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HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING:  
ANNUAL SUMMARY REPORT 1 September 82 - 31 August 83

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Anacapa Sciences, Inc.

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for

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U. S. Army

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This report presents a summary of the work performed under Contract No. MDA 903-81-C-0504, Human Factors Research in Aircrew Performance and Training for the Army Research Institute Field Unit at Fort Rucker, Alabama. The report contains summary descriptions for each of the 19 projects on which ASI personnel worked during the second contract year - from September 1, 1982 to August 31, 1983. Each summary description contains: (a) a background section that describes			
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the rationale for the research need and the project objectives, (b) a research approach section that describes the tasks and activities required to fulfill the project objectives, and (c) a project status section that describes the work completed, preliminary findings (if available), and the anticipated project completion date.

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## GLOSSARY OF ACRONYMS

AAPART	- Annual Aviator Proficiency and Readiness Test
ACE	- Aviation Contractor Employees
AFTP	- Additional Flight Training Period
AH	- Attack Helicopter
AHC	- Attack Helicopter Company
AHIP	- Army Helicopter Improvement Program
AN/PVS	- Army Navy/Pilot Visual System
ANVIS	- Aviator's Night Vision Image System
APS	- Applied Psychological Services
AQC	- Aviation Qualification Course
ARI	- U.S. Army Research Institute
ARNG	- Army National Guard
ARTEP	- Army Training and Evaluation Program
ASI	- Anacapa Sciences, Inc.
AT	- Annual Training
ATM	- Aircrew Training Manual
AVRADCOM	- Aviation Research and Development Command
AWO	- Aviation Warrant Officer
BOIP	- Basis of Issue Plan
CAS	- Close Air Support
CAV	- Constant Angular Velocity
CH	- Cargo Helicopter
CINC	- Commander in Chief
COI	- Course of Instruction
CPG	- Copilot/Gunner
CPT	- Cockpit Procedural Trainer
CTEA	- Cost and Training Effectiveness Analysis
DA	- Department of the Army
DARCOM	- Development and Readiness Command
DCD	- Directorate of Combat Developments
DCSOPS	- Deputy Chief of Staff for Operations
DCSPER	- Deputy Chief of Staff for Personnel
DES	- Directorate of Evaluation and Standardization
DIVARTY	- Division Artillery
DTD	- Directorate of Training Developments
FAAO	- Field Artillery Aerial Observer
FAC	- Flight Activity Category; Forward Air Controller
FAR	- Functional Arm Reach
FAST	- Flight Aptitude Selection Test
FLIR	- Forward-Looking Infrared
FORSCOM	- Forces Command
FM	- Field Manual
FS	- Flight Simulator
FTTD	- Full Time Training Duty
FY	- Fiscal Year
HEL	- Human Engineering Laboratory
HELLFIRE	- Helicopter Launched Fire and Forget Missile System
IERW	- Initial Entry Rotary Wing
IHADSS	- Integrated Helmet and Display Sight System
IP	- Instructor Pilot

IPR - In-Process Review  
 IRR - Individual Ready Reserve  
 JWG - Joint Working Group  
 LAF - Light Attenuation Filters  
 LHX - Light Helicopter Family  
 LL - Leg Length  
 MASSTER - Modern Army System Test and Evaluation Review  
 MILES/AGES- Multiple Integrated Laser Engagement and Air-Ground  
 Engagement Simulation  
 MILPERCEN - Military Personnel Center  
 MITAC - Map Interpretation and Terrain Analysis Course  
 MOI - Method of Instruction  
 MOS - Military Occupational Specialty  
 MTAB - Mission Track Assignment Battery  
 MUTA - Multiple Unit Training Assembly  
 NETT - New Equipment Training Team  
 NOE - Nap of the Earth  
 NVG - Night Vision Goggles  
 OB - Officer Battery  
 OH - Observation Helicopter  
 POC - Point of Contact  
 POI - Program of Instruction  
 PNVS - Pilot Night Vision System  
 PTDS - Preliminary Training Development Study  
 RA - Regular Army  
 R&D - Research and Development  
 RCPAC - Reserve Component Personnel and Administration Center  
 REFRAD - Release from Active Duty  
 RFAST - Revised Flight Aptitude Selection Test  
 ROC - Required Operational Capability  
 SCAT - Scout-Attack  
 SFTS - Synthetic Flight Training System  
 SH - Sitting Height  
 SIP - Standardization Instructor Pilot  
 SME - Subject Matter Expert  
 TADS - Target Acquisition and Detection System  
 TC - Training Circular  
 TDS - Training Development Study  
 TEC - Training Extension Course  
 TH - Training Helicopter  
 THESIS - Training Helicopter Initial Entry Students in Simulators  
 TNOD - Training Night Operations During Daylight  
 TRADOC - Training and Doctrine Command  
 UH - Utility Helicopter  
 USAARL - U.S. Army Aeromedical Research Laboratory  
 USAAVNC - U.S. Army Aviation Center  
 USAREUR - U.S. Army Europe  
 UT - Unit Trainer  
 UTA - Unit Training Assembly  
 UTM - Universal Transverse Mercator  
 WOC - Warrant Officer Candidate  
 WOCB - Warrant Officer Candidate Battery

## INTRODUCTION

Anacapa Sciences, Inc. (ASI) is under contract to provide on-site research support to the Army Research Institute (ARI) Field Unit at Fort Rucker, Alabama. This contract (Contract No. MDA903-81-C-0504) commenced on 1 September 1981 and is scheduled to terminate on 31 August 1985. One of the contract requirements is to prepare a Yearly Summary Report that presents a brief description of each project that ASI personnel worked on during the contract year. This report, prepared to fulfill that requirement, describes the projects on which ASI personnel worked during the second contract year--1 September 1982 through 31 August 1983.

This report contains summary descriptions for each of the 19 projects on which ASI worked during the second contract year. Most project summaries follow the same format. Each summary begins with a background section that presents the information an uninitiated reader needs to understand the requirement for the project. Also, if relevant, the background section describes the key events that led to the project's initiation. The background section is followed by a concise statement of the project objectives. When the need for the research cannot be inferred clearly from either the background or the objectives, the background section is followed by a statement of the need for the research.

The next section of the project summary, entitled "Research Approach," contains a moderately detailed description of what must be (or has been) done to accomplish the project objectives. For some projects, the research approach is an experiment in the strict sense of the word. For other projects, the research approach is a set of analytical or product-development tasks. In the research approach section, tasks and activities completed before the end of the first contract year are described in the past tense; tasks and activities planned but not yet completed are described in the future tense.



The final section of the project summaries describes the status of the project and, if available, preliminary findings. An attempt was made to provide the reader with an indication of when the project work will be completed and when the project results will be documented in a preliminary or a final report. Readers who need information that is more current or more detailed than is presented in this report are invited to contact Mr. Charles A. Gainer, Chief, ARI Field Unit. His address and phone number are shown below.

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It is important to point out that the projects summarized in this report represent only a portion of the projects presently under way at the ARI Fort Rucker Field Unit; ARI's research program also includes numerous projects that are the sole responsibility of ARI personnel.

The names and titles of members of ASI's Fort Rucker research team are listed below. Also listed are the ARI personnel who serve as the point of contact (POC) for one or more of the projects summarized herein. Every POC worked closely with ASI personnel and provided both technical direction and administrative support during all phases of the effort.

- Dr. Kenneth D. Cross, Program Manager
- Mr. Theodore B. Aldrich, Project Director
- Ms. Elinor F. Cunningham, Project Director
- Dr. Dennis H. Jones, Project Director
- Dr. Sandra S. Martin, Project Director
- Mr. Steven L. Millard, Project Director
- Dr. Kathleen A. O'Donnell, Project Director
- Dr. John W. Ruffner, Project Director
- Mr. Daniel T. Wick, Project Director
- Mr. Walker Craddock, Operations Research Analyst
- Mr. Claude O. Miles, Research Associate
- Mr. David G. Russell, Data Analyst
- Ms. C. Nadine McCollim, Technical Assistant
- Mrs. M. Ernestine Pridgen, Technical Assistant

- Dr. Jack B. Keenan, Project Director (left ASI Aug 83)
- Dr. Robert E. Lockwood, Project Director (leaving ASI Sep 83)
- Mr. Ronald J. Cohen, Research Associate (left ASI Dec 82)
- Miss Susie Britt, Data Processor (left ASI Feb 83)

- Dr. William R. Bickley, ARI POC
- Mr. William R. Brown, ARI POC
- Dr. Jack H. McCracken, ARI POC
- Dr. Michael G. Sanders, ARI POC
- Dr. Brian D. Shipley, Jr., ARI POC
- Dr. Robert H. Wright, ARI POC

**DEVELOPMENT OF A SEPARATION FORM FOR  
ARMY AVIATION WARRANT OFFICERS**

Dr. Sandra S. Martin, Project Director

**BACKGROUND**

In October 1979, Warrant Officer Division, U. S. Army Military Personnel Center (MILPERCEN), requested that ARI provide research support to investigate an apparent trend toward decreased retention of aviation warrant officers (AWOs). The request stemmed from retention data obtained by MILPERCEN that indicated a significant decrease in retention of first-term AWOs. These AWOs leave the Army at the end of the three-year obligation incurred by attending the Army's Initial Entry Rotary Wing (IERW) flight training program. This career point is the first opportunity for AWOs to separate from the Army following completion of flight training.<sup>1</sup>

Specifically, the retention data indicated that, for the AWOs who completed training during the period fiscal year (FY) 1973 through FY 1975, retention beyond initial obligation remained relatively stable at approximately 65 percent. For the AWOs who completed flight training during FY 1976 and FY 1977T<sup>2</sup>, however, the retention rate at the same career point had declined to approximately 45 percent (Bills, 1979).

MILPERCEN was concerned that the increased rate of AWO attrition might signal the onset of an aviator retention problem that already was troubling the other military services. MILPERCEN also was concerned that a continued high rate of AWO separation might seriously reduce the Army's aviation readiness and combat effectiveness. The problem was exacerbated by the following additional considerations (Everhart & Sanders, 1981):

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<sup>1</sup>The initial obligation was extended from three to four years effective 1 October 1978.

<sup>2</sup>Beginning with FY 1977, the fiscal year was changed from 1 July through 30 June to 1 October through 30 September. FY 1977T represents the period 1 July 1976 through 30 September 1976 during which the transition to the new fiscal year concept occurred.

- the increasing costs of aviator training and replacement,
- the increasing aviation force structure needs,
- the limitations in aviator training rates, and
- a decreasing manpower pool for recruitment of aviators.

In response to MILPERCEN's request for research assistance, ARI conducted a worldwide survey of Army aviators. The survey used a questionnaire, constructed by ARI, to identify factors that contribute to attrition of AWOs. The questionnaire items were organized into two sections: a personal data section and a career factors section. Items in the personal data section were designed to provide information about the demographic characteristics, assignments, and career intentions of the respondents. Items in the career factors section were designed to determine the amount of influence that each of 46 factors have on AWOs' decisions to leave the Army.

During the four-month period from September to December 1980, approximately 900 AWOs and 300 commissioned officer aviators were surveyed. The AWOs were subsequently defined as retainees or attritees. The distinction was based on the AWOs' stated intentions to remain in or to leave the Army. Data provided by the survey identified demographic characteristics, such as age, rank, and Military Occupational Specialty (MOS), that are related to AWO attrition (Sundy, Ruffner, & Wick, 1981). In addition, the survey provided three different sources of information about the career factors that influence AWOs' decisions to leave the Army--AWO attritees (self-reports), AWO retainees (peer perceptions), and commissioned officer aviators (supervisor perceptions) (Rogers and King, 1981).

The ten most influential factors identified by the AWO attritees reflect three major areas of concern: (a) pay and benefits, (b) leadership and supervision, and (c) career and assignment factors (Rogers & King, 1981). These areas subsequently became the focus of a series of initiatives that were developed by MILPERCEN to enhance retention of AWOs. Included in the initiatives was an overall increase in flight pay, as well as equalization of flight pay between warrant officer and commissioned officer aviators (Morgan & Johnson, 1981).

## NEED/PROBLEM

Since the MILPERCEN initiatives were enacted, retention of AWOs has steadily increased. Feedback from individuals in the field suggests that the increase in retention is due to both the retention initiatives and a decline in the economy. A third factor that has contributed to a high rate of retention in recent months is the limited number of first-term AWOs who are eligible to leave the Army (due to the transition from a 3-year to a 4-year initial commitment, effective for AWOs who began training after 1 October 1978). Retention rates are expected to decline again, however, now that the 4-year AWOs are eligible to leave the Army and the economy is beginning to improve. These considerations, together with increasing aviator requirements and training costs, make AWO retention a continuing concern to the Army.

As part of its ongoing effort to improve retention of AWOs, MILPERCEN has tasked ARI to develop a separation questionnaire that will be administered to all AWOs who leave the Army. The questionnaire will provide a mechanism for the continuous assessment of AWO retention in the future. Specifically, information provided by the questionnaire will be used to implement and maintain a continuous, closed-loop feedback system that will provide MILPERCEN with current information about (a) the number and types of AWOs who separate from the Army, and (b) the type and importance of factors that influence AWOs' decisions to leave the Army. This information, in turn, can be used by the Department of the Army as an aid in activities such as:

- determining the number of aviators, by MOS, that must be trained for replacement,
- planning and projecting the AWO personnel strength, and
- developing and assessing Army policies that impact on retention of AWOs.

Major users of the information include MILPERCEN, the Deputy Chief of Staff for Personnel (DCSPER), and the U. S. Army Aviation Center (USAAVNC).

## PROJECT OBJECTIVES

The project has four specific research objectives. The objectives are as follows:

- to identify the factors that historically have been related to military aviator retention,
- to develop a preliminary version of the separation questionnaire,
- to conduct pretests of the preliminary questionnaire and use the resulting information to develop the final version of the separation questionnaire, and
- to develop and implement a data analysis plan for analyzing data yielded by the separation questionnaire.

