6. Task 1062

Perform slope operations (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter or UH-60FS with aircraft cleared.

STANDARDS: Appropriate common standards plus these additions/modifications:

Rated :

Select a suitable landing area.

From memory, know the slope landing limitations per TM 1-1520-237-10 and as they apply to the existing conditions.

Set the parking brakes before landing.

Perform a smooth and controlled descent and touchdown.

Maintain heading ±5 degrees.

Maintain drift ±1 foot until touchdown and then no drift allowed.

Perform a smooth and controlled ascent from the surface.

Nonrated.

Confirm suitable landing area.

Confirm parking brakes set before landing.

Announce drift and altitude.

DESCRIPTION:

Crew actions.

The P* will announce his intent to perform a slope operation and establish the helicopter over the slope. He will ensure the brakes are set. He will announce his intended landing area and any deviation from the intended maneuver. P* should be aware of the common tendency to become tense and, as a result, to over control the aircraft while performing the slope operation. The P* will note the aircraft attitude at a hover, prior to starting descent to land on the slope.

The P and NCM will provide adequate warning of obstacles, unannounced drift, or altitude changes. The P will assist in setting the parking brakes and verify when they are set. He will note the aircraft attitude on the VSI, and notify the P* prior to exceeding aircraft slope limitations. The P and NCM will confirm the suitability of the intended landing area and announce when their attention is focused inside the aircraft and again when attention is reestablished outside.

The NCM will provide wheel height information of the up slope landing gear until it is firmly on the ground.

Procedures.

Landing. Select a suitable area for slope operations. If possible, orient the aircraft into the wind. Set the parking brakes. Announce the initiation of the slope landing. Smoothly lower the collective until the tail or main landing gear contacts the ground. Adjust the cyclic to maintain the aircraft in a level attitude while maintaining heading with the pedals. Continue lowering the collective and simultaneously apply cyclic into the slope to maintain the position of the up slope wheel until the landing gear is firmly on the ground. Coordinate the collective and cyclic to control the rate of attitude change when lowering the down slope gear to the slope. With the down slope gear on the ground, simultaneously lower the collective full down and neutralize the cyclic. If cyclic or aircraft slope limits are reached before the aircraft is firmly on the ground, return the aircraft to a hover. Select a new area where the slope is less steep and attempt another slope landing.

Takeoff. Before takeoff, announce initiation of an ascent. Smoothly increase the collective and apply the cyclic into the slope to maintain the position of the up slope wheel. Continue to increase the collective to raise the down slope wheel(s), maintain heading with the pedals, and simultaneously adjust the cyclic to attain a hover attitude.

As the aircraft leaves the ground, adjust the cyclic to accomplish a vertical ascent to a hover with minimum drift.

Before performing slope operations, it is important to understand dynamic rollover and droop-stop pounding characteristics.

When the tail wheel is locked and on the ground, over-controlling the pedals may result in roll oscillations caused by the lift component of the tail rotor.

Crewmembers must be aware of the helicopter's normal hovering attitude prior to putting a wheel on the ground.

NIGHT OR NVG CONSIDERATIONS:

When conducting slope operations, determine the need for artificial illumination prior to starting the maneuver. Select reference points to determine slope angles. (References probably will be limited and difficult to ascertain.) If, at any time, successful completion of the landing is doubtful, abort the maneuver.

When performing operations during unaided night flight, ensure that the searchlight or landing light (white light) is in the desired position. Use of the white light will impair night vision several minutes. Therefore, exercise added caution if resuming flight before reaching fully dark adaptation.

EH-60A CONSIDERATIONS: Crewmembers must be familiar with the limitations of the aft DF antennas impose on nose down slope operations.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training will be conducted in the aircraft.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.7 Task 1054

Select landing zone/pickup zone (Department of the Army, 2000b)

CONDITIONS: In a UH-60 helicopter orUH-60FS given a map or photo data.

STANDARDS: Appropriate common standards plus the following additions/modifications:

Perform map, photo, or visual reconnaissance.

Determine that the LZ is suitable for operations and provide accurate and detailed information to supported unit if applicable.

Confirm suitability on initial approach.

DESCRIPTION:

Crew actions. The crew will confirm location of plotted hazards and call out location of unplotted hazards.

The PC will confirm suitability of the area for the planned mission.

The P* will remain focused primarily outside the aircraft throughout the maneuver for aircraft control and obstacle avoidance. He will announce his intent to deviate from the maneuver.

The P and NCM will assist in reconnaissance of the LZ, clearing the aircraft, and will provide adequate warning of obstacles. They will acknowledge the P*'s intent to deviate from the maneuver.

Procedures. Gather map or photo data on potential LZ(s) or conduct an in-flight suitability check if map or photo data is unreliable. Determine the suitability by evaluating size, long axis, barriers, surface conditions, tactical situation, and effects of the wind. Select a flight path, altitude, and airspeed that affords the best observation of the landing area, as required. Determine an approach, desired touchdown point, and departure path. The tactical, technical, and meteorological elements must be considered in determining suitability.

If wind conditions will be a factor, a wind evaluation should be performed. Techniques for evaluating wind conditions are found in FM 1-202.

Depending on the mission, an in-flight suitability check may not be feasible. Suitability may be determined by a map reconnaissance. Make a final determination of suitability upon arrival to the LZ/PZ.

Tactical.

Mission. Determine if the mission can be accomplished from the selected LZ. Consider flight time, fuel, number of sorties, and access routes.

Location. To reduce troop fatigue, consider distance of PZ or LZ from supported unit or objective, and supported unit's mission, equipment, and method of travel to/from PZ/LZ.

Security. Consider size and proximity of threat elements versus availability of security forces. The supported unit normally provides security. Consider cover and concealment, key terrain, avenues of approach and departure. The area should be large enough to provide dispersion.

Technical.

Number and type of aircraft. Determine if the size of the LZ can support all the aircraft at once, or if they must rotate into LZ for in-flight link-up.

Landing formation. Plan landing formation for shape and size of LZ.

External Loads. For missions requiring external loads at or near maximum gross weight of the helicopter select larger LZs where barriers have minimum vertical development.

Surface conditions. Consider slopes, blowing sand, snow, or dust. Be aware that vegetation may conceal surface hazards (for example, large rocks, ruts, or stumps). Areas selected should also be free of sources of rotor wash signature.

Obstacles. Hazards within the LZ that cannot be eliminated must be plotted. Plan approach and departure routes over lowest obstacles.

Meteorological.