## RESEARCH APPROACH

The initial step in developing the questionnaire is an extensive review of contemporary retention research. Since the separation questionnaire is designed specifically for AWOs, the literature review focuses on investigations of military aviator retention.

The primary purpose of the literature review is to determine the factors that historically have been related to retention of military aviators. These factors help define the types of items the questionnaire must contain to yield the necessary data about AWO attrition. Two additional sources used to define the information requirements are (a) interviews of AWO attritees and subject matter experts (SMEs), and (b) reviews of existing Air Force and Navy separation questionnaires.

Once the information requirements had been defined, specific items representative of each of the major types of information were designed. The items were then compiled to form a preliminary version of a four-part separation questionnaire. Part I of the questionnaire contains items designed to determine the demographic characteristics of AWOs who separate from the Army. Parts II and III consist of career factors that are rated by respondents on a 7-point numerical scale. In Part II, the respondents rate each career factor to indicate their opinion about the extent to which the factor affects job satisfaction. In Part III, the

respondents rate the same career factors to indicate the influence that each factor had on their decision to remain in or to leave the Army. Part IV contains items designed to yield feedback about the suitability of the questionnaire's content and format.

A field test of the preliminary questionnaire will be conducted throughout FY 1984. The field test data will be collected from two criterion groups--attritees and retainees. Attritees are defined as:

- first-term attritees--AWOs who leave the Army at the end of their initial obligation,
- REFRADs--AWOs with more than four years but less than 20 years of active military service who request release from active duty (REFRAD), and
- voluntary retirees--AWOs who have Regular Army (RA) career status and who voluntarily retire prior to mandatory retirement at 30 years of active military service.

Retainees are defined as:

- first-term retainees--first-term AWOs who remain in the Army beyond their initial obligation, and
- mandatory retirees--AWOs who remain in the Army until mandatory retirement at 20 years (Reserve Component) or 30 years (Regular Army Component) of active military service.

Potential respondents in each of the criterion groups have been identified by MILPERCEN. The questionnaire will be administered to all the AWO attritees and to a selected sample of AWO retainees at each of 17 major Army aviation installations. Local POCs at the field test installations will administer the questionnaire and return the completed forms to ARI.

Following completion of the field test, the data will be analyzed and the results will be used to produce the final version of the separation questionnaire. Particular emphasis will be given to the inclusion of items that (a) are shown in statistical analyses to discriminate between AWO attritees and AWO retainees, and/or (b) are identified as having particular relevance for Army personnel and policy decisions.

Once the final questionnaire is developed, it will be submitted to MILPERCEN for Army-wide administration to all AWOs leaving the Army.

Information provided by the questionnaire will be analyzed to produce quarterly reports of AWO losses to the Army and the factors influencing the AWOs' decisions to leave the Army.

## PROJECT STATUS

### Work Completed

The preliminary version of the separation questionnaire has been developed. Initial feedback about the preliminary questionnaire has been derived through the project director's personal administration of the questionnaire and interviews with the respondents.

Further field test data collection from AWOs who leave the Army at the end of their initial obligation has been delayed until October 1983. The delay is necessary because of the year of ineligibility for attrition of first-term AWOs. The period of ineligibility is due to the transition from a 3-year to a 4-year initial commitment in FY 1979.

The potential field test AWOs have been identified, and demographic data about the AWOs have been entered into a computerized subject file. The file permits selection of the AWOs who are located at each of the field test installations. The POCs who will administer the questionnaire to the field test AWOs have also been identified. Instructional packets describing the POCs' responsibilities have been prepared and are ready for mailing.

A summary report of ARI's AWO retention research has been written. The report presents an overview of past research, research currently in progress, and projections for future research (Martin, 1982). In addition, an article entitled "Aviation Warrant Officer Retention: A Continuing Effort" was published in the April 1983 issue of the U. S. Army Aviation Digest (Martin and Washer, 1983). The primary purpose of the article is to inform the aviation community about the Army's continuing AWO retention effort and about ARI's ongoing program of research on AWO retention.



### Projected Date of Completion

The field test of the preliminary questionnaire will be conducted throughout FY 1984. During the first quarter of FY 1985, the field test data will be analyzed and the results used to produce the final questionnaire. Current projections are that the final questionnaire will be available for implementation during the second quarter of FY 1985.

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DEVELOPMENT OF A 1984-85 VERSION OF THE  
ARMY FLIGHT APTITUDE SELECTION TEST

Dr. Robert E. Lockwood, Project Director

BACKGROUND

This research project is a part of a continuing ARI program to ensure that the Army's procedures for selecting applicants for IERW flight training remain effective and valid.

The Army's initial selection device--the Flight Aptitude Selection Test (FAST)--was developed during the 1950s in response to the problem of unacceptable attrition from the flight training program. The FAST was composed of two batteries--an Officer Battery (OB) and a Warrant Officer Candidate Battery (WOCB); each battery yielded a fixed-wing and a rotary-wing aptitude score for each applicant (Kaplan, 1965). The FAST was implemented in 1966 and resulted immediately in a reduction in attrition.

In 1974, a decision was made to revise the FAST. By that time, the Army had ceased to train initial entry students in fixed-wing aircraft, so there was no longer a need for the fixed-wing aptitude scores from the FAST. A more important motive for revising the FAST was the desire for a single test battery that can be used for all applicants and that contains fewer, shorter, and more easily scored subtests. The revision was based on (a) a factor analysis of both FAST batteries, and (b) a regression analysis of the FAST subtests. The resulting battery--the Revised Flight Aptitude Selection Test (RFAST)--contains seven subtests from the FAST; each subtest contains approximately one-half the items from the original FAST subtest (Eastman & McMullen, 1978a). The FAST subtests and items used in the RFAST were selected because of their predictive validity. That is, the subtests that correlated most highly with successful performance in IERW were selected as subtests for the RFAST. Then, the items on each subtest were reduced in number by selecting items that had the highest item validities until each subtest was approximately one-half its original length. The RFAST became operational in 1980.

## PROJECT OBJECTIVES

The ultimate objective of this project is to develop a more effective version of the Army's RFAST. The specific technical objectives of this research are as follows:

- determine an appropriate criterion measure for skill acquisition during IERW,
- conduct a detailed statistical analysis of the RFAST,
- identify requisite abilities necessary to successfully complete IERW,
- identify the abilities being assessed by the RFAST and the proposed Mission Track Assignment Battery (MTAB), and
- develop a future version of the Army's FAST with all ancillary materials.

## RESEARCH APPROACH

The first phase of this research is aimed at evaluating the RFAST in two ways. One evaluation is designed to assess how well the RFAST items, subtests, and the battery as a whole are working. The analyses required to conduct such an evaluation are (a) an item analysis of the 200 items in the RFAST, (b) computation of reliability coefficients for each subtest and for the total battery, and (c) computation of validity coefficients for individual subtests and for the total battery. The criterion measure used to validate the FAST and, subsequently, the RFAST is simply whether or not a student graduated from the training program (Eastman & McMullen, 1978b). Since pass vs. fail is an insensitive criterion for use in estimating the predictive validity of a selection test, there is a pressing need to identify or derive a better criterion measure to use in evaluating the RFAST.

The second evaluation is designed to assess the extent to which the RFAST tests the full range of abilities that are required to complete IERW training. This evaluation requires (a) the conduct of an abilities analysis to identify the requisite abilities and to quantify their relative importance, and (b) the conduct of an analysis to identify the requisite abilities that are measured by the RFAST and those that are not.

The second phase of this research consists of traditional test development activities. Based on the item analysis data, the current subtests from the RFAST to be included in the future RFAST will be modified as necessary to increase reliability and validity. Using the data from the abilities analysis, additional subtests will be developed for inclusion in the future version of the RFAST. Once the updated version is developed, a pretest will be conducted to ensure that the test is functioning as designed. Following the pretest, statistical analyses will be conducted to document the reliability and validity of the updated version. The final activity will be to compile two parallel versions of the updated RFAST and to develop all ancillary materials, including answer sheets, test administration manuals, directions, and scoring keys.

#### PROJECT STATUS

##### Work Completed

The statistical analysis of the RFAST has been completed. The item analysis data indicate that the current RFAST is a heterogeneous battery composed of six homogeneous subtests and one heterogeneous subtest. The one heterogeneous subtest, Self-Description, appears to be unrelated to total battery scores. With the exception of the Self-Description subtest, all subtests were found to have acceptably high reliability coefficients--ranging from .64 to .88. The reliability coefficient for the total battery was .90.

Considerable effort was expended in evaluating criterion measures that promise to be more efficient than pass vs. fail. This effort resulted in the derivation of a measure of benefit resulting from exposure to training (Shipley & Lockwood, 1983). The measure of benefit is a transformed ratio of actual flight time to scheduled flight time. This benefit criterion measure was used to investigate the validity of the RFAST as a predictor of success in IERW. This analysis yielded a validity coefficient of .21 for the initial sample and .11 for the cross-validation sample (Officers and Warrant Officer Candidates [WOCs]

combined). Separate analyses for Officers and WOCs yielded validity coefficients of .24 and .26, respectively.

A procedure for identifying the abilities required to successfully complete IERW was developed and data collection/analysis has been completed. This procedure required experienced IERW instructor pilots (IPs) to define the critical tasks that are most indicative of successful performance in the primary and the instrument phases of IERW and to judge the type and importance of the abilities that are required to perform each of the critical tasks. Fleishman's ability definitions and rating methods were used (Theologus, Romashko, & Fleishman, 1970) in tapping IP judgments of requisite abilities. Concurrently, individuals who are both experts in test development and thoroughly familiar with the RFAST were required to rate the type and relative importance of the abilities assessed by the RFAST. Once both sets of rating data were in hand, an analysis was performed to identify the requisite abilities that are not assessed by either the RFAST or the MTAB. (The MTAB is a battery of tests that has been developed by Myers, Jennings, and Fleishman (1982) for use in assigning aviators to training in the different types of helicopters in the Army's inventory.)

The composite results of the analyses described above have been used to identify potential areas for RFAST modification and additional test development. A preliminary test specification matrix has been developed to guide future efforts to refine existing RFAST items/subtests and to augment the RFAST with additional tests.

#### **Projected Completion Date**

A research report that fully describes the statistical analysis of the RFAST will be completed by 30 September 1983. The report is an evaluation of the RFAST as a predictor of performance in IERW. A second research report on the development of the preliminary test specification matrix will also be available by 30 September 1983. Efforts to refine and augment the RFAST will continue through FY 1986.

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## VALIDATION OF AIRCREW TRAINING MANUAL REQUIREMENTS

Dr. John W. Ruffner, Project Director

### BACKGROUND

With the passage of the Aviation Career Incentive Act of 1974, Congress and the General Accounting Office imposed on all military services a requirement to "justify" their flying-hour programs in order to receive continued funding. In June 1976, the Comptroller General of the United States reviewed the flying-hour programs of the military services and criticized the Army's inability to justify its program. The other services were able to show how flight hours were being used, but the Army was unable to satisfactorily document the use and benefits of the 80 flying hours allotted annually for each aviator.

As a result of the Comptroller General's report, the Vice Chief of Staff of the Army directed that a task force be formed to develop a program that specifies, for each type of aircraft, how the flight hours allocated annually should be used to maintain individual proficiency and combat readiness. A task force from the Army Training and Doctrine Command (TRADOC) was created in 1976 to develop the Aircrew Training Manual (ATM) program (Lovejoy & Presley, 1980).

An ATM was developed for each operational aircraft in the Army inventory. The ATM for each aircraft lists (a) the individual flying tasks that must be satisfactorily performed during qualification training, mission training, and refresher training, (b) the flight hours and academic hours allotted to specific subject areas within each type of training, and (c) the standards for the satisfactory performance of each flight task. In addition, the ATM specifies the minimum number of times each ATM task should be performed (i.e., practice iterations) and the minimum number of hours that should be flown by mission-ready aviators during each six-month period of continuation training. The purpose of continuation training is to maintain aviator currency and individual proficiency in an aircraft.

The minimum number of iterations and flight hours required to fulfill the ATM continuation training requirements depends on the Flight Activity Category (FAC) selected for the aviator by the unit commander. Aviators who are placed in FAC 2 positions need only fly the number of iterations and flight hours required to maintain proficiency in basic flight tasks. Aviators placed in FAC 1 positions must be capable of performing combat, combat support, or combat service support missions. Hence, FAC 1 aviators must maintain proficiency in both (a) basic flight tasks and (b) the tactical tasks appropriate for the type of aircraft flown (e.g., utility) and the mission of the unit to which the aviator is assigned (e.g., troop support).

Unit commanders are responsible for establishing a training-task list for each FAC 1 and FAC 2 position (Department of the Army, 1980). Ordinarily, the unit commander's training-task lists correspond closely with the task lists presented in the ATMs. However, training tasks may be added to or deleted from the ATM task lists if the commander judges that such additions/deletions will enhance the aviators' combat readiness.

#### NEED

The ATM iteration and flying-hour requirements were subjectively estimated by the subject matter experts (SMEs) who served on the TRADOC task force. The number of iterations for each task and the number of flying hours specified in the ATMs represent the SMEs' best estimate of the minimum necessary to maintain individual flight proficiency over a six-month period of continuation training. However, until now, no attempt has been made to confirm empirically the SMEs' subjective estimates. Since the cost of flying hours continues to increase, a need exists to determine empirically the minimum number of ATM task iterations and the minimum number of flying hours required to maintain individual flight proficiency. Empirical data on the iteration and flight-hour requirements are needed to help Army decision-makers determine the most effective ways to use the limited number of flying hours available to them.



In 1980, ARI was tasked by the Aviation Center Directorate of Evaluation and Standardization (DES) to validate the semiannual ATM task-iteration requirements for continuation training.