Ceiling and visibility. Ceiling and visibility are critical when operating near threat elements. Inadvertent IMC recovery can expose the aircraft and crew to radar guided and heat seeking weapons, with few options for detection and avoidance. If one aircrew of a multiship operation must perform inadvertent IMC procedures the element of surprise will be lost, the assets on board will not be available for the mission, and the entire mission may be at risk. If the crew of a single-ship mission goes inadvertent IMC, the mission must be aborted or modified.

Winds. Determine approach and departure paths.

Pressure Altitude. High PA may limit loads, and therefore require more sorties.

NOTE: Avoid planning approach or departure routes into a rising or setting sun or moon.

NIGHT OR NVG CONSIDERATIONS:

Unimproved and unlit areas are more difficult to evaluate at night because of low contrast. Knowledge of the various methods for determining the height of obstacles is critical to successfully completing this task. Visual obstacles such as shadows should be treated the same as physical obstacles.

When performing operations during unaided night flight, ensure that the searchlight or landing light (white light) is in the desired position. Use of the white light will impair night vision several minutes. Therefore, exercise added caution if resuming flight before reaching full dark adaptation.

CONFINED AREA CONSIDERATIONS: Determine a suitable axis and path for a go-around. For multi-aircraft operations, determine the number of aircraft that the area can safely accommodate.

SNOW/SAND/DUST CONSIDERATIONS: Evaluate surface conditions for the likelihood of encountering a whiteout/brownout. Determine a suitable axis and path for a go-around.

MOUNTAIN/PINNACLE/RIDGELINE CONSIDERATIONS: When practical, position the aircraft on the windward side of the area. Evaluate suitability paying particular attention to pressure altitude and winds. Determine a suitable axis and escape route for a go-around. Operations at high altitudes are more likely to expose the crews to visual detection, radar, or heat seeking weapons.

TRAINING AND EVALUATION REQUIREMENTS:

Training. Training may be conducted in the aircraft or simulator.

Evaluation. Evaluation will be conducted in the aircraft.

REFERENCES: Appropriate common references.

B.6.2.5.8 UH-60 Common Performance Standards

(Department of the Army, 2000b)

The standards describe the minimum degree of proficiency or standard of performance to which the task must be accomplished. The terms, “Without error”, Properly”, and “Correctly” apply to all standards. The standards are based on ideal conditions. Many standards are common to several tasks. Individual instructor techniques will not be treated as standards nor used as grading elements. Unless otherwise specified in the individual task, the standards below apply. Alternate or additional standards will be listed in individual tasks. Standards unique to the training environment for simulated conditions are established in TRAINING CONSIDERATIONS section or each task. Standards are based on ideal conditions. The following standards apply to all tasks.

Hover.

Maintain heading ±10 degrees.

Maintain altitude, ±3 feet* (±5 feet for OGE).

Do not allow drift to exceed 3 feet* (10 feet for OGE hover).

Maintain ground track within 3 feet.

Maintain a constant rate of movement for existing conditions.

Maintain a constant rate of turn not to exceed 30 degrees per second.

NOTE: *These standards require the NCM(s) to announce drift and altitude before exceeding the standard.

In flight.

Maintain heading ±10 degrees.

Maintain altitude ±100 feet.

Maintain airspeed ±10 KIAS.

Maintain rate of climb or descent ±200 FPM.

Maintain the aircraft in trim ±½ ball width.

All tasks with the APU/engines operating. (RCMs and NCMs)

Maintain airspace surveillance (Task 1026).

Apply appropriate environmental considerations.

The only subtask for which the US Army Training Circular 1-237 “Aircrew Training Manual Utility Helicopter, UH-60/EH-60” provides a complete set of objectives measures of performance is “Perform VMC flight maneuvers” (Task 1052, Department of the Army, 2000b). Therefore, this experiment will train and collect performance data on the “Perform VMC flight maneuvers” subtask and on the overall CSAR mission.

B.7 Knowledge, Skills and Abilities

Knowledge of the operation of fixed wing aircraft or helicopters.

Knowledge of the effect of weather on flight characteristics.

Skill in flying aircraft at all times of day, all seasons and weather conditions, and flying at low altitudes and low air speeds.

Ability to respond quickly in emergencies.

Ability to make judgments concerning flight safety based on weather, flight plans, and other information.

Ability to read maps.

APPENDIX C: EXCERPTS FROM HUMANALYSIS, INC.

Humananalysis, Inc. (1994). Cues and Conditions for UH-60 Blackhawk Helicopter Flight and Mission Tasks Performed by Pilots and Co-Pilots. Orlando, FL: US Army Simulation, Training and Instrumentation Command.

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1		●	●	●	●	●	●	●				
Trees	2.3.7.1.2		●	●	●	●	●	●	●				●
Grass	2.3.7.1.3		●	●	●	●	●	●	●				●
Water	2.3.7.1.4		●	●	●	●	●	●	●				●
Sand	2.3.7.1.5		●	●	●	●	●	●	●				●
Barren ground	2.3.7.1.6		●	●	●	●	●	●	●				●
Jungle/rain forest	2.3.7.1.7		●	●	●	●	●	●	●				●
Woods	2.3.7.1.8		●	●	●	●	●	●	●				●
Bushes & hedgerows	2.3.7.1.9		●	●	●	●	●	●	●				●
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1												
Building destruction	2.3.7.2.2												

C19

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform engine start/run-up proc.	Inspect/perf. opr's prev. maint. on ALSE	Perform AFCS operation	Perform hovering flight	Perf. in-flight internal rescue hoist ops	Perform VMC takeoff	Perform fuel management proc.	Perform VMC flight maneuvers	Perform VMC approach	Perform slope operations	Perform pinnacle/ridgeline operations	Perf shallow approach to run'g/roll-on landing
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1								●	●	●	●	
Trees	2.3.7.1.2				●	●	●		●	●	●	●	●
Grass	2.3.7.1.3				●	●	●		●	●	●	●	●
Water	2.3.7.1.4				●	●	●		●	●			
Sand	2.3.7.1.5				●	●	●		●	●	●	●	●
Barren ground	2.3.7.1.6				●	●	●		●	●	●	●	●
Jungle/rain forest	2.3.7.1.7				●	●	●		●	●	●	●	●
Woods	2.3.7.1.8				●	●	●		●	●	●	●	●
Bushes & hedgerows	2.3.7.1.9				●	●	●		●	●	●	●	●
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1					●							
Building destruction	2.3.7.2.2					●							