#### PROJECT OBJECTIVES

The ATM Requirements Validation research has three specific objectives:

- to determine whether or not the minimum number of semiannual task iterations specified in the ATMs are appropriate for the maintenance of individual aviator proficiency on FAC 2 tasks,
- to identify the tasks for which changes in the iteration requirements are needed to achieve training effectiveness, and
- to determine if the number of iterations required to maintain proficiency depends on the total number of flight hours an aviator has logged during his career.

#### RESEARCH APPROACH

Because of time and resource constraints, the scope of the ATM Requirements Validation project was limited to the investigation of semiannual task iteration requirements for a FAC 2 continuation training program. Iteration requirements for FAC 2 aviators apply directly to FAC 1 aviators, who also must maintain proficiency in FAC 2 tasks.

A field experiment conducted at USAAVNC, Fort Rucker, was designed to meet the project objectives. A total of 79 staff aviators assigned to FAC 2 positions served as subjects in the experiment. Staff aviators were selected as subjects because they do not fly as a regular part of their duty assignments, but are required to meet ATM semiannual task iteration and flying hour requirements.

The subjects were assigned to one of four groups--a control group and three experimental groups--such that the mean number of rotary wing flight hours logged prior to the outset of the study was approximately the same for each group. At the beginning of the six-month period, subjects were given initial checkrides by USAAVNC Standardization Instructor Pilots (SIPs) to establish their baseline level of performance.

Subjects assigned to the control group were prohibited from all flying during the six-month period following the initial checkride. Subjects assigned to the three experimental groups were required to complete either two, four, or six practice iterations of 47 FAC 2 contact and terrain flight tasks during the six-month period. All practice iterations were performed in the UH-1 helicopter. The UH-1 is the aircraft used by the majority of FAC 2 aviators to maintain proficiency. Fourteen of the tasks were procedural tasks; 33 were psychomotor tasks.

Half the subjects assigned to an experimental group were scheduled to fly during the first three months of the test period; the other half were scheduled to fly during the second three months. Staff IPs supervised and graded performance on all practice flights.

At the end of the six-month period, each subject was given a final checkride by an SIP to measure level of performance on each of the tasks. Performance data were collected during both checkrides and practice flights. Practice flight data were retained for later analysis.

In addition to flight performance data, data were collected on the aviators' confidence in their ability to perform each task. Aviators rated their confidence to perform each task to ATM standards both before and after the initial and the final checkride. Confidence data were analyzed to determine the relationship between confidence level and checkride scores at the beginning and at the end of the test period.

## **PROJECT STATUS**

### **Work Completed**

All data have been collected and analyzed. The data analysis procedures and results are summarized in the following paragraphs.

For the purpose of data analysis, subjects were divided into two flight-hour groups of approximately equal size: (a) those with less than 900 total rotary wing flight hours, and (b) those with more than

900 hours. Analysis of initial checkride scores indicated that there were no significant performance differences among the control and experimental groups prior to the six-month test period.

Performance data were analyzed in an analysis of variance using checkride scores as the dependent variable. The number of iterations and flight hour groups were treated as between-subjects independent variables; tasks and checkrides (initial and final) were treated as within-subject independent variables.

The results show that there is no significant difference between average pretest and posttest performance scores for either control-group or experimental-group subjects. In other words, the performance of the control-group subjects (no practice) did not degrade significantly during the six-month period; nor did the performance of experimental-group subjects improve as a result of the practice iterations they received. This finding is true regardless of the number of total rotary wing flight hours logged and whether the tasks are psychomotor or procedural. The data suggest that, during a six-month training period, proficiency on the 47 contact and terrain flight tasks evaluated does not degrade appreciably even with no practice whatsoever. The results are consistent with previous research on the retention of psychomotor flight skills (e.g., Mengelkoch, Adams, and Gainer, 1960; Prophet, 1976).

Factor analysis of the final checkride performance data suggests that there are six independent sets of tasks that underly overall checkride performance. The descriptive labels for the task sets are listed below:

- emergency tasks,
- terrain flight tasks,
- hovering tasks,
- high-angle approach tasks
- procedural tasks, and
- basic airwork tasks.

Overall performance can be estimated reliably using as few as ten tasks sampled from the six task groups.

Overall checkride performance at the end of a six-month period is not reliably predicted by (a) the number of hours flown by the subjects during the last six or 12 months, (b) initial checkride scores, (c) the length of the no-practice period, or (d) aviators' self-rated confidence. In short, the results of this research do not support the requirement for aviators to perform the current minimum number of ATM FAC 2 contact and terrain flight task iterations over a six-month continuation-training period. However, sufficient data are not available to generalize the results to (a) training periods longer than six months, or (b) instrument tasks, emergency tasks, night tasks, or mission-specific tasks.

The draft final report for the ATM Requirements Validation project has been completed. The draft report has been formally reviewed by ARI and has been revised, based on comments made by the reviewers.

#### Projected Completion Date

The final report will be submitted to ARI on 2 November 1983.

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**REVISION/VALIDATION OF THE INDIVIDUAL READY RESERVE  
AVIATOR PROGRAM OF INSTRUCTION: UH-1 AIRCRAFT**

Mr. Daniel T. Wick, Project Director

**BACKGROUND**

It has been estimated that between 1.3 and 1.8 Army rotary wing aviators per cockpit seat would be required to sustain operations in any major conflict (Department of the Army, 1979). Currently, there is only one active duty aviator per aircraft seat in the Army inventory. This shortfall of Army aviators would be made even greater by a migration of officers from flying positions to staff positions during a major mobilization.

In 1978, the Department of the Army created the Individual Ready Reserve (IRR) Aviator Training Program as a means for eliminating the aviator shortfall that otherwise would exist during a major mobilization. The IRR Aviator Training Program is designed to fill the cockpit seats with individuals who once served successfully as Army aviators but subsequently chose not to remain on active duty. The fundamental premise underlying the IRR Aviator Training Program is that it is less costly to retrain former aviators and to maintain their flying skills through periodic refresher training than it is to train and to maintain a larger force of active duty aviators.

The Reserve Component Personnel and Administration Center (RCPAC) was given the responsibility for administering the IRR Aviator Training Program. This program differs from the Army Reserve and National Guard in that the IRR Aviator Training Program requires participation only during a single period each year, rather than the monthly participation required by the other reserve programs. As initially designed, the program required that an IRR aviator be assigned to a specific field unit and that he report to his assigned unit for a 19-day training period once each year at the outset of the program. Each unit commander was made responsible for developing a program to train the IRR aviator assigned to his unit. This arrangement proved unsuitable because RCPAC

had no means of standardizing or evaluating the type and quality of training that the IRR aviator received at his assigned unit.

In 1979, the Deputy Chief of Staff for Operations (DCSOPS), in conjunction with Forces Command (FORSCOM) and RCPAC, requested the ARI Field Unit at Fort Rucker to develop a standardized IRR Aviator Training Program. The specific tasks that ARI was requested to accomplish are as follow:

- to evaluate the amount of deterioration in the flying skills of IRR aviators,
- to determine the amount and nature of training needed to correct this deficiency, and
- to develop a program for accomplishing the required training in a cost-effective manner.

ARI personnel commenced work on the assigned project by conducting a mail survey of (a) IRR aviators who had attended one or more on-site training periods, and (b) active duty personnel who had been directly involved in training one or more IRR aviators. The survey resulted in two clear-cut and important findings. First, it was found that the flying skills of the typical IRR aviator had deteriorated substantially during the period he had been away from active duty. Although the survey provided no precise measure of the amount and type of skill deterioration, the results clearly indicated that a significant amount of refresher training would be necessary to increase IRR aviators' flying skills to an acceptable level. Second, the survey results showed that the type and amount of training received by IRR aviators varied greatly from one installation to another. Training at some installations consisted of little more than self-study of military publications. At other installations, the entire training program consisted simply of passive rides in the copilot seat of a helicopter during routine mission-training exercises. Overall, there was an apparent lack of a standardized and systematic training program.

The survey results and information from SMEs were used by ARI personnel to develop a preliminary version of a Program of Instruction (POI) for the IRR Aviator Training Program (Allnutt & Everhart, 1980;

Everhart & Allnutt, 1981). The POI consisted of two training phases. Phase I consisted of training in basic flight maneuvers and in academic study of a wide range of topics. Phase II consisted of refresher training on Phase I maneuvers and academic topics, additional flight training in special and tactical maneuvers, and academic training in terrain analysis and map interpretation. All flight maneuvers trained in Phase I and Phase II were selected by FORSCOM for IRR aviators.

The preliminary version of the POI was used to train a sample of 17 IRR aviators on Phase I maneuvers; the 19 days of training were conducted at Fort Rucker by experienced IPs. One year after the Phase I training period, six of the original 17 aviators returned to Fort Rucker for 19 days of Phase II training. The preliminary version of the POI proved to be generally effective, but the results revealed a number of ways in which the POI could be improved. The POI was revised in accordance with these findings.

#### PROBLEMS

Copies of the second version of the POI were distributed to field units along with a questionnaire designed to provide feedback on the POI's effectiveness. IPs were requested to use the POI and complete the questionnaire. An analysis of the questionnaire results revealed that two problems clearly compromised the effectiveness of the POI.

- Due to the lack of preparation by IRR aviators prior to their arrival at the unit, an unacceptably large portion of the 19-day training period was spent studying academic topics.
- An excessive amount of IP time was required to complete the academic instruction specified in the POI.

It was the need to eliminate these problems that led to the initiation of the present project.

## **PROJECT OBJECTIVES**

This project was designed to address the problems revealed by the questionnaire results. The specific objectives of this project are as follows:

- to develop self-study materials that IRR aviators can use at home or at the unit training site to complete some or all of the academic preparation,
- to modify the academic portion of the POI to reduce the amount of IP time required to administer the training, and
- to evaluate the revised POI in a controlled environment.

## **RESEARCH APPROACH**

The research plan for the project identified five general tasks that must be accomplished to fulfill the objectives of this project. These tasks are discussed below under separate headings. A description of both the task and the outcome is presented for the tasks that had been completed by the end of the contract year.

### **Definition of Academic Training Requirements**

The purpose of this task is to define the academic topics that must be covered in the academic portion of the training program, and for each topic, to specify the specific knowledge that IRR aviators must possess in order to complete the course successfully. This task was accomplished by a team of SMEs composed of experienced IPs and experts in training technology.

The consensus of SME opinion was that the academic units for Phase I training should provide the student aviator the knowledge necessary to pass the pilot's oral examination as outlined in TC 1-135 (Department of the Army, 1980), the ATM for the UH-1 aircraft. It was also agreed that academic units for Phase II training would be limited to map interpretation and terrain analysis. The order, content, and number of academic units in the original POI were revised to cover more thoroughly the germane academic topics. The revised POI consists of 12 academic units for Phase I and five academic units for Phase II.



### Development of Academic Training Materials

The original POI required 80 hours of IP lectures to cover the academic topics. The primary objective of this task is to develop a training approach and requisite materials that eliminate the requirement for IP involvement in academic training. An approach considered highly desirable is to provide IRR aviators with the opportunity to complete some academic study at home, prior to their arrival at the unit training site. Another desirable approach is to provide the IRR aviators with self-study materials that they can study at the training site during proctored study periods. Since the amount of time IRR aviators will devote to home study is uncertain, a combination of the two training approaches is employed; that is, each IRR aviator will be provided an opportunity to engage in home study and an incentive for doing so. However, because the amount of home study cannot be controlled, the program must be designed such that all or any part of the academic training can be accomplished through self-study at the unit training site.

Another factor considered in developing academic training materials is that individual IRR aviators can be expected to differ greatly in their need for academic training. Individual differences in the need for academic training stem from differences in the amount of flight time logged by the aviators, differences in the time that has transpired since the aviators have flown regularly, and differences in the aviators' fundamental abilities. Hence, it is essential that academic training materials be developed that enable individual aviators to (a) study only the topics on which their knowledge is deficient, and (b) proceed through the training as swiftly as their capabilities permit.

Three types of materials were developed: a comprehensive set of reference materials, a detailed study guide, and a set of diagnostic examinations. The use of the materials is explained in the following description of the general training concept.

- Step One--The reference materials and study guide, consisting of 12 units, are sent to the IRR aviator's home about four weeks before he is scheduled to arrive at the training site. The IRR aviator is instructed that home study is not mandatory but that time spent on home study will increase the amount of on-site time that can be spent on inflight instruction. Aviators who choose to engage in home study are instructed to complete the work specified in the study guide.
- Step Two--The IRR aviator is required to complete a diagnostic (paper-and-pencil) examination as soon as he arrives at the training site. The examination contains 12 subtests covering 12 academic topics. A score of 90% or greater on any subtest excuses the IRR aviator from further study on the academic topic covered by the subtest.
- Step Three--An IRR aviator who fails to score at least 90% on any subtest is required to complete the self-study material specified for that topic in the study guide. Once the self-study has been completed, the IRR aviator is required to take a second examination on the topic. Any IRR aviator who fails to score at least 90% on the examination is directed to review the study material more thoroughly and is tested again on the same topic. Any IRR aviator who fails to score at least 90% on the third examination is provided one-on-one tutoring by an IP until the IP judges that the IRR aviator has sufficient knowledge about the topic. This procedure is repeated until self-study of all 12 academic topics has been completed.

#### **Development of Inflight Training Plan**

The goal in developing an inflight training plan is to enable IRR aviators to relearn flying skills as rapidly as is commensurate with safety. The flying tasks/maneuvers to be taught were specified by FORSCOM. The Phase I tasks/maneuvers include most of the tasks/maneuvers that must be mastered to qualify for FAC 2 positions. The FAC 2 positions are flying assignments in which an aviator must maintain basic flying skills. The main exception is that no training is provided on instrument flight tasks. In Phase II, IRR aviators are provided refresher training on all Phase I tasks/maneuvers and are trained on a set of tactical and special tasks.