C20

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform emergency procedures	Perform emergency procedures for NVG	Perform instrument takeoff	Perform CIS operations	Perform unusual attitude recovery	Perform radio communications procedures	Perform procedures for two-way radio failure	Perform inadvertent IMC/VHIRP procedures	Perform instrument approach	Perform instrument maneuvers	Perform terrain flight mission planning	Perform masking and unmasking
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1	●	●										●
Trees	2.3.7.1.2	●	●										●
Grass	2.3.7.1.3	●	●										●
Water	2.3.7.1.4	●	●										
Sand	2.3.7.1.5	●	●										
Barren ground	2.3.7.1.6	●	●										●
Jungle/rain forest	2.3.7.1.7	●	●										●
Woods	2.3.7.1.8	●	●										●
Bushes & hedgerows	2.3.7.1.9	●	●										●
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1												
Building destruction	2.3.7.2.2												

C21

VISUAL CUES / TASKS	Paragraph w/narrative	Perform tactical communications procedures	Perform terrain flight	Perform aerial observation	Transmit spot report	Operate ASE	Perform techniques of movement	Perform actions on contact	Negotiate wire obstacles	Operate night vision devices	Prepare for operation in an NBC environment	Perform refueling operations	Perform multi-aircraft operations
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1		●	●			●	●	●	●			●
Trees	2.3.7.1.2		●	●			●	●	●	●			●
Grass	2.3.7.1.3		●	●			●	●	●	●			●
Water	2.3.7.1.4		●	●			●	●	●	●			●
Sand	2.3.7.1.5		●	●			●	●	●	●			●
Barren ground	2.3.7.1.6		●	●			●	●	●	●			●
Jungle/rain forest	2.3.7.1.7		●	●			●	●	●	●			●
Woods	2.3.7.1.8		●	●			●	●	●	●			●
Bushes & hedgerows	2.3.7.1.9		●	●			●	●	●	●			●
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1		●	●	●								
Building destruction	2.3.7.2.2		●	●	●								

C22

VISUAL CUES \ TASKS	Paragraph w/narrative	Select/recom'nd landing zone/pickup zone	Call for and adjust indirect fire	Perform after landing tasks	Perform aircraft shutdown	Perf. operat'ns for transport of hazardous cargo	Perform rappelling procedures	Perform aerial mine delivery	Perform paradrop operations	Perform Aerial flare delivery	Perform external load operations	Perform internal load operations	Perform rescue hoist operations
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1	●	●				●	●	●	●	●	●	
Trees	2.3.7.1.2	●	●				●	●	●	●	●	●	●
Grass	2.3.7.1.3	●	●				●	●	●	●	●	●	●
Water	2.3.7.1.4		●						●	●			●
Sand	2.3.7.1.5	●	●				●	●	●	●	●	●	●
Barren ground	2.3.7.1.6	●	●				●	●	●	●	●	●	●
Jungle/rain forest	2.3.7.1.7	●	●				●	●	●	●	●	●	●
Woods	2.3.7.1.8	●	●				●	●	●	●	●	●	●
Bushes & hedgerows	2.3.7.1.9	●	●				●	●	●	●	●	●	●
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1		●					●					
Building destruction	2.3.7.2.2		●					●					

C23

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform shipboard operations	Perform route reconnaissance	Perform zone reconnaissance	Perform area reconnaissance	Operate EERFS	Perform wing stores jettison						
Mission & Flight Scenes	2.3.7												
Natural terrain features	2.3.7.1												
Mountains/hills	2.3.7.1.1		●	●	●								
Trees	2.3.7.1.2		●	●	●								
Grass	2.3.7.1.3		●	●	●								
Water	2.3.7.1.4	●	●	●	●								
Sand	2.3.7.1.5		●	●	●								
Barren ground	2.3.7.1.6		●	●	●								
Jungle/rain forest	2.3.7.1.7		●	●	●								
Woods	2.3.7.1.8		●	●	●								
Bushes & hedgerows	2.3.7.1.9		●	●	●								
Battle Effects	2.3.7.2												
Craters	2.3.7.2.1												
Building destruction	2.3.7.2.2												

C24

VISUAL CUES / TASKS	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Damaged equipment	2.3.7.2.3												
Dead/injured person'l	2.3.7.2.4												
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1	●	●		●	●	●						●
Emplacements	2.3.7.3.2	●	●		●	●	●						●
Bridges	2.3.7.3.3	●	●		●	●	●						
Towers	2.3.7.3.4	●	●		●	●	●						●
Wire	2.3.7.3.5	●	●	●	●	●	●						●
Engineer obstacles	2.3.7.3.6	●	●	●	●	●	●						●
Roads	2.3.7.3.7	●	●	●	●	●	●						●
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1												
Helicopters	2.3.8.2												
Track vehicles	2.3.8.3												

C25

VISUAL CUES / TASKS	Paragraph w/narrative	Perform engine start/run-up proc.	Inspect/perf. op'r's prev. maint. on ALSE	Perform AFCS operation	Perform hovering flight	Perf. in-flight internal rescue hoist ops	Perform VMC takeoff	Perform fuel management proc.	Perform VMC flight maneuvers	Perform VMC approach	Perform slope operations	Perform pinnacle/ ridgeline operations	Perf shallow approach to run'g/roll-on landing
Damaged equipment	2.3.7.2.3				●							●	
Dead/injured person'l	2.3.7.2.4				●	●						●	
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1				●	●	●		●	●			
Emplacements	2.3.7.3.2				●	●	●		●	●	●	●	
Bridges	2.3.7.3.3				●		●		●	●	●		
Towers	2.3.7.3.4				●	●	●		●	●	●	●	
Wire	2.3.7.3.5				●	●	●		●	●	●	●	●
Engineer obstacles	2.3.7.3.6				●		●						
Roads	2.3.7.3.7				●	●	●		●	●			●
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1												
Helicopters	2.3.8.2								●	●	●	●	●
Track vehicles	2.3.8.3												

C26

VISUAL CUES / TASKS	Paragraph w/narrative	Perform emergency procedures	Perform emergency procedures for NVG	Perform instrument takeoff	Perform CIS operations	Perform unusual attitude recovery	Perform radio communications procedures	Perform procedures for two-way radio failure	Perform inadvertent IMC/VHIRP procedures	Perform instrument approach	Perform instrument maneuvers	Perform terrain flight mission planning	Perform masking and unmasking
Damaged equipment	2.3.7.2.3												
Dead/injured person'l	2.3.7.2.4												
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1	●	●										●
Emplacements	2.3.7.3.2	●	●										●
Bridges	2.3.7.3.3	●	●										●
Towers	2.3.7.3.4	●	●										
Wire	2.3.7.3.5	●	●										
Engineer obstacles	2.3.7.3.6	●	●										●
Roads	2.3.7.3.7	●	●										●
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1						●						
Helicopters	2.3.8.2						●						●
Track vehicles	2.3.8.3						●						

C27

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform tactical communications procedures	Perform terrain flight	Perform aerial observation	Transmit spot report	Operate ASE	Perform techniques of movement	Perform actions on contact	Negotiate wire obstacles	Operate night vision devices	Prepare for operation in an NBC environment	Perform refueling operations	Perform multi-aircraft operations
Damaged equipment	2.3.7.2.3		●		●								
Dead/injured person'l	2.3.7.2.4		●		●								
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1		●		●		●		●	●			
Emplacements	2.3.7.3.2		●		●		●		●	●			
Bridges	2.3.7.3.3		●		●				●	●			
Towers	2.3.7.3.4		●		●				●	●			
Wire	2.3.7.3.5		●		●		●		●	●			
Engineer obstacles	2.3.7.3.6		●		●		●		●	●			
Roads	2.3.7.3.7		●		●		●		●	●			
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1									●		●	
Helicopters	2.3.8.2						●			●	●	●	●
Track vehicles	2.3.8.3									●		●	

C28

VISUAL CUES / TASKS	Paragraph w/narrative	Select/recom'nd landing zone/pickup zone	Call for and adjust indirect fire	Perform after landing tasks	Perform aircraft shutdown	Perf. operat'ns for transport of hazardous cargo	Perform rappelling procedures	Perform aerial mine delivery	Perform paradrop operations	Perform Aerial flare delivery	Perform external load operations	Perform internal load operations	Perform rescue hoist operations
Damaged equipment	2.3.7.2.3	●	●							●			●
Dead/injured person'l	2.3.7.2.4	●	●							●			●
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1	●	●				●	●	●	●		●	●
Emplacements	2.3.7.3.2	●	●				●	●		●		●	●
Bridges	2.3.7.3.3		●				●	●	●	●		●	●
Towers	2.3.7.3.4	●	●				●	●		●	●	●	●
Wire	2.3.7.3.5	●	●				●	●		●		●	●
Engineer obstacles	2.3.7.3.6	●	●				●	●		●		●	●
Roads	2.3.7.3.7	●	●				●	●	●	●		●	●
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1	●		●	●			●		●		●	●
Helicopters	2.3.8.2	●		●	●		●	●		●	●	●	●
Track vehicles	2.3.8.3	●		●	●			●	●	●	●		●

C29

VISUAL CUES / TASKS	Paragraph w/narrative	Perform shipboard operations	Perform route reconnaissance	Perform zone reconnaissance	Perform area reconnaissance	Operate EERFS	Perform wing stores jettison						
Damaged equipment	2.3.7.2.3		●	●	●								
Dead/injured person'l	2.3.7.2.4		●	●	●								
Man-made objects	2.3.7.3												
Buildings/landmarks	2.3.7.3.1		●	●	●								
Emplacements	2.3.7.3.2		●	●	●								
Bridges	2.3.7.3.3		●	●	●								
Towers	2.3.7.3.4		●	●	●								
Wire	2.3.7.3.5		●	●	●								
Engineer obstacles	2.3.7.3.6		●	●	●								
Roads	2.3.7.3.7		●	●	●								
Blue Forces	2.3.8												
Fixed wing aircraft	2.3.8.1	●											
Helicopters	2.3.8.2	●											
Track vehicles	2.3.8.3												

C30

VISUAL CUES / TASKS	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Wheeled vehicles	2.3.8.4	●											●
Dismounted infantry	2.3.8.5	●											●
Opposing Forces	2.3.9												
Fixed wing aircraft	2.3.9.1												
Helicopters	2.3.9.2	●											
Track vehicles	2.3.9.3	●											
Wheeled vehicles	2.3.9.4	●											
Dismounted infantry	2.3.9.5	●											
Refugee Scenes	2.3.10	●											
Ordnance Effects	2.3.11	●											

C31

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform engine start/run-up proc.	Inspect/perf. opr's prev. maint. on ALSE	Perform AFCS operation	Perform hovering flight	Perf. in-flight internal rescue hoist ops	Perform VMC takeoff	Perform fuel management proc.	Perform VMC flight maneuvers	Perform VMC approach	Perform slope operations	Perform pinnacle/ridgeline operations	Perf shallow approach to run'g/roll-on landing
Wheeled vehicles	2.3.8.4	●			●	●		●	●			●
Dismounted infantry	2.3.8.5			●	●	●		●	●	●	●	●
Opposing Forces	2.3.9											
Fixed wing aircraft	2.3.9.1				●			●				
Helicopters	2.3.9.2				●			●				
Track vehicles	2.3.9.3				●			●				
Wheeled vehicles	2.3.9.4				●			●				
Dismounted infantry	2.3.9.5				●			●				
Refugee Scenes	2.3.10				●			●				
Ordnance Effects	2.3.11				●			●				

C32

VISUAL CUES / TASKS	Paragraph w/narrative	Perform emergency procedures	Perform emergency procedures for NVG	Perform instrument takeoff	Perform CIS operations	Perform unusual attitude recovery	Perform radio communications procedures	Perform procedures for two-way radio failure	Perform inadvertent IMC/VHIRP procedures	Perform instrument approach	Perform instrument maneuvers	Perform terrain flight mission planning	Perform masking and unmasking
Wheeled vehicles	2.3.8.4						●	●					●
Dismounted infantry	2.3.8.5						●	●					●
Opposing Forces	2.3.9												
Fixed wing aircraft	2.3.9.1												●
Helicopters	2.3.9.2												●
Track vehicles	2.3.9.3												●
Wheeled vehicles	2.3.9.4												●
Dismounted infantry	2.3.9.5												●
Refugee Scenes	2.3.10												●
Ordnance Effects	2.3.11												●

C33

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform tactical communications procedures	Perform terrain flight	Perform aerial observation	Transmit spot report	Operate ASE	Perform techniques of movement	Perform actions on contact	Negotiate wire obstacles	Operate night vision devices	Prepare for operation in an NBC environment	Perform refueling operations	Perform multi-aircraft operations
Wheeled vehicles	2.3.8.4	●	●				●			●			●
Dismounted infantry	2.3.8.5	●	●				●			●			●
Opposing Forces	2.3.9												
Fixed wing aircraft	2.3.9.1		●	●	●		●	●		●			●
Helicopters	2.3.9.2		●	●	●		●	●		●			●
Track vehicles	2.3.9.3		●	●	●		●	●		●			●
Wheeled vehicles	2.3.9.4		●	●	●		●	●		●			●
Dismounted infantry	2.3.9.5		●	●	●		●	●		●			●
Refugee Scenes	2.3.10		●	●	●		●			●			●
Ordnance Effects	2.3.11		●	●	●		●	●		●			●