### **Conduct On-Site Evaluation of POI**

The objective of this task is to evaluate the POI's effectiveness when used to train a representative sample of IRR aviators under realistic training conditions. The research plan developed for this project stipulates that: (a) a total of 48 IRR aviators are to be trained at USAAVNC, Fort Rucker, Alabama; (b) each month for six consecutive months, a group of eight IRR aviators are to receive training on 19 consecutive days; c) the last group of aviators are to complete training on 19 November 1982; and d) the 48 IRR aviators are to return to USAAVNC for refresher training and Phase II training in 1983. Critical questions addressed by the evaluation are listed below.

- How much of the study guide will the average IRR aviator complete during home study?
- Are the study guide and reference material comprehensive in their coverage of academic topics?
- Are the study guide and reference material sufficiently clear and easy to use?
- How much time do aviators require to complete the self-study of each academic training unit?
- How many flying hours do IRR aviators require to relearn the requisite flying skills?

### **Revise the POI**

The objective of the final task is to use the information from the evaluation to refine the POI. The revision of the Phase I POI was completed in July of 1983. The revision of the Phase II POI is scheduled for completion in June of 1984.

### **PROJECT STATUS**

#### **Work Completed**

**First Year Aviator Training.** Forty-seven IRR aviators participated in training during the first year. Flight time for hands-on flight training averaged 21.0 hours per aviator. The aviators required approximately 20 hours of proctored self-study to complete their academic training.

**First Year Findings.** The 47 aviators trained in the first year of training varied widely in their demographic characteristics and flight experience. The age of the IRR aviators varied from 28 to 47 years, with a median age of 34 years. The flight time logged prior to the start of IRR training averaged 1622 hours, with a range of 235 to 5000 hours. The time that had transpired since the aviators left active Army service varied from one to 19 years, with a median of 7.5 years.

All aviators were able to pass the pilot's oral examination after completing the academic training portion of Phase I training. On the average, Phase I academic training required 9.8 days to complete, with a range of five to 18 days. Two demographic characteristics were related to the number of days required to complete Phase I academics. The number of hours required to complete Phase I academic training increased as a function of the number of years that had elapsed since the aviator left active Army service, and decreased as a function of the number of study guide units completed by the aviator prior to training. These two demographic characteristics were used in a mathematical equation that proved to be both statistically reliable and practically useful in predicting the days required to complete academic training. Total military flight experience was not related to the days required to complete academic training.

When given initial checkrides, the 47 aviators performed 14% of all tasks to ATM standards. On the average, 17 hours of flight training were required to relearn the flying skills needed to complete a Phase I checkride.

Two demographic characteristics were related to flight hours required to pass a Phase I checkride. The number of hours required to complete Phase I flight training increased as a function of the amount of time that had elapsed since the aviator had left active Army service, and decreased as a function of the aviator's total number of military flight hours. These two demographic characteristics were used in a second mathematical equation that proved to be both statistically reliable and practically useful in predicting the hours required to successfully pass a Phase I checkride.

Forty-five of the 47 aviators completed Phase II academics. Twenty-four of the 47 aviators also successfully completed a Phase II checkride during the first 19-day training period. The average flight hours required to complete Phase II training was 4.3 hours, with a range of 1.0 to 9.1.

The findings indicate that approximately 94% of all IP time is spent in flight training or related activities, such as preflight and debriefs. Most of the remaining 6% of an IP's time is devoted to administrative paperwork.

Student assessment of the program reveals that the POI is acceptable to IRR aviator trainees. Ninety-eight percent of the students indicated that the POI was adequate or more than adequate as a training program for IRR aviators.

The results of the first training year demonstrate that the program has significantly reduced the requirements made on IP training and, at the same time, greatly increased the amount of training accomplished during the 19-day training program. Using the previous POI, many IRR aviators were unable to complete all of Phase I training during the 19-day training period. In contrast, all of the aviators trained with the new POI were able to complete Phase I training and one-half of them were able to complete both Phase I and Phase II training during the first 19-day training period. It appears from these results that the revised POI is acceptable to the IRR aviators trained and should result in a significant reduction in both IP requirements and the time necessary to complete training.

**Second Year Aviator Training.** All 47 IRR aviators were contacted four months prior to the commencement of the second year of training to determine if they could participate in training. Twenty-nine of the aviators were available for the second year of training. Most of the remaining aviators were unable to attend due to civilian job conflicts or because they had joined reserve units. The first class of IRR aviators commenced training in June 1983. By the end of the second contract year, 13 aviators had participated in the second year of

training. Time for hands-on flight training averaged 21 hours per aviator. The aviators required an average of 20 hours of proctored self-study to complete their academic training.

**Second Year Preliminary Findings.** The 13 aviators trained thus far have very similar demographic characteristics to the 47 aviators trained in the first training year. The median age of the 13 aviators is 34 years, with a range of 28 to 43 years. The flight time logged prior to the start of the second 19-day training period averages 1242 hours, with a range of 600 to 3100 hours. The time that had transpired since the last flying experience with the active Army varies from three to 13 years, with a median 10 years.

When given initial checkrides after one year of no practice, the 13 aviators performed 43% of all tasks to ATM standards. An average of 14 hours of flight training were required to successfully complete a Phase I checkride. Ten of the 13 aviators completed both Phase I and Phase II training. In contrast, only three of these 13 aviators completed both phases during the first year of training.

The preliminary findings of the second year suggest that proficiency in some flight skills of IRR aviators is maintained following a one-year period of no flying. Also, there is an increase in the number of aviators who are able to complete the second year of training. However, the findings suggest that two 19-day training periods, separated by one year, is not enough time for some aviators to complete the training program.

The mathematical equations developed following the first year of training will be refined incorporating the results of the second year of training. The equations may prove useful for selecting pilots for the IRR Aviator Training Program who are likely to complete the program in two years.

In summary, the preliminary findings of the second year of training indicate that the revised POI continues to meet the goals of the IRR aviator training program while reducing the requirements on IP

resources. Also, the findings may contribute to the understanding of the factors that affect the retention of flight skills.

#### PROJECTED COMPLETION DATE

An interim report covering the first training period, having undergone formal review by ARI, will be completed on or about 1 December 1983.

The first group of IRR aviators trained for this project will complete training in November 1983. Draft results describing this second year of training should be available 1 February 1984. A final report covering this project, having undergone formal review by ARI, will be completed on or about 1 June 1984.

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DEVELOPMENT OF AN INDIVIDUAL READY RESERVE AVIATOR  
PROGRAM OF INSTRUCTION: AH-1S AIRCRAFT

Mr. Steven L. Millard, Project Director

**BACKGROUND**

A recent study of Army aviator assets revealed that there are approximately 5,500 individuals who, after completing Army rotary wing qualification training and fulfilling their service obligation, were released from active duty and chose not to join a National Guard or active reserve unit.

In 1978, the Department of the Army, in concert with RCPAC, initiated the IRR Aviator Training Program. The IRR program's goals are to enlist in the program civilians who previously were qualified Army rotary-wing aviators, provide these individuals with the training they need to regain and maintain their flying skills, and use them as assets in active-duty aviation units should a major mobilization be required.

ARI was tasked to develop, evaluate, and field a POI to be used to retrain IRR aviators. The initial POI, developed in 1979, was designed to retrain IRR aviators in the UH-1 aircraft. The initial draft of the POI for the UH-1 IRR Aviator Training Program was tested during 1980-81. The original POI was revised in 1981 and the revised POI is presently undergoing a formal evaluation at USAAVNC, Fort Rucker, Alabama.

To date, the UH-1 retraining program has proven viable as a source for "mobilization assets." In early 1981, largely due to the success of the UH-1 retraining program, RCPAC personnel made a decision to expand the program to include additional types of rotary wing aircraft. In response to RCPAC and ARI tasking, ASI personnel prepared a draft POI for retraining previously Cobra-qualified aviators. This draft was delivered to ARI in June, 1982. Based upon original guidance, the POI was designed to retrain aviators in the AH-1G airframe; it did not include gunnery training. Since that time, the decision to retrain IRR aviators in G-model Cobras has been reversed. Instead, it has been concluded that the training program should be designed to qualify IRR



aviators (previously qualified in the G-model Cobra) in the fully modernized "S" family of Cobras--including weapons qualification.

#### PROJECT OBJECTIVE

The objective of this project is to formulate a POI whereby previously Cobra-qualified Army aviators can be retrained to current Army standards in the AH-1S (including weapons qualification) and can maintain their currency and qualifications.

#### APPROACH

Project personnel have completed a thorough study of the training requirements and constraints and have formulated four candidate training strategies. The four candidate training strategies are presented at the conclusion of this subsection. The comments presented prior to the listing of training strategies are meant to provide the reader with a general understanding of special problems that must be overcome in order to accomplish the desired training and the trade-offs that must be considered in selecting the most suitable training strategy.

Most of the problems stem from the numerous modifications to the AH-1 aircraft since the AH-1G model was in common usage. Examples of the major modifications are:

- new engine,
- new airframe,
- new hydraulic and electrical systems,
- new weapons systems, and
- new avionics and navigation equipment.

The net result is that IRR aviators who were previously qualified in the G-model Cobra are ill prepared to fly the modernized versions of the Cobra. Not only must these individuals refresh their knowledge of basic principles of flight and their basic aircraft handling skills, but they also must acquire altogether new knowledge and skills. As a consequence, qualifying IRR aviators (previously qualified in the G-model Cobra) in the S-model Cobra is certain to require far more training than is required to requalify IRR aviators (previously qualified in the UH-1) in the UH-1 aircraft.

The training problem is severely complicated in that training time for IRR aviators is limited to a single 19-day training period each year. Extensive study by RCPAC personnel has resulted in the conclusion that few IRR aviators are able to devote more than about 19 continuous days to training without undue hardship. To fully appreciate the importance of this constraint, consider that about 32 training days are needed for an active-duty aviator, who is currently qualified in another aircraft, to become qualified in the S-model Cobra.

The above considerations and an assessment of the detailed training requirements for S-model Cobra qualification led to the formulation of the following candidate training strategies:

- extend the length of the on-site training period as needed to conduct all refresher and qualification training, including gunnery, in the AH-1S aircraft during the first training period,
- extend the length of the on-site training period as needed to complete refresher and airframe qualification training in the AH-1S aircraft during the first training period and to complete weapons qualification training during the second training period (one year after the first),
- maintaining the desired 19-day training period, conduct refresher training in the UH-1 aircraft during the first training period and conduct AH-1S airframe qualification training and weapons qualification training during the second and third training periods, respectively, or
- maintaining the desired 19-day training period, conduct refresher training in the UH-1 aircraft during the first training period and provide weapons qualification training during the second training period (the aviator would not receive full airframe qualification training, but would be trained to maneuver to and land the aircraft at a safe site in the event the pilot becomes disabled).

#### PROJECT STATUS

All course materials, to include lesson plans, training schedules, and student handout materials presently used at USAAVNC for AH-1S qualification training, have been reviewed. SMEs from both the flight and academic arenas of the New Equipment Training Team (NETT) for AH-1S have been consulted and will continue to assist in formulating the draft and final POIs.

The candidate training strategies have been submitted to ARI and RCPAC for review. Work on this project will continue once the most suitable training strategy or combination of training strategies has/have been selected.

**PROJECTED COMPLETION DATE**

As stated above, further work on this project must await a decision by RCPAC personnel. However, the immediate project goal is to have completed all work on this project by 1984.

**DEVELOPMENT OF A DETAILED PLAN FOR CH-47 FLIGHT SIMULATOR  
TRAINING DEVELOPMENT STUDY**

Dr. Robert E. Lockwood, Project Director

**BACKGROUND**

Although many improvements have been made in the realm of U.S. Army helicopter flight training, the most important part of the student's instruction is still performed in an aircraft under the direct supervision of an IP. This method is extremely costly in terms of time expended by students and instructors and in terms of flying hour costs in today's sophisticated aircraft.

The costs increased dramatically during the late 1960s when the Army experienced a rapid expansion of its aviation capability. The increase in the cost of aviation training during this period of expansion clearly indicated the need for synthetic flight training systems (SFTS) that reduce the requirement to use operational helicopters.

To fulfill this need, the Army approved a Qualitative Materiel Requirement for development of SFTSs in July 1967. Concept formulation was initiated by awarding feasibility study contracts in December 1967. The results of the feasibility studies were positive, so it was recommended that development be initiated. Technical characteristics were presented at the In-Process Review (IPR) in September 1968 and approved in November 1968.

A contract was awarded in June 1973 for the construction of an operational CH-47 flight simulator (CH47FS) equipped with a camera-model-board visual system. A preliminary acceptance test was performed at the factory during September 1976 and the final acceptance test was conducted at USAAVNC, Fort Rucker in January 1977. An operational test of the CH47FS was begun in January 1977 and completed in August 1977 (U.S. Army Aviation Test Board, 1978).

The results of the operational test indicated that the CH47FS was an effective training device for both institutional and unit-training

environments. However, the test revealed the need for improvements in (a) the quality of the night visual displays, (b) the maneuver demonstration system, and (c) the yaw motion cues associated with emergency conditions.

A Cost and Training Effectiveness Analysis (CTEA) of the prototype CH47FS was conducted by the Directorate of Combat Developments (DCD), USAAVNC, during the period between January 1977 and February 1980 (DCD, 1980a). A review of the CTEA was conducted by the Analysis Branch, Directorate of Training Developments (DTD), USAAVNC, during August 1980 (DCD, 1980b). Based upon the review findings, it was concluded that the CTEA report did not provide adequate data to address the following questions:

- What is the cost and training effectiveness of the CH47FS given significant design changes in the production model CH47FS, including the addition of a side window, a larger computer, and an advanced system technology motion system?
- What is the mix of simulator time and aircraft flight time that will maximize training benefits and minimize training costs?
- How should the ATMs be refined to reflect this mix?
- What should be the basis-of-issue-plan (BOIP)<sup>3</sup> that will maximize training effectiveness and minimize training costs?