C34

VISUAL CUES \ TASKS	Paragraph w/narrative	Select/recom'nd landing zone/pickup zone	Call for and adjust indirect fire	Perform after landing tasks	Perform aircraft shutdown	Perf. operat'ns for trans-port of hazardous cargo	Perform rappeling procedures	Perform aerial mine delivery	Perform paradrop operations	Perform Aerial flare delivery	Perform external load operations	Perform internal load operations	Perform rescue hoist operations
Wheeled vehicles	2.3.8.4						●				●		
Dismounted infantry	2.3.8.5						●		●		●		●
Opposing Forces	2.3.9												
Fixed wing aircraft	2.3.9.1	●											
Helicopters	2.3.9.2	●											
Track vehicles	2.3.9.3	●	●				●	●		●			
Wheeled vehicles	2.3.9.4	●	●				●	●		●			
Dismounted infantry	2.3.9.5	●	●					●		●			
Refugee Scenes	2.3.10	●					●						
Ordnance Effects	2.3.11	●	●				●	●		●			

C35

VISUAL CUES \ TASKS	Paragraph w/narrative	Perform shipboard operations	Perform route reconnaissance	Perform zone reconnaissance	Perform area reconnaissance	Operate EERFS	Perform wing stores jettison						
Wheeled vehicles	2.3.8.4												
Dismounted infantry	2.3.8.5												
Opposing Forces	2.3.9												
Fixed wing aircraft	2.3.9.1												
Helicopters	2.3.9.2		●	●	●								
Track vehicles	2.3.9.3		●	●	●								
Wheeled vehicles	2.3.9.4		●	●	●								
Dismounted infantry	2.3.9.5		●	●	●								
Refugee Scenes	2.3.10		●	●	●								
Ordnance Effects	2.3.11		●	●	●								

C36

KINESTHETIC CUES \ TASKS	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4	●	●	●	●	●	●			●			●
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)			●	●	●	●	●			●			●
Leaning in seat during slope landing ops													●
Force from back to chest direction during takeoff (Forward Transverse-G)		●								●			●
Force from chest to back direction during deceleration (Backward Transverse-G)			●		●	●							
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)			●	●	●	●							●

C37

KINESTHETIC CUES / TASKS	Paragraph w/narrative	Perform engine start/run-up proc.	Inspect/perf. op'r's prev. maint. on ALSE	Perform AFCS operation	Perform hovering flight	Perf. in-flight internal rescue hoist ops	Perform VMC takeoff	Perform fuel management proc.	Perform VMC flight maneuvers	Perform VMC approach	Perform slope operations	Perform pinnacle/ridgeline operations	Perf shallow approach to run'g/roll-on landing
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4				●		●		●				
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)									●	●		●	●
Leaning in seat during slope landing ops									●		●		
Force from back to chest direction during takeoff (Forward Transverse-G)							●		●				
Force from chest to back direction during deceleration (Backward Transverse-G)									●	●	●	●	●
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)					●				●	●	●	●	●

C38

KINESTHETIC CUES / TASKS	Paragraph w/narrative	Perform emergency procedures	Perform emergency procedures for NVG	Perform instrument takeoff	Perform CIS operations	Perform unusual attitude recovery	Perform radio communications procedures	Perform procedures for two-way radio failure	Perform inadvertent IMC/VHIRP procedures	Perform instrument approach	Perform instrument maneuvers	Perform terrain flight mission planning	Perform masking and unmasking
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4	●	●	●		●					●		●
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)		●	●			●				●	●		●
Leaning in seat during slope landing ops													
Force from back to chest direction during takeoff (Forward Transverse-G)		●	●	●		●							
Force from chest to back direction during deceleration (Backward Transverse-G)		●	●			●				●	●		
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)		●	●			●				●	●		●

C39

KINESTHETIC CUES \ TASKS	Paragraph w/narrative	Perform tactical communications procedures	Perform terrain flight	Perform aerial observation	Transmit spot report	Operate ASE	Perform techniques of movement	Perform actions on contact	Negotiate wire obstacles	Operate night vision devices	Prepare for operation in an NBC environment	Perform refueling operations	Perform multi-aircraft operations
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4		●				●	●	●				●
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)			●				●	●	●				●
Leaning in seat during slope landing ops													
Force from back to chest direction during takeoff (Forward Transverse-G)			●				●		●				●
Force from chest to back direction during deceleration (Backward Transverse-G)			●				●	●	●				●
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)			●				●	●					●

C40

KINESTHETIC CUES / TASKS	Paragraph w/narrative	Select/recom'nd landing zone/pickup zone	Call for and adjust indirect fire	Perform after landing tasks	Perform aircraft shutdown	Perf. operat'ns for trans-port of hazardous cargo	Perform rappeling procedures	Perform aerial mine delivery	Perform paradrop operations	Perform Aerial flare delivery	Perform external load operations	Perform internal load operations	Perform rescue hoist operations
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4												
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)													
Leaning in seat during slope landing ops													
Force from back to chest direction during takeoff (Forward Transverse-G)													
Force from chest to back direction during deceleration (Backward Transverse-G)													
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)							●						●

C41

KINESTHETIC CUES \ TASKS	Paragraph w/narrative	Perform shipboard operations	Perform route reconnaissance	Perform zone reconnaissance	Perform area reconnaissance	Operate EERFS	Perform wing stores jettison						
Body forced downward in seat during forward acceleration/nose pitching upward (Positive-G)	2.4	●					●						
Body lifted out of seat during deceleration/ pitch of nose downward (Negative-G)		●											
Leaning in seat during slope landing ops		●											
Force from back to chest direction during takeoff (Forward Transverse-G)		●											
Force from chest to back direction during deceleration (Backward Transverse-G)		●											
Force from shoulder to shoulder during side-to-side yawing (Right or Left Lateral-G)		●	●		●		●						