#### NEED/PROBLEM

With the introduction of the production model of the CH47FS, there is a need to reevaluate the cost and training effectiveness of the simulator. This reevaluation is needed because of the design changes that occurred after the CTEA (DCD, 1980b) was conducted for the prototype simulator. In addition, the data available from the original CTEA were not sufficient to address the issue of usage of the CH47FS in a unit-training context--specifically, unit continuation-training. Thus, there is a need to reevaluate the cost and training effectiveness of the

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<sup>3</sup>The BOIP is the plan that specifies the number of simulators to be purchased and the installations to which the simulators are to be sent.

production model CH47FS for use in conducting unit continuation-training. The present research, therefore, is designed to determine the actual cost and training effectiveness of the CH47FS and to optimize its use for unit continuation-training.

One of the critical issues associated with any study of the effectiveness of flight simulators in a continuation-training program is the measurement of training effectiveness. Classical transfer designs use varying levels of aircraft time and varying levels of simulator time to train aviators to proficiency in a particular task or maneuver. The transfer effectiveness ratio is defined in terms of aircraft time saved by using the simulator, assuming all subjects are trained to proficiency (Roscoe, 1980). Within a continuation-training program, the emphasis is on maintaining skills rather than on initial skill acquisition. Thus, training data from an institutional setting, where the simulator is used for initial skill acquisition, cannot be generalized to a unit-training context. Because of the lack of generalizability of institutional training data, it is essential that a study be conducted that focuses directly on the unit-training situation.

Within a unit-training program, three possible training options exist:

- train all tasks/maneuvers in the aircraft,
- train some subset of tasks/maneuvers in the simulator and the remainder in the aircraft, or
- train all tasks/maneuvers in the simulator.

The third option may be possible in theory, but it is not a practical option for unit continuation-training because of the necessary flying conducted in support of other Army units. The first two options, therefore, represent the only practical training alternatives. An implicit assumption underlying the development of advanced flight simulators is that simulator training can be substituted for some aircraft training and, thereby, reduce training costs without degradation of proficiency. Thus, the usefulness of the CH47FS in a unit-training situation must be established by demonstrating that there is

some mix of simulator and aircraft training that is more cost effective than aircraft training alone.

#### PROJECT OBJECTIVES

The general objectives of this project are to determine the cost and training effectiveness of the CH47FS (production model) for unit continuation-training, and to define the mix of simulator training and aircraft training that is most cost effective for maintaining the flying skills of unit aviators. The specific technical objectives of this project are:

- determine the cost of each training alternative (all training conducted in the aircraft versus aircraft and simulator training in varying mixes,
- establish the relative training effectiveness of each training alternative,
- recommend an optimal cost and training effective alternative for CH-47 aviator unit continuation-training,
- based upon cost and training effectiveness, develop a valid list of ATM training tasks for (a) the CH-47C helicopter as the desired training medium, and (b) the CH47FS as the desired training medium, and
- determine the adequacy of the present CH47FS BOIP and revise it as necessary.

#### RESEARCH APPROACH

The research approach developed for this project was designed to (a) define the ATM tasks that require some amount of continuation-training, (b) derive an initial estimate of the mix of aircraft and simulator time that will maximize training effectiveness while minimizing cost, and (c) use sequential analyses to monitor unit-training procedures and refine the initial estimate of the optimal mix of aircraft and simulator time. The proposed research will be conducted in three phases. Each phase is described below.

### Phase 1: Training Survey

A survey will be undertaken to determine the amount of aircraft and simulator training currently being received by operational CH-47 pilots. The survey will address both training time and number of practice iterations for both training flights and mission-support flights. The data from the survey will be used to define the initial mixes of aircraft and simulator training that will be investigated in the transfer-of-training study.

### Phase 2: Transfer-of-Training Study

The transfer-of-training study is designed to determine the ATM tasks that require training and to derive, for each ATM task requiring training, an initial estimate of the type and amount of training that is most cost effective. During the transfer-of-training study, the amount of aircraft training and simulator training will be controlled for each participating aviator. As stated above, decisions about the specific mixes of aircraft and simulator training to be investigated will be based on the data obtained during the survey of operational units.

A basic assumption underlying the transfer-of-training study is that certain flight skills deteriorate in the absence of practice. Given this assumption, it is then necessary to specify the skills that deteriorate and to determine the most effective method of maintaining those flight skills in operational units. Consequently, the proposed experimental design for the transfer-of-training study requires that four groups of aviators engage in the flight activity specified below:

- one group will continue to fly their normal aircraft missions during the period of the study, but will be required to refrain from any practice in the CH47FS,
- a second group will be restricted from all flight activity for six months,
- a third group will receive all their training in the CH47FS, and
- a fourth group will be required to practice ATM tasks in both the aircraft and the simulator in accordance with a rigidly controlled practice schedule.



The training alternative that maximizes training effectiveness while minimizing training costs will be determined by assessing changes in proficiency for all participating aviators at the end of the six-month study period. By investigating varying mixes of aircraft and simulator time, it will be possible to specify, for each task/maneuver, the mix that produces optimal training effectiveness. Once these mixes are established, cost data for the simulator and the aircraft can be used to estimate the total cost for each training alternative.

### **Phase 3: Sequential Analysis**

The transfer-of-training study will provide the data needed to (a) identify the ATM tasks that can and should be trained using some mix of aircraft and simulator training, and (b) derive an initial estimate of the mix of aircraft and simulator training that is most cost effective for maintaining an acceptable level of proficiency on each ATM task. Further study may be required for two reasons. First, since the optimal training-mix curves will be based on a relatively small sample of aviators, the initial estimate of the optimal training mix derived from the transfer-study data may be imprecise and, therefore, may result in some amount of undertraining or overtraining of aviators. Second, because all the data in the transfer study are based on a six-month study period, additional research may be required to determine whether the optimal mix data are valid for longer periods. It is altogether possible that a training mix that maintains proficiency for periods as long as six months may result in proficiency deterioration if continued for periods of 12 months, 18 months, or longer. It is for these reasons that the sequential analysis is considered essential.

The objectives of the sequential analysis are to monitor the unit continuation-training program and to modify the mixes of aircraft and simulator time, should the initial training mixes fail to result in optimal training effectiveness. The data required to conduct the sequential analysis will be collected from operational pilots in six-month increments after the completion of the transfer study. These data include:

- number of iterations for each ATM task completed during mission flights,
- number of iterations for each ATM task completed during CH47FS training, and
- data on task performance from checkrides given at the end of the six-month period.

When the data indicate that the training mixes of aircraft and simulator time fail to result in optimal training effectiveness, the data gathered to that point in the study will be used to adjust (refit) the training mix curves, and data collection will continue for another six-month period (Wald, 1947).

In order to collect data consistent with the requirements specified in the transfer study, each CH-47 aviator will be requested to restrict aircraft flight time to mission-essential flying. Any additional training will be conducted in the CH47FS, except for the tasks that cannot be practiced in a simulator. The additional training will be specified by the initial function generated during the transfer study for each task. Performance data from the aviators' checkrides will be used to determine if the mix of aircraft and simulator training is optimal. The sequential analysis will continue until there is a statistically sound basis for concluding that the training mix for each task is optimal.

## **PROJECT STATUS**

### **Work Completed**

A Training Development Study (TDS) plan has been developed and reviewed by ARI personnel, revised as necessary, and delivered to the DTD. The submission of the final TDS plan on 14 December 1982 completes ASI's tasking on this project. It is possible that ASI will play a role in implementing the research, but a decision on this matter has not yet been made.

### **Projected Completion Date**

All work on this project was completed on 14 December 1982.

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**ASSESSMENT OF THE NEED/FEASIBILITY OF A SCOUT HELICOPTER  
TEAM TRAINING SIMULATOR**

Mr. Steven L. Millard, Project Director

**BACKGROUND**

This project was initiated by DTD, USAAVNC, for the purpose of defining the extent of need for a scout team<sup>4</sup> mission training device and to assess the feasibility of developing such a device.

The three major factors that prompted DTD to initiate this research are (a) the importance and complexity of the scout helicopter missions, (b) the criticality to mission success of team coordination, and (c) the difficulties associated with the conduct of realistic, team training (DTD Fund Cite, 1981). Each of these factors is discussed in the following paragraphs.

Scout helicopter crews are organic to three combat units: attack helicopter (AH) companies, air cavalry troops, and division artillery (DIVARTY) flight support sections. The basic mission of the Attack Helicopter Company (AHC) is to destroy armored vehicles. Scout helicopters support this mission by establishing and maintaining communication with the ground commander and with the crews of the attack aircraft to ensure proper integration of fires within the larger scheme of battle. The attack team leader, operating from a scout helicopter, manages the aviation assets during the mission. The remaining scout helicopters acquire targets and other combat information for the attack helicopters and reconnoiter avenues of approach to the engagement area and to firing positions. During the actual engagement, the scout teams (a) locate and maintain contact with the enemy, (b) designate targets for attack helicopters, and sometimes for close air support (CAS)

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<sup>4</sup>The term "team task" is used to refer to any interaction between the crew members of two or more aircraft, or between members of an aircrew and the crew of a ground-based unit. The term "crew task" is used to refer to interaction between crew members of the same aircraft.

aircraft, and field artillery batteries as well, and (c) provide local security for the attack helicopters by searching for enemy activity in the immediate vicinity.

The basic mission of the air cavalry troop is to perform reconnaissance and provide security for ground forces. The air cavalry scout helicopter's primary function is to provide combat information to the supported unit commander. A scout helicopter is normally deployed as a member of a team, with other scouts or with attack helicopters, depending upon the nature of the enemy situation. The attack helicopters of the air cavalry unit provide overwatch protection for the scout. With such protection, the scout helicopters of the air cavalry unit can make first contact with the threat, forcing the enemy to reveal their position and strength and to commit resources for battle before they are fully prepared. When augmented with both attack helicopters and artillery support, the scouts provide a credible anti-armor capability and are capable, when necessary, of defeating a sizable tank force.

Scout helicopters provide an aerial platform that greatly augments the mission of the DIVARTY flight support section. Each division has ten scout helicopters that provide the Field Artillery Aerial Observers (FAAO) of DIVARTY with the capability of rapid maneuver to critical areas on the battlefield for observation and adjustment of artillery fire.

The variety of scout aircraft, scout personnel, and scout missions in these three combat units largely determines the scope of this investigation. Consequently, the scope of the research encompasses the missions performed by a scout helicopter crew alone as well as missions performed by teams composed of: a scout helicopter crew (OH-58 or AHIP) and one or more attack helicopter crews (AH-1 or AH-64), a scout helicopter crew and DIVARTY personnel, a scout helicopter crew and either a Forward Air Controller (FAC) or a CAS aircraft crew. The teams of interest are listed below along with the abbreviations that will be used hereafter to refer to them:

- OH-58/AH-1 - The crew of an OH-58 scout aircraft and the crew of one or more AH-1 attack aircraft.
- OH-58/AH-64 - The crew of an OH-58 scout aircraft and the crew of one or more AH-64 attack aircraft.
- OH-58/DIVARTY - The crew of an OH-58 scout aircraft and DIVARTY personnel.
- OH-58/CAS - The crew of an OH-58 scout aircraft and a FAC or the crew of one or more CAS aircraft.
- AHIP/AH-1 - The crew of an AHIP scout aircraft and the crew of one or more AH-1 attack aircraft.
- AHIP/AH-64 - The crew of an AHIP scout aircraft and the crew of one or more AH-64 attack aircraft.
- AHIP/DIVARTY - The crew of an AHIP scout aircraft and DIVARTY personnel.
- AHIP/CAS - The crew of an AHIP scout aircraft and a FAC or the crew of one or more CAS aircraft.

Analyses of the air cavalry, aerial observer (artillery), and attack helicopter missions reveal that these helicopter crews are not capable of performing the full range of their combat mission tasks independently. Scout helicopter crews serve as the eyes and ears for ground commanders, artillery units, and attack helicopter crews. In this capacity, the scout crew is required to process large amounts of information quickly and accurately and to interact smoothly and efficiently with other battlefield elements. Mission success, in most instances, is directly contingent upon such spatially and temporally coordinated action.

The modern battlefield on which these crews must be capable of fighting is characterized by highly sophisticated weapons systems and a numerically superior threat force. In response to this situation, the new AH-64 attack helicopter and the Army Helicopter Improvement Program (AHIP) scout helicopter were developed. The advanced technologies incorporated into the mission equipment of these aircraft can be expected to increase rather than decrease the requirements for team interaction. For example, the AHIP scout helicopter has a laser range finder/designation system that will designate targets for the laser-guided Helicopter Launched Fire and Forget (HELLFIRE) missile fired from

the AH-64 and for laser-guided artillery munitions. The target designation capability of the AHIP scout helicopter may impose a new and critically important requirement for team coordination by the AHIP scout crew.

As the importance of team coordination increases, the difficulty of conducting realistic team training also increases. Realistic team training under the multiple task loadings of the battlefield is not easily achieved. Training resources required to support such an effort are extensive. The necessary resources include ammunition (missiles and "smart" artillery rounds), fuel, ranges large enough for the conduct of realistic navigation exercises, ranges that are safe for ordnance and laser firing, realistic threat vehicles and aircraft, as well as friendly combat and combat support elements. Another complicating factor is that the AHIP scout is a two-seat aircraft that cannot support IP training and evaluation of both crew members during the same flight. The requirement to assess the need for and feasibility of developing a scout team mission training device that will simulate battlefield conditions and team coordination exists, in large part, because of such constraints on live training exercises.

#### PROJECT OBJECTIVES

The specific technical objectives of this project, as stated in the DTD Fund Cite, (1981) are listed below.

- Identify all scout-attack or scout-field artillery mission tasks and skills for which team training is required to achieve or maintain proficient performance.
- Determine the advantages and feasibility of training team tasks using actual equipment as compared with a simulation device.
- Determine the simulation device capabilities which are necessary to achieve proficiency in performance of individual and coordinated team mission tasks.
- Determine the feasibility (costs and benefits) of adopting a device with the requisite capabilities identified by the analyses.

## RESEARCH APPROACH

A two-phase approach has been developed to accomplish the project objectives. The Phase I tasks are aimed at compiling a comprehensive inventory of the team tasks that must be performed by each of the crews under investigation and, for each team task listed, determining the extent to which a team training device is needed to train the task effectively. The tasks to be performed during the second phase are aimed at defining the costs and benefits of one or more candidate training systems. The data compiled during the second phase will be used to assess the feasibility of developing a cost-effective team training device.

The following tasks will be performed in compiling an inventory of team tasks for each of the eight teams defined above:

- Define the basic missions of each team.
- Subdivide each mission into mission segments.
- Identify the mission segments in which some team coordination is required and prepare a detailed description of each team function.
- Develop a detailed description of the tasks that must be performed by each team member in order to accomplish the function.

The resulting inventory of team tasks will be the subject of a training requirements analysis. The purpose of this analysis is to answer the following sequence of questions about each team task: Is the task presently being trained effectively? If not, can the task be trained effectively with conventional ground-based training techniques? If not, can the task be trained effectively in the aircraft? Tasks receiving a negative answer on all three questions are candidates for training in a team training device. The completion of this task necessitates the collection of detailed information on the training currently conducted at both training institutions and in operational field units. The data gathered on the training of OH-58 and AH-1 aviators will be used as a base from which to extrapolate, when necessary, and predict training for the new AHIP scout and AH-64 aircraft.



At this point, the information gathered will be presented to a panel of experts in both training technology and in the operating characteristics, mission equipment, and battlefield tactics of the aircraft identified earlier. The panel's job will be to identify the tasks that can and should be trained in a training device rather than in an aircraft or classroom.

Phase II will be initiated only if the results show that there are a significant number of important team tasks that can be trained effectively only in a team training device.

The first task in Phase II is to consider all the tasks that can be trained effectively in a device and to develop a comprehensive list of training objectives. The general equipment characteristics necessary to achieve those training objectives will then be specified.

One or more design concepts for a team training device will be developed and specific equipment characteristics for each design concept will be defined. Cost data for each design concept will be derived. *The benefits in potential dollar savings to be realized by using a training device to replace operational equipment will be specified.* Finally, recommendations concerning the development of a design concept will be made.

## PROJECT STATUS

### Work Completed

Work on Phase I activities is nearing completion. The basic missions for each team have been identified and each mission subdivided into mission segments. The mission segments have been analyzed to determine the functions performed during each mission segment by each member of the team. Based upon guidance from ARI, a detailed task analysis, that was performed by Applied Psychological Services (APS) in September 1981, was used as the basic reference document for the OH-58D mission segment analysis. No such task list was available for OH-58A/C. So, the mission segment analysis for that aircraft was also based upon

the APS detailed task analysis for OH-58D and then modified by an experienced aeroscout SIP, to produce the OH-58A/C function list. A detailed task analysis was conducted on each of the functions identified above. The completed task analysis was forwarded to ARI in June.

Review of germane literature has continued throughout the year. The review has included the draft Controls and Displays Information for AHIP, System Description and Operational Information for Multiple Integrated Laser Engagement and Air-Ground Engagement Simulation (MILES/AGES), the Analysis of Control and Coordination During Helicopter Anti-Armor Operations (Mitre Corp, February 1982), and the draft Preliminary Training Development Study (PTDS) for OH-58D (DTD, Fort Rucker, September 1983). Collection of training data has also continued and will continue until the design of the AH-64 and AHIP Scout (OH-58D) has been frozen.

The completion of Phase I work requires the establishment of two Joint Working Groups (JWGs). The first JWG will be composed primarily of operational Army aviators knowledgeable in aeroscout-attack helicopter and modern battlefield operations. This group will be required to review and validate the task analysis data. The second JWG will be composed of training managers and device/equipment requirement experts. This JWG will meet to judge whether the team tasks identified by the task analysis can and should be trained and, then to judge whether a team training device is needed. The final task in Phase I is to prepare a Phase I report that will detail the conduct of Phase I activities, report function/task analysis data, and document the results of the team training and training device need analysis.

#### **Projected Completion Date**

The anticipated completion date is September 1984.

#### **REFERENCE**

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**IDENTIFICATION OF PREREQUISITES AND SELECTION CRITERIA FOR  
AH-64 ADVANCED ATTACK HELICOPTER CREW MEMBERS**

Mr. Theodore B. Aldrich, Project Director

**BACKGROUND**

Army aviators selected to fly the AH-64 attack helicopter will encounter a greater workload and a greater division of labor between the pilot and copilot/gunner (CPG) than they have encountered in any previous Army helicopter.

The CPG position features a target acquisition and detection system (TADS) composed of high technology components that include forward looking infrared (FLIR), a video day television viewing system, and direct view optics. A laser range finder and an airborne laser tracking and target cueing system will aid the CPG in reducing target acquisition time and in accomplishing the target acquisition functions under adverse visibility conditions. The TADS interfaces with a fire control system that enables the CPG to fire the Army's new HELLFIRE missile in several different modes. The AH-64 aircraft is equipped with a doppler navigation system that interfaces with the TADS and fire control computer. The operation of the doppler navigation system requires the CPG to perform a host of complex tasks. Finally, redundant controls are provided in the front crew station to enable the CPG to fly the aircraft when the mission or situation warrants (Hughes Helicopters, 1979).

The most striking example of the new technology in the pilot's crew station is the Pilot's Night Vision System (PNVS). The PNVS provides the visual information the pilot needs to fly the aircraft during darkness and under other adverse visibility conditions. The Integrated Helmet and Display Sight System (IHADSS) presents information to the pilot on a one-inch diameter, helmet-mounted cathode ray tube. This display, generated in part by the FLIR sensor mounted in the nose of the aircraft, provides flight instrument symbology superimposed on a thermal "real world" contact display. The flight instrument symbols

provide information about heading, altitude, airspeed, engine power management, attitude, and trim. The FLIR image on the IHADSS allows the pilot to stay "outside the cockpit" while flying under conditions of restricted or limited visibility. The AH-64 pilot has an exacting and demanding job flying nap-of-the-earth (NOE) in poor visibility conditions because the PNVIS field-of-view is limited to 40 degrees. In addition to controlling the aircraft, the pilot must perform air-navigation tasks, weapon control and firing, emergency procedures, and must remain cognizant of the functions being performed by the CPG and the other combatants within the battle area (Hughes Helicopters, 1979).

Two tentative decisions have been made about the selection and training of AH-64 crew members. First, it has been decided that, initially, AH-64 trainees will be selected from the population of Army aviators who have demonstrated a high level of proficiency in the AH-1 aircraft (Hipp, 1978). The assumption underlying this decision is that highly proficient AH-1 aviators are likely to possess the abilities required to perform effectively in the AH-64. Second, the Army's current plans are to train all AH-64 aviators to perform both the pilot and the CPG functions (Browne, 1981). This decision is based on (a) a desire for maximum operational flexibility, and (b) the assumption that individuals who possess the abilities to perform effectively in one crew position will also be able to perform effectively in the other crew position.

#### NEED

The AH-64 subsystems are so different and so much more complex than the subsystems in other Army helicopters that there is a strong reason to suspect that effective performance in the AH-64 may require that AH-64 crew members possess abilities above and beyond those required to perform effectively in other Army helicopters. Hence, there is a need to determine whether AH-64 crew members must possess unique abilities and, if so, to develop tests that can be used to select individuals who possess the requisite abilities (Human Resource Need, undated).

There is reason to question the assumptions that there is a high degree of commonality in the abilities required for effective performance in the two AH-64 crew positions. Because of the differences in the tasks performed in the two crew positions and because of the differences in the subsystems used to perform these tasks, it is altogether possible that effective performance in the two crew positions may require different sets of abilities that are rarely found in the same individual. As a consequence, there is a need to determine whether or not the abilities required to perform effectively in the pilot position differ in type or extent from the abilities required to perform effectively in the CPG position. If it is found that different abilities are required, a need will exist to develop tests for selecting individuals with the requisite sets of abilities.

#### PROJECT OBJECTIVES

As is suggested by the title, the general objective of this project is to define prerequisites and selection criteria for AH-64 crew members. The specific technical objectives are as follows:

- identify for each crew position the critical crew functions required to perform the attack helicopter mission,
- determine the critical crew functions, if any, that are unique to the AH-64,
- develop for each crew position the predictors of the abilities required to perform the critical functions,
- validate these predictors against performance measures in the AH-64 crew training program, and
- cross-validate the predictors against performance measures in the AH-64 crew training program.

#### RESEARCH APPROACH

The approach to be followed in this project differs from the traditional approach to aviator selection test development. Instead of a detailed analysis of the aviator tasks, the project will take advantage of a number of task analyses that already have been performed for the AH-64 (Applied Sciences Associates, 1981; Singer Company, 1977;

Applied Psychological Services, 1982). The test development will not deal with the entire inventory of AH-64 crew functions under the assumption that a large proportion of the AH-64 crew functions are the same as crew functions in the AH-1 aircraft. It is further assumed that the same fundamental abilities underlie the functions that are common to both aircraft. If the assumptions are valid, there is no need to develop test instruments to assess common abilities. Since all candidates for AH-64 qualification training are successful AH-1 aviators, it is presumed that all candidates possess an acceptable level of the common abilities. Selection measures developed in this project will be based on crew functions and the underlying abilities that are unique to the AH-64 aircraft.

A job sample test development approach has been selected to complement a separate project presently under way to develop test instruments to select students for the attack (AH-1) training track. That test development effort is based on AH-1 crew functions, so the resulting test instruments will assess the abilities underlying AH-1 crew functions (Myers, Jennings, & Fleishman, 1982). If the Army decides at some future time to select AH-64 aviators from the general population of flying students, it will be possible to base the selection decision on a combination of tests: (a) the fundamental abilities tests developed to select trainees for the attack helicopter training track and (b) the job sample tests developed during this project to assess the job-specific abilities that AH-64 aviators must possess above and beyond the abilities required to pilot the AH-1 aircraft.

Job sample tests were deemed more appropriate for selecting AH-64 crew members from among operational aviators who already have demonstrated that they possess the requisite abilities for flying. Moreover, the high technology hardware associated with the unique AH-64 crew functions provide an identifiable source of job sample test content.

## **PROJECT STATUS**

### **Work Completed**

Project personnel have become thoroughly familiar with the AH-64 attack mission and have completed a comprehensive review of the research literature on aviator selection. Task lists and task analyses conducted during the design and production of the AH-64 system have been collected and used to compile a composite list of AH-64 crew functions.

The composite list of AH-64 crew functions has been formatted into a survey instrument and administered to 27 AH-64 SMEs. The SMEs rated 146 pilot functions and 88 CPG functions on four dimensions: difficulty to learn, probability of deficient performance, frequency of performance, and likelihood that deficient performance will have serious consequences.

The survey data have been entered into a computerized data file. Descriptive statistics have been produced for all 234 ratings. Problems have been encountered in attempting to combine the results from the four survey scales into one overall measure of criticality. A two-way analysis of variance with replications has been performed on the data from the pilot functions portion of the survey. The significant interaction effects between scales and functions prevents summing mean ratings to derive overall criticality scores for the pilot and copilot functions. Further analyses must be conducted before the survey functions can be rank ordered as specified in the research plan. The overall criticality ratings of the various unique AH-64 crew functions will be used to prioritize job sample test development activities.

### **Projected Completion Date**

AH-64 Aircrew Qualification Training will start at Fort Rucker on 1 January 1985. Identification of the critical crew functions and development of the predictor test battery will be completed before the first students arrive for training. The predictor test battery will be administered to all attendees. The estimated completion date for the

development and cross-validation of the predictor equations is 31 December 1985. The actual date of completion may vary depending upon the number of tests included in the battery and the number of students who flow through the training.

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## DEVELOPMENT OF A METHODOLOGY FOR GENERATING A FLIGHT GRADING SYSTEM

Mr. Theodore B. Aldrich, Project Director

### BACKGROUND

IPs responsible for training in the Combat Skills course of the U.S. Army's IERW training program have expressed considerable dissatisfaction with the gradeslip presently being used and have requested that ARI provide support in developing and evaluating an improved gradeslip (Shiple, 1981). Preliminary investigation revealed that the gradeslip was only one part of a more general problem. As a result, project personnel recommended that the scope of the project be expanded to encompass all aspects of the Combat Skills grading system. The project description presented below reflects the intention to investigate the full range of problems associated with the Combat Skills grading system.

### NEED/PROBLEM

Many of the traditional problems associated with flight grading systems are manifest in the U.S. Army's flying training program. Four problems considered especially crucial are discussed below. First, daily flying lessons and periodic check flights within the IERW training programs are graded using a four-increment scale (A, B, C, or U). The standards for the four increments are stated in descriptive terms and allow for a range of individual IP judgments. The regulation prescribing the grading procedures calls for criterion-referenced grading; and yet, the same regulation (U.S. Army Aviation Center, 1970) directs IPs to adjust grading standards to correspond to the student's phase of training.

Second, the gradeslip lists the maneuvers to be graded, but the rationale for including the maneuvers on the gradeslip is obscure. The maneuvers listed on the gradeslip do not correspond exactly with either the maneuvers contained in the training syllabus or those listed in the ATM. Apparently, this lack of correspondence is the result of training

managers' failure to modify the gradeslip in step with changes to the training syllabus. This failure raises questions about training managers' requirements for grade information and suggests that management information requirements for grades be identified and specified during the design of the grading system.