C42

TACTILE CUES \ TASKS	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Foot pedals binding - hydraulic problems	2.6	●	●	●	●	●						●	●
Power control levers hard to operate when cold			●									●	
Cyclic moves to compensate for load shifts													
Vibrations felt in seats because of nose-down attitudes or acceleration		●											
Trim actuators jamming because of "hard-overs"						●							
Jolt felt in cyclic when back-up hydraulic pump initializes													
Wheels touching down on landing			●	●	●	●	●						
Wheels bumping across ground during lift-off		●											●
Wheels clearing ground upon lift-off		●											
Aircraft yawing to left during auto-rotation			●	●									

C49

TACTILE CUES \ TASKS	Paragraph w/narrative	Perform engine start/run-up proc.	Inspect/perf. opr's prev. maint. on ALSE	Perform AFCS operation	Perform hovering flight	Perf. in-flight internal rescue hoist ops	Perform VMC takeoff	Perform fuel management proc.	Perform VMC flight maneuvers	Perform VMC approach	Perform slope operations	Perform pinnacle/ ridgeline operations	Perf shallow approach to run'g/roll-on landing
Foot pedals binding - hydraulic problems	2.6	●		●	●	●	●		●	●	●	●	●
Power control levers hard to operate when cold		●											
Cyclic moves to compensate for load shifts						●							
Vibrations felt in seats because of nose-down attitudes or acceleration							●		●				
Trim actuators jamming because of "hard-overs"													
Jolt felt in cyclic when back-up hydraulic pump initializes													
Wheels touching down on landing											●	●	●
Wheels bumping across ground during lift-off													
Wheels clearing ground upon lift-off							●				●	●	
Aircraft yawing to left during auto-rotation													

C50

TACTILE CUES \ TASKS	Paragraph w/narrative	Perform emergency procedures	Perform emergency procedures for NVG	Perform instrument takeoff	Perform CIS operations	Perform unusual attitude recovery	Perform radio communications procedures	Perform procedures for two-way radio failure	Perform inadvertent IMC/VHIRP procedures	Perform instrument approach	Perform instrument maneuvers	Perform terrain flight mission planning	Perform masking and unmasking
Foot pedals binding - hydraulic problems	2.6	●		●		●			●	●	●		●
Power control levers hard to operate when cold													
Cyclic moves to compensate for load shifts													
Vibrations felt in seats because of nose-down attitudes or acceleration						●					●		
Trim actuators jamming because of "hard-overs"		●											
Jolt felt in cyclic when back-up hydraulic pump initializes		●											
Wheels touching down on landing													●
Wheels bumping across ground during lift-off				●									●
Wheels clearing ground upon lift-off				●									●
Aircraft yawing to left during auto-rotation		●											

C51

TACTILE CUES / TASKS	Paragraph w/narrative	Perform tactical communications procedures	Perform terrain flight	Perform aerial observation	Transmit spot report	Operate ASE	Perform techniques of movement	Perform actions on contact	Negotiate wire obstacles	Operate night vision devices	Prepare for operation in an NBC environment	Perform refueling operations	Perform multi-aircraft operations
Foot pedals binding - hydraulic problems	2.6		●	●	●	●	●	●	●			●	●
Power control levers hard to operate when cold													
Cyclic moves to compensate for load shifts													
Vibrations felt in seats because of nose-down attitudes or acceleration			●										●
Trim actuators jamming because of "hard-overs"													
Jolt felt in cyclic when back-up hydraulic pump initializes													
Wheels touching down on landing												●	
Wheels bumping across ground during lift-off												●	
Wheels clearing ground upon lift-off												●	
Aircraft yawing to left during auto-rotation													

C52

TACTILE CUES \ TASKS	Paragraph w/narrative	Select/recom'nd landing zone/pickup zone	Call for and adjust indirect fire	Perform after landing tasks	Perform aircraft shutdown	Perf. operat'ns for trans-port of hazardous cargo	Perform rappelling procedures	Perform aerial mine delivery	Perform paradrop operations	Perform Aerial flare delivery	Perform external load operations	Perform internal load operations	Perform rescue hoist operations
Foot pedals binding - hydraulic problems	2.6				●		●	●	●	●	●	●	●
Power control levers hard to operate when cold													
Cyclic moves to compensate for load shifts							●	●	●	●	●	●	●
Vibrations felt in seats because of nose-down attitudes or acceleration													
Trim actuators jamming because of "hard-overs"													
Jolt felt in cyclic when back-up hydraulic pump initializes													
Wheels touching down on landing													
Wheels bumping across ground during lift-off													
Wheels clearing ground upon lift-off													
Aircraft yawing to left during auto-rotation													

C53

TACTILE CUES \ TASKS	Paragraph w/narrative	Perform shipboard operations	Perform route reconnaissance	Perform zone reconnaissance	Perform area reconnaissance	Operate EERFS	Perform wing stores jettison						
Foot pedals binding - hydraulic problems	2.6	●	●	●	●								
Power control levers hard to operate when cold													
Cyclic moves to compensate for load shifts							●						
Vibrations felt in seats because of nose-down attitudes or acceleration													
Trim actuators jamming because of "hard-overs"													
Jolt felt in cyclic when back-up hydraulic pump initializes													
Wheels touching down on landing		●											
Wheels bumping across ground during lift-off													
Wheels clearing ground upon lift-off		●											
Aircraft yawing to left during auto-rotation													