Third, there are a number of human factors design deficiencies in the gradeslip. Grouping of items is not functional and the large number of graded items are crowded onto a small form by reducing the type size below established legibility standards.

Finally, the Combat Skills IPs receive limited and ineffective training on performance evaluation and grading. New IPs develop their individualized set of evaluation criteria based upon informal discussions with more experienced IPs and upon their own experience from flight school and operational flying assignments.

#### PROJECT OBJECTIVES

This project has two broad objectives. The first objective is to develop and implement an improved grading system for the Combat Skills course. The second objective is to test a methodology for developing improved flight grading systems. A key attribute of this methodology is that experienced IPs play an important and continuous role in all aspects of the design process.

A set of secondary objectives, aimed at eliminating specific deficiencies in the present grading system, will be addressed during the development of the improved grading system. The secondary objectives include:

- define specific grading criteria and standards,
- design a gradeslip that satisfies management information requirements and that complies with human factors standards,
- develop a grading scale that contributes to interrater reliability and allows the IP to accurately record the grades in accordance with the established standards, and
- develop a training program that instructs IPs and check pilots on how to grade flight performance accurately and consistently.

## RESEARCH APPROACH

The approach to be followed in this project is described below in three phases: design and pretest, test and evaluation, and implementation.

### Design and Pretest

Design of the grading system will be accomplished through a series of consensual decision-making design meetings involving eight Combat Skills IPs and four IPs assigned to key training directorates at USAAVNC. Design features will be decided by IPs during consensual decision-making design meetings. Design decisions will be made about such features as the scale, the items to be graded, the system for calculating an overall grade, the frequency of grading, and the format for the gradeslip. Project personnel will accomplish the following tasks prior to the first design meeting:

- conduct an audit of the training management information system for the purpose of documenting the requirements for flight grades,
- perform a content analysis of the combat skills maneuvers,
- develop human factors specifications to be used as design constraints for the design of the gradeslip, and
- develop grading system design guidelines.

The results from these tasks will be provided to the IPs as guidelines and factors to be considered in their design decisions.

The IPs who design the grading system will pretest the system by participating in flight tests in an instrumented helicopter. Results of the flight tests will be reported at subsequent design meetings and used to refine the grading system design. The flight tests also will be used to refine procedures to be used in the test and evaluation phase.

A program to train IPs on the new grading procedures and materials will be developed as the prototype grading system design nears completion. Video tapes, recorded during the flight tests, will serve as visual aids in the program.

## Test and Evaluation

The test and evaluation phase will feature operational use of the prototype grading system during simultaneous inflight grading of students by two IPs. Prior to the inflight grading, participating IPs will be introduced to the prototype grading system through the training program developed earlier. The inflight grading will be performed initially in the Method of Instruction (MOI) course used to train rated aviators to be Combat Skills IPs and subsequently in the Combat Skills Course of Instruction (COI) with actual students. After each flight, the two IPs will be asked to resolve their differences in grading through discussion of the student's performance on the graded items. Video tape recordings of the inflight maneuvers will be provided to assist the IPs in resolving their differences.

Additional pairs of IPs will be asked to grade the recorded maneuvers based only on the information they can derive from viewing the video tapes. Differences in grades, assigned during the video grading, will be resolved through consensual decision-making.

A fundamental assumption underlying this project is that the discussions IPs engage in to resolve differences in assigned grades will reveal valuable information about performance criteria and standards. Consequently, project personnel will be present at all discussions that IPs engage in to resolve grading differences, and will record information bearing on (a) the set of flight parameters that IPs consider in evaluating performance on a given maneuver, and (b) the relationship between assigned grades and the amount by which a flight parameter deviates from its command or "nominal" value. In short, all information will be recorded that may prove useful in defining performance criteria and standards.

The data compiled during this phase of the project will be analyzed and the results used to define tentative performance criteria and standards for each Combat Skills maneuver to be graded. In addition, the data on initial assigned grades will be used to measure the level of interrater reliability that exists prior to the introduction of the new grading system.

A series of design review meetings will be held to review the composite findings to this point in the project and to make final decisions about all aspects of the grading system. This series of meetings will be attended by a group of IPs selected from among those who participated in either the inflight grading or the video tape grading. The products that are expected to result from the design review meetings include:

- a listing of the individuals/agencies who use information on flight grades and the purposes for which they use the information,
- a listing of the flight maneuvers that are to be graded by Combat Skills IPs,
- a definition of the performance criteria and standards for each maneuver to be graded,
- a description of all grading procedures and materials,
- a description of the flow of information on grades throughout the training management system, and
- a complete training program design for use in training Combat Skills IPs to use the recommended grading procedures and materials.

### **Implementation**

The third phase of the project consists of implementing the new grading system throughout the Combat Skills course. The training program on grading and performance evaluation will be administered to all Combat Skills IPs. Thereafter, the training program will be taught regularly as a part of the MOI course so that new IPs will be instructed properly on the subject of grading and performance evaluation.

A final report that describes all of the project activities and results will be written. The report will contain conclusions about the applicability of the project's methodology to other flight grading programs.

## PROJECT STATUS

### Work Completed

Considerable planning has been completed for this project. An issues paper has been written that reviews the relevant performance measurement literature and discusses the problems encountered when developing a new grading system within an operational environment. An analysis of the deficiencies in the existing grading system has been completed and a set of design criteria for the new system has been developed. Included in the design criteria are the major human factors considerations that will constrain and guide the grading system design.

An outline plan for conducting the project has been prepared in the form of a task flow diagram. Resources required for the duration of the project have been spelled out in fine detail. Manpower and logistic resources have been estimated for each step of the project on a weekly timeline.

One of the primary resource requirements is an instrumented UH-1 helicopter and an instrumentation package to support the inflight tests. An available helicopter and an instrumentation package adaptable for the project have been located, and preliminary commitments of support have been obtained.

IP manpower is another key resource required for this project. A briefing on the research plan has been presented to a group of Combat Skills IPs; the plan received their tentative endorsement. A subsequent briefing was presented to the Lowe Training Division Commander who is responsible for the Combat Skills course. He stated that he could not commit the required IPs to the project because present IP resources constitute only 75% of the authorized manning level. He suggested that project personnel further investigate the utility of the instrumented helicopter and informally discuss the grading system problems with IPs on an as-available basis until IP strength is increased to a level that will allow assignment of IPs to the project.

Rather than delay the project, a decision was made to conduct a pilot study using ARI/ASI IP resources and an instrumented helicopter available from the U.S. Army's Aviation Test Activity at Cairns Field. The objectives of the pilot test are to investigate the feasibility of the following:

- engaging IPs in consensual decision-making exercises leading to the design of a prototype gradeslip,
- inflight grading using the prototype gradeslip,
- recording student performance on video tape in flight, and
- grading student performance from video tape collected in flight.

A series of consensual decision-making meetings with the three IPs from ARI/ASI started in January and continued through March. The consensual decision-making approach to the design of a gradeslip proved to be very time consuming. Eighteen separate meetings were required before the three IPs completed their gradeslip design.

ARI contracted with the Test Activity for technical support and five hours of flying time in the instrumented helicopter. Project personnel identified performance measurements to be collected and consulted with the Test Activity about the optimum placement of three video cameras. One camera was mounted on the nose of the helicopter and recorded a forward field-of-view 87 degrees wide. A second camera was mounted above and to the rear of the left pilot's head and was directed at the student pilot. A third camera was focused on a specially constructed "little theater" in which an array of repeater flight instruments could be video recorded. All three cameras were connected to video recorders. A time signal generator was provided to project a time onto each recording.

The IPs assigned to the project designed a combat skills test mission to be flown in the instrumented helicopter. The mission consists of 44 segments and was planned to fill a two-hour period.

Numerous installation problems delayed the flight test until 6 July, when project personnel conducted the first flight test. Lowe Division officials, responsible for the Combat Skills course, provided a

fledgling IP to serve in the test as a volunteer student pilot. Video cameras and recorders were operated during the flight, which extended to 2.5 hours because of deficiencies in the subject's performance. The cameras directed toward the subject and the little theater were connected to two-hour recorders and were operated continuously. The nose camera was connected to a 30-minute recorder that operated intermittently during critical performance segments. Two IPs graded the subject's performance and entered their grades on the prototype gradeslip. They discussed their grades and reached consensus for many of their differences. A third IP viewed the video tapes, graded the student's performance, and provided his comments about the utility of the video tapes. He was able to grade the student from information acquired solely through the video tapes. There was a high degree of agreement between his grades and the grades provided by the IPs who had observed the flight.

Minor redesign of the prototype gradeslip was accomplished as a result of the comments collected from the IPs who had performed the grading.

Review of the video tapes resulted in the identification of several changes required to improve the quality of the recordings. Recommended modifications include:

- improve the focus and/or lighting for the camera directed at the little theater,
- dampen the vibration for the camera directed at the subject pilot,
- troubleshoot and repair the pitot pressure line to the airspeed indicator in the little theater, and
- substitute a different multiplex unit and/or time signal generator in order to provide readable time codes on both the little theater and subject-pilot videotapes.

The Test Activity agreed to implement the above improvements before the second test flight was flown.

Extensive changes in recorder configuration were required before the Test Activity could produce the required quality from the little theater. Additional project delays were incurred to make the necessary



changes. The multiplex unit previously used to combine video from the little theater camera and the student camera onto one recorder was eliminated. Each camera was linked to an independent two-hour recorder. Also, the recorder for the nose camera was changed to provide a full two-hour capability. Without the multiplex unit, the time code appeared on only two of the tapes. However, the three video recordings were initiated by a single switch and were in close synchrony from the start. A different camera was installed for the "little theater" scene. The camera position was moved closer to the panel so the instruments could be read more clearly.

On 12 August, a second test flight (2.5 hours) was flown. Again, the Lowe Division provided a fledgling IP to serve as the student. The two IPs exchanged the flight position they filled during the first flight, with one serving as the IP at the controls (left seat) and the other as the IP observing from behind the left seat. During the flight, a "fault" light indicated intermittent problems with the recorder for the camera focused on the pilot. A sampling of the films, however, indicated that the video cameras from all three cameras were of improved quality in comparison to those of the first flight. Flight test results were discussed with the Test Activity planners and agreement reached that the flight test portion of the pilot study had been completed.

### **Preliminary Findings**

At year's end, the results from the flight tests are still being assembled. Preliminary findings are listed below.

- A Combat Skills gradeslip can be designed by involving a group of IPs in a series of consensual decision-making meetings. However, the number of meetings and time required to accomplish this effort will be greater than estimated when planning for the project.
- IPs are able to grade student performance by reference to video tapes of student performance recorded in flight. Video tape and audio tape from the test missions provide enough detail to enable reliable grading to be accomplished.
- IPs are able to grade reliably from a jump seat, located behind the left pilot's seat, normally occupied by the IP. In fact, both IPs commented that they were able to observe student performance better from the jump seat location.

- The Test Activity is not able to provide the technical support required to provide an instrumented helicopter on a dedicated daily flight schedule, as required by the project research plan.
- The video tapes have good potential value for use in developing instructional material for courses on grading to be presented to newly assigned IPs.

#### Projected Completion Date

The project plan presents an 88-week schedule from start to completion. However, the future directions to be taken in this project are under review for the reasons summarized below.

- The Test Activity is unable to support the planned project with a mission-ready instrumented helicopter for a daily flying schedule.
- The ARI Field Unit is investigating the feasibility of procuring their own video recording capability and, perhaps, having a full-time helicopter assigned to them for this and other projects.
- Unit reorganizations currently being implemented at Fort Rucker, and especially within DTD, may bring about a realignment of responsibilities for grading policies and changing requirements for this research.
- The requirement for prolonged IP involvement, as documented by the pilot study, may be unacceptable to training managers.

These issues will be addressed early in next year's work. The original research plan objectives will be updated and milestones and completion dates will be revised to match changing requirements.

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THE USE OF LIGHT ATTENUATION FILTERS FOR NIGHT-FLIGHT TRAINING  
DURING THE DAY: FIELD VALIDATION

Dr. Kathleen A. O'Donnell, Project Director

**BACKGROUND**

Terrain flight is both an offensive and defensive tactic employed by pilots during combat. The aircraft is flown at or below treetop level so that terrain, vegetation, and man-made objects serve to mask and camouflage the aircraft. An enemy's ability to detect an aircraft visually, optically, or electronically is greatly reduced under these conditions. At night, terrain flight is an even more effective tactic for enhancing survivability. However, terrain flight at low luminance levels creates special demands on the pilot's visual, attentional, and response capabilities. Substantial training is required to develop and maintain night terrain flight skills.

Four problems complicate night terrain flight training at aviation field units. The first problem is accident risk; night terrain flight is one of the most hazardous modes of flight. The second problem is a shortage of night qualified IPs capable of training aviators to perform terrain flight maneuvers at night. The third problem is that the conduct of night training disrupts typical duty schedules. The fourth, and most significant, problem is the existence of local, civil restrictions on night terrain flight at many of the field units where night training is needed. For example, flight after 10:00 PM local time is not permitted on the Island of Oahu, and is restricted in the Federal Republic of Germany as well. Such restrictions make it extremely difficult to train and maintain night terrain flight skills.

One approach to the range of problems associated with training night terrain flight is to develop a methodology for training night flight procedures during daylight hours. A device developed for use in training night operations during daylight (TNOD) has been tested by the Army (Farrell, 1975; Bleda & Farrell, 1979; Peters, Bleda, & Fineberg, 1979; Bauer & Bleda, 1979; Bleda, 1979; Ciley & Allnutt, 1979; Ruffner, Ciley, & Wick, 1981). This device, the Light Attenuation Filter (LAF),

consists of two neutral density filters (of molded polycarbonate), fitted into modified Army Sun, Wind, and Dust Goggle frames. Light reaching the eye through the LAF is reduced by a factor of 1,000,000. Therefore, the daylight image perceived through the LAF closely resembles a night visual scene. A bright, sunny day appears to the aviator as a fairly bright, three-quarter moon night; a dark, overcast day appears as a dark, moonless night (Ciley & Allnutt, 1980).