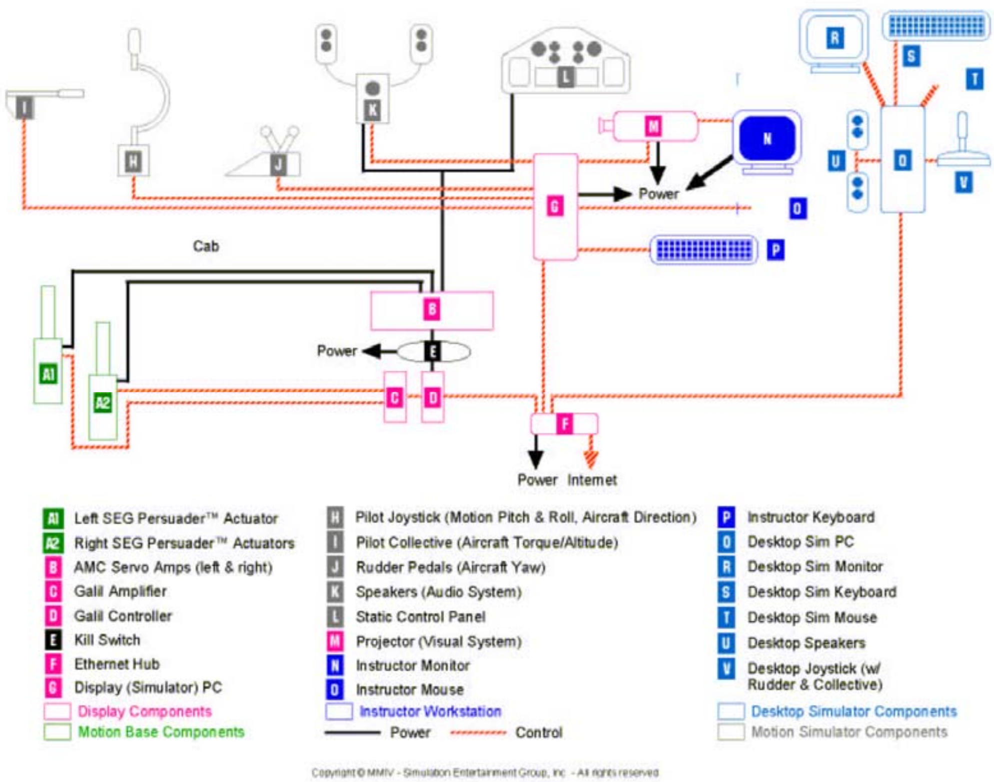
C54

TASKS / TACTILE CUES	Paragraph w/narrative	Perform maximum performance takeoff	Perform standard autorotation	Perform sim. eng. fail. from hover alt.	Perform sim. eng. fail. from altitude	Perform sim. hydraulic system malfunction	Perform stabilator malfunction	Perform radio navigation	Perform holding procedures	Desc./perf. vertical helo IFR recov'y proc.	Perform preflight inspection	Perform checks prior to takeoff	Perform ground taxi
Aircraft "shuddering" when slowing to ETL													

C55

APPENDIX D
SIMULATOR SCHEMATICS

(Provided by Simulation Entertainment Group, Inc.)



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Power
Internet
A1 Left SEG Persuader™ Actuator
A2 Right SEG Persuader™ Actuators
B AMC Servo Amps (left & right)
C Galil Amplifier
D Galil Controller
E Kill Switch
F Ethernet Hub
G Display (Simulator) PC
Display Components
Motion Base Components
H Pilot Joystick (Motion Pitch & Roll, Aircraft Direction)
I Pilot Collective (Aircraft Torque/Altitude)
J Rudder Pedals (Aircraft Yaw)
K Speakers (Audio System)
L Static Control Panel
M Projector (Visual System)
N Instructor Monitor
O Instructor Mouse
Instructor Workstation
Power
Control
P Instructor Keyboard
Q Desktop Sim PC
R Desktop Sim Monitor
S Desktop Sim Keyboard
T Desktop Sim Mouse
U Desktop Speakers
V Desktop Joystick (w/ Rudder & Collective)
Desktop Simulator Components
Motion Simulator Components
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APPENDIX E
MOTION PLATFORM SPECIFICATION

(Provided by Simulation Entertainment Group, Inc.)

TWO-AXIS-PLUS™ SPECIFICATIONS

MECHANICAL

Weight.. 350 lbs. (159 Kg)
Payload .... <=1000 lbs. (<= 455 Kg)
Platform Dimensions:
With Legs..............................61.5" W x 98.5" L x 24" H (1562mm x 2502mm x 610mm)
Footprint..42 sq.ft. (3.91 sq.m.)
Without Legs..................................24" W x 36" L x 24" H (610mm x 914mm x 610mm)
Footprint.. 6 sq.ft. (0.56 sq.m.)
Actuation.. (2) Proprietary SEG Persuader™ Electro-Mechanical Actuators, 2:1 Gear Ratio w/ Belt Drive
PERFORMANCE
Max. Pitch Angle...43° front, 67° rear
Max. Pitch Acceleration... 290°/sec2
Max. Pitch Velocity.. 62.5°/sec
Max. Roll Angle... 43° right, 43° left
Max. Roll Acceleration.. 290°/sec2
Max. Roll Velocity... 62.5°/sec
Heave (incidental)... 1" (25mm)
ELECTRICAL/CONTROL
Motors.............................. 1.5 hp DC Servo Motors w/ Digital Optical Encoder Feedback
System Power.. 110/220VAC, 60Hz, Single Phase input
Connectors / Cables.. Mil-Spec quick-disconnect / shielded
Control Box Electronics……............................... Fully integrated & patented digital servo electronics, rack-mount, fan-cooled enclosure
Computer Interface.. Ethernet T-base 10, USB and/or RS-232/485
Motor Interface......................... Galil Motion Controller w/ Ethernet, AMC 20KHz servo amplifiers w/ thermal overcurrent and undervoltage protection, 8-bit digital input @ ±5 VDC, motor DC supply @ 12-48 VDC, Logic Power @ 7.5-12 VDC, 500 mA max, user-adjustable optical limit switches
User Interface.. Proprietary motion software & GUI w/ user-definable: velocity, acceleration, database interface performance,washout, latency, stop points, home position; local & remote control; emergency stop; on-screen feedback provides user with accurate indications of motion base performance and status
Computing System…............................. PC or Apple G4/5; Windows NT/2000, Linux or Apple OS.X
* These figures are approximations in lieu of independent test data.

APPENDIX F MOTION PLATFORM SIMULATOR SETUP INSTRUCTIONS

(Provided by Simulation Entertainment Group, Inc.)

BE ADVISED that this is a temperamental $100,000 prototype system (and the only one in existence), and SEG would appreciate it if you treated it better than if it was your own...

DO NOT MAKE ANY ADJUSTMENTS TO THE SOFTWARE (AFFECTING SYSTEM PERFORMANCE) WITHOUT SEG'S PERMISSION - INJURY COULD RESULT

PLEASE FAMILIARIZE YOURSELF WITH THESE PROCEDURES PRIOR TO TURNING ON THE SYSTEM, AND FOLLOW THESE DIRECTIONS PRECISELY - FAILURE TO DO SO MAY DAMAGE THE SYSTEM:

Power-Up:

1) Turn on the system computer, display & monitor:

a) Turn on power strip "A" (under the computer in the back of the display cabinet)

b) Turn on the LCD projector (hanging upside-down in the middle of the display cabinet)

i) the LCD's START button is in the back of the unit (closest to you), under it, on the right-hand side (put your hand below where the monitor cable is attached to the projector) - it's a large (1/2") round button (you can't miss it)

ii) push it once (the projector will "beep" - within 10-15 seconds, you should begin to see an image on the screen)

iii) if the computer freezes, just hit the "reset" button on the front of the CPU (the smaller & lower of the two oval buttons)

2) Turn on the motion system:

a) Turn on power strip “B” (to the left of the system monitor)

i) IN CASE OF EMERGENCY, IMMEDIATELY TURN OFF THIS SWITCH - IT WILL CUT POWER TO THE MOTION SYSTEM WITHOUT DAMAGING THE SYSTEM (OR ANYONE IN IT)

b) Remove the support board under the nose of the simulator

3) Enable the motion simulator system:

a) Enter your “User” password at the “login” screen (you must be approved by Mark Stoklosa and SEG prior to receiving a password from SEG)

b) Once the desktop appears, double-click the “Motion Software Interface” icon

4) Center the motion simulator system:

a) Once the motion GUI appears (green and black), choose “Manual Controls”

i) Manually move the simulator (by eye) to CENTER position (by clicking on the

“forward” or “back” buttons under the “pitch” bar, and the “left” and “right”

buttons under the “roll” bar) - just clicking once will move the system a little,

holding the button down will move it a lot - CAUTION: DO NOT ATTEMPT TO MOVE THE SYSTEM MORE THAN NECESSARY TO MAKE IT CENTERED, MAKE A BEST EFFORT TO MAKE SURE THAT THE SYSTEM IS CENTERED (it’s best to have someone close to the base guide your inputs) BOTH pitch and roll (they must both read "Center" before you can continue)

5) Enable X-Plane:

a) On the desktop (leave the "Motion Simulator Interface" GUI up!), double-click the "XPlane 7" icon (Blackhawk in Burbank is the default)

b) Once X-Plane is up

i) Pause (P)

ii) Alt-Tab - to go back to the "Motion Simulator Interface" GUI

c) Go to "Simulator Settings"

i) Click "Connect to X-Plane"

(A) The system should not move. If it does:

(1) If it's major (pitching all the way down or rolling all the way over), hit the EMERGENCY SWITCH IMMEDIATELY, exit X-Plane and the "Motion Simulator Interface", then re-open the "Motion Simulator Interface" and manually home the system

(2) If it's minor (less than a couple degrees in any direction), then you will

need to recalibrate the system in X-Plane

6) Calibrate the joystick controls:

a) Once X-Plane starts, pull the trigger (or hit "P") to PAUSE

b) Under "Settings / Joystick & Equipment", follow the instructions to calibrate the

joystick/cyclic, rudder pedals and collective.

7) Start flying! (pull the trigger or hit “P”)

To Exhibit Motion Platform Performance (Administrator ONLY!):

1) In “Motion Simulator Interface”, go to “Manual Controls”

a) Use mouse to change bar settings up to 100%

b) Use “Back/Front” or “Left/Right” buttons (BE CAREFUL! JUST TAP THE BUTTONS IN HIGHEST MODE!), or, select “Connect to Joystick” (BE CAREFUL! SYSTEM MUST BE SECURED TO FLOOR!)

c) When finished, exit “Motion Simulator Interface” (DO NOT SAVE - DEFAULT IS 26%)

2) Platform Settings - DON’T TOUCH!

3) Simulator Settings: Max Motion Speed - controls how fast/realistic the motion platform performs in relation to the flight model

Power-Down:

1) Exit “X-Plane”

2) In the “Motion Simulator Interface” GUI, go to “Simulator Settings”

a) Click “Disconnect”

3) Go to “Manual Controls”

a) Click both (pitch & roll) “Center” buttons - this will move the system back to the original center position you chose

4) Place the nose support board under the nose of the simulator (PLEASE PLACE UNDER THE METAL SUPPORT - DO NOT PLACE UNDER THE FIBERGLASS - it will scratch it!)

5) Exit the “Motion Simulator Interface”

6) Turn off power strip “B”

7) Power down the PC(s) via Windows

8) Push the START button on the LCD projector TWICE (once to tell it to shut down, twice to turn off the lamp) -- DO NOT CUT POWER TO THE LCD PROJECTOR UNTIL THE PROJECTOR’S FAN HAS SHUT OFF - CUTTING THE POWER EARLY MAY DAMAGE THE ($350) LAMP

9) Turn power strip “A” off

10) Have a nice day! We hope that you will fly again with us, soon!

APPENDIX G
IMMERSIVE TENDENCIES QUESTIONNAIRE

Indicate your preferred answer by checking the box corresponding to your choice on the seven point scale. Please consider the entire scale when making your responses, as the intermediate levels may apply. For example, if your response is “once or twice”, the second box from the left (choice '2') should be marked. If your response is “many times but not extremely often,” then choice '6' (second box from the right) should be marked.

1. Do you easily become involved in movies or tv dramas?

1	2	3	4	5	6	7

Never Occasionally Often

2. Do you ever become so involved in a television program or book that people have problems getting your attention?

1	2	3	4	5	6	7

Never Occasionally Often

3. Do you ever become so involved in a movie that you are not aware of things happening around you?

1	2	3	4	5	6	7

Never Occasionally Often

4. How frequently do you find yourself closely identifying with the characters in a story line?

1	2	3	4	5	6	7

Never Occasionally Often

5. Do you ever become so involved in a video game that it is as if you are inside the game rather that moving a joystick and watching the screen?

1	2	3	4	5	6	7

Never Occasionally Often

6. How good are you at blocking out external distractions when you are involved in something?

1	2	3	4	5	6	7

Not very good Somewhat good Very good

7. When watching sports, do you ever become so involved in the game that you react as if you were one of the players?

1	2	3	4	5	6	7

Never Occasionally Often

8. Do you ever become so involved in a daydream that you are not aware of things happening around you?

1	2	3	4	5	6	7

Never Occasionally Often

9. Do you ever have dreams that are so real that you feel disorientated when you awake?

1	2	3	4	5	6	7

Never Occasionally Often

10. When playing sports, do you become so involved in the game that you lose track of time?

1	2	3	4	5	6	7

Never Occasionally Often

11. How well do you concentrate on enjoyable activities?

1	2	3	4	5	6	7

Not at all Moderately well Very well

12. How often do you play arcade or video games?

1	2	3	4	5	6	7

Never Occasionally Often

13. Have you ever gotten excited during a chase or fight scene on TV or in the movies?

1	2	3	4	5	6	7

Never Occasionally Often

14. Have you ever gotten scared by something happening on a TV show or in a movie?

1	2	3	4	5	6	7

Never Occasionally Often

15. Have you ever remained apprehensive or fearful long after watching a scary movie?

1	2	3	4	5	6	7

Never Occasionally Often

16. Do you ever become so involved in doing something that you lose all track of time?

1	2	3	4	5	6	7

Never Occasionally Often

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