Initial field tests of the LAF were conducted using UH-1 rotary wing aircraft at Fort Rucker, Alabama. The tests included flight and navigation tasks performed at both terrain flight levels and higher altitudes. Pilot performance on flight tasks with the LAF was found to be approximately the same as performance previously observed at night (Farrell, 1975). However, the LAF was found to degrade performance on navigation tasks (Farrell, 1975). The degradation of performance on navigation tasks was attributed to the fact that the aviator's visual access to maps and instruments was dependent upon the aircraft's orientation with respect to the sun. That is, when flying away from the sun, the ambient illumination in the cockpit was very high. Under these conditions, aviators reported that the instruments and larger features on the maps were visible with the LAF and that thorough preflight planning would have made it possible to perform navigation tasks while wearing the LAF. When the aircraft was flying into the sun, however, the instruments were in the shadow of the instrument panel and could not be seen with the LAF. Moreover, aviators reported that maps could not be read when the aircraft was flying toward the sun.

#### **NEED/PROBLEM**

The inability to perform navigation tasks under certain training conditions led to an alteration of the filters. An area  $1.5 \text{ cm}^2$  was cut out of both nasal portions of one of the filters, which created two small areas where more light was transmitted to the eye. Through these areas, the pilot has visual access to the maps and instruments.

There is a need to assess the utility of the new LAF and accompanying LAF Training Module as a means of training and maintaining night flying skills at aviation field units. Information from this type assessment is essential for the development of a fully exportable, modularized COI for implementing the TNOD technique in field aviation units.

#### PROJECT OBJECTIVES

The specific objectives of this research are as follows:

- to obtain performance and user acceptability data on the use of the LAF for the training of night flight skills,
- to identify appropriate methods and materials for implementing the LAF for TNOD in aviation field units,
- to assess the utility of the LAF as a means of meeting the needs of aviation field units for training and maintaining night flight skills, and
- to develop a fully exportable and modularized COI for implementing the TNOD program in aviation field units.

#### RESEARCH APPROACH

Resource constraints and the need to conduct this research under conditions that naturally occur in operational units dictate the adoption of a non-experimental, survey approach to the validation effort.

#### Research Site

All aviation field units that are currently under local civil restrictions on night flight will be identified. From these installations, two company-sized units, with approximately equal numbers of rotary-wing aviators, will be selected for the validation effort. A POC will be identified at each unit at the earliest possible date. Each POC will be requested to retain all non-current copies of gradeslips for later analyses.

## Data Collection

Checkride grades, questionnaires, and structured interviews by project personnel will be used to obtain the training effectiveness and user acceptability information required to validate the LAF training. Grades from regularly scheduled night qualification flights, refresher flights, and continuation evaluation flights will provide information relevant to the training effectiveness of the LAF.

User acceptability of LAF training will be evaluated in two ways. First, unit utilization of the LAF will provide one measure of user acceptability. The proportion of night training flights during which the LAF was used will be derived from the gradeslip (DA Form 4507-R), currently used in the units as a training record. Second, all LAF-trained aviators will complete a pre-training questionnaire, a post-training questionnaire, and a structured interview--all designed to obtain the trainees' evaluations of the utility of the LAF and their recommendations concerning the integration of LAF training with other unit training.

Three visits to each field unit will be made by the Project Director during a six-month period. The purpose of the first visit is to distribute the LAF and accompanying training module and to administer the pre-training questionnaire to all rated aviators in the units. Unit SIPs, IPs, Unit Trainers (UTs), the unit commander, and the unit training officer will be briefed on the purpose of the research, the schedule of the validation effort, the care and use of the LAF, and special LAF training implications. They also will be given a brief (15 to 20 minute) in-flight LAF orientation. All available current and non-current night training and evaluation gradeslips will be examined and relevant information will be recorded.

The second visit will be scheduled approximately one month after the initial visit. The objective of this visit is to review the units' implementation of the LAF training technique and ensure that the appropriate records are being maintained. A review of the tasks trained with the LAF will be conducted. If necessary, unit personnel will be

encouraged to expand the use of the LAF to additional tasks. Informal interviews with unit pilots, IPs, and unit training officers will be conducted to obtain information concerning any factors judged to be limiting the use of the LAF training technique. Where possible, solutions to such problems will be recommended.

The final visit to the units will be scheduled approximately six months after the initial distribution of the LAF. The objective of this final visit is to obtain information relevant to the performance and user acceptability of the LAF training technique. Each aviator in the unit will be required to complete the post-training questionnaire in a structured interview format. All unit SIPs, IPs, and UTs who have conducted LAF training will be interviewed. All LAF and night training and evaluation gradeslips completed in the previous six months will be examined and the data required for this project will be recorded.

#### **Data Analyses and Recommendations**

Actual unit utilization of the LAF is the best available measure of user acceptability. A high ratio of LAF training to actual night training will be interpreted as an indication of high user acceptability. Questionnaire and structured interview data will be used to identify specific factors that might have limited the acceptability of the LAF training technique.

Overall flight and specific maneuver grades given during evaluation flights before and during LAF training will be compared for information relevant to training effectiveness. Marked differences between these data sets may be a function of LAF training; therefore, unit SIPs, IPs, and UTs will be questioned regarding such a possibility.

Finally, the LAF Training Module, which accompanies the LAF, will be revised in accordance with the results and the recommendations obtained.

## PROJECT STATUS

### Work Completed

The research plan was approved by ARI in December 1982. The LAF Training Module, pre- and post-training questionnaires, and a brief outline of instructions for use of the LAF were completed by January 1983. All the documents were reviewed by three IPs. Their recommendations were received and incorporated by June 1983.

Acquisition of the equipment necessary for fabrication of the LAFs proved to be more difficult than project personnel anticipated. Assembly of the LAFs was initiated in February 1983 and nearly completed by June 1983, when project personnel were informed that the LAF lenses designed to fit the Sun, Wind, and Dust Goggle frames were too large for the frames.

To date, only five pairs of LAF lenses have been ground to fit the goggle frames. These fully assembled LAFs were mailed to the ARI Field Unit, U.S. Army Europe (USAREUR) in July 1983, at the request of General Otis, Commander in Chief (CINC). A copy of the LAF Training Module and the outline of instructions for LAF use accompanied the five sets of goggles.

In June, the LAFs were used by two IRR students in order to evaluate the pre- and post-training questionnaires. The questionnaires were found to be acceptable (i.e., no ambiguities or misunderstanding occurred).

Lack of substantial progress on the project is due to the unwillingness of FORSCOM units to support the field testing. Project personnel have waited one year for FORSCOM support. As of this date, there is still no FORSCOM support for the research effort.

### Projected Completion Date

It is anticipated that all aspects of the project will be completed within one year from the project initiation date. Six months will be required for data collection, and six months for data analyses, report writing, reviews, and revisions.



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**AN ASSESSMENT OF THE EFFECTIVENESS OF TRAINING HELICOPTER  
INITIAL ENTRY STUDENTS IN SIMULATORS**

Mr. Steven L. Millard, Project Director

**BACKGROUND**

Students entering the Army's IERW course learn their basic contact flying skills in the TH-55 aircraft--a small two-place helicopter the Army uses exclusively for training. After 50 hours of in-flight training in the TH-55, IERW students receive 125 hours of training in the UH-1H aircraft. To achieve instrument qualification, students must complete 40 hours of instruction in the UH-1 flight simulator. After becoming qualified in the UH-1 aircraft, students may join an operational unit as a UH-1 aviator or enter qualification training in another aircraft type.

There is a clear and pressing need to consider alternatives to training basic flight skills in the TH-55 helicopter. The reasons for this need are explained below.

**Cost/Availability of Training Aircraft**

The TH-55 is the only helicopter in the Army's inventory that requires high octane aviation fuel. In the event of a major fuel shortage, high octane fuel could become costly enough or scarce enough to disrupt the Army's IERW training program. Furthermore, maintaining a separate fleet of aviation fuel trucks and an aviation fuel contract is bothersome and expensive.

A more important concern is the impending end of the useful life of the TH-55. At present, no new TH-55 aircraft are being acquired to replace those in the aging fleet. A phase-out of the TH-55 would require the Army to select from among three training options: the acquisition of a new training aircraft to replace the TH-55, the conduct of primary flight training in an aircraft that is now in the Army inventory, or training helicopter initial entry students in simulators (THESIS).

It seems unlikely that a decision will be made to purchase a new training helicopter. The Department of Defense has resisted proposals to develop and produce aircraft that are to be used solely for training. Furthermore, the Army has a strong desire to channel all available resources into operational equipment (Roscoe, 1980).

The replacement of training in the TH-55 with training in an operational helicopter is not a promising option because most operational Army helicopters are far more costly and consume considerably more fuel than the TH-55 (Grice & Morresette, 1982). Based upon initial cost and fuel consumption alone, it appears that the OH-58 is the only helicopter in the Army inventory that is even marginally suitable for use in conducting primary training.

There are no data available for use in evaluating the feasibility of replacing training in the TH-55 with training in a flight simulator; the research reported here has been designed to provide the data needed to assess this option.

#### **Availability of Other Training Resources**

Because of limited training resources at Fort Rucker, the Army is unable to accommodate a large and sudden surge in the training load. During the mobilization of Army aviation for the Vietnam War, IERW graduates exceeded 5,000 per year. During this period, primary training in the TH-55 was conducted at Fort Wolters, Texas; only the advanced phases of IERW were conducted at Fort Rucker. When the Army phased down pilot training, all IERW training was consolidated at Fort Rucker, and the number of IERW graduates was reduced to fewer than 1,000 per year. The current IERW training load--about 2,000 students per year--severely taxes the usable airspace and physical facilities at the USAAVNC. In the event of another major mobilization, USAAVNC would be hard pressed to increase the number of graduates to that of the Vietnam era without exceeding the capacity of existing airspace, stagefields, and other physical facilities at Fort Rucker. The reactivation of Fort Wolters is a feasible option, but a very costly one. It is possible that a more

cost-effective option is to increase the training capability of Fort Rucker by increasing the amount of training that is conducted in flight simulators.

#### **PROJECT OBJECTIVES**

The specific technical objective of this research is to assess the extent to which contact flight training in a simulator equipped with an external visual system transfers to a UH-1H aircraft for initial entry flight students. A factor complicating the accomplishment of this objective is the absence of a UH1FS equipped with a visual system. The lack of a UH1FS with a visual system necessitates the use of a simulator for a different aircraft--the AH1FS, the CH47FS, or the UH60FS. Therefore, a secondary objective of this project is to identify the existing simulator that is the best surrogate for a UH1FS with a visual system.

#### **RESEARCH APPROACH**

##### **Overview**

An experimental group of student aviators will be given training on basic flight tasks in a flight simulator equipped with a visual system. A matched control group will receive conventional training in the TH-55 aircraft. Then, members of both the experimental group and the control group will receive transition training in the UH-1 aircraft. Final evaluation measures of proficiency on selected flight tasks will be used to measure relative training transfer for the two groups.

##### **Selection of a Flight Simulator**

As was stated above, three simulators with visual systems are available for training students during this research: the AH1FS, the UH60FS, and the CH47FS. The CH47FS has been eliminated as a candidate because of airframe and powerplant differences between the CH-47 and the UH-1H, the lack of a side window in the CH47FS, and the schedule of usage anticipated for the CH47FS. The AH1FS and the UH60FS are viable candidates for training. Both simulators have comparable visual

systems, fidelity, and instructional features. Differences arise when comparing the simulators with the target aircraft, the UH-1H. The AH-1 and the UH-1 are manufactured by the same company, are single-engine, two-bladed, single-rotor, skid-type helicopters. The UH-60 is a twin-engine, four-bladed, single-rotor, wheeled-gear helicopter. The UH-60 has advanced instrumentation that is dissimilar to the UH-1H instrumentation. The AH-1 instrumentation, however, is almost identical to the instrumentation in the UH-1H. Consequently, in an effort to provide for maximum transfer, the AH1FS has been selected for this research.

### Subjects

A total of 10 experimental-group subjects will be selected from an IERW class. Experimental-group subjects will be selected randomly from class members who have had no prior flight instruction. Once the experimental-group subjects have been selected, a matched sample of 10 control-group subjects will be selected from the same class. Factors to be used in selecting a control-group counterpart for each experimental-group subject include: RFAST score, age, sex, source of commission, and prior flight instruction (none). To avoid an impact on the appointment and date of rank of WOCs, all subjects selected for this research will be commissioned officers.

### Method

The 10 control-group subjects will undergo conventional primary training in the TH-55 aircraft; the 10 experimental-group subjects will receive primary training in the AH1FS. Both groups will be trained by Aviation Contractor Employees (ACE) IPs--civilian IPs who administer primary training to all IERW trainees. Both groups of subjects will receive classroom instruction of the type currently administered during the primary phase of IERW training. The aircraft-specific classroom instruction administered to the experimental-group subjects will deal only with the UH-1H aircraft. At the completion of primary training, the 20 subjects will receive UH-1 transition training as conducted

during normal IERW training. At the beginning of the UH-1 transition training, the 10 experimental-group subjects will enter the normal IERW training flow.

Since these students are a part of an experimental program, a special setback/elimination policy has been adopted. In essence, the policy dictates that no experimental-group subject may be eliminated from training during the UH-1 transition phase. Should a student's performance indicate a lack of proficiency usually associated with elimination, the student will be allowed to return to the primary phase of training and progress through a normal IERW training cycle.

The end-of-phase checkrides, administered to all students completing UH-1 transition training, will be conducted such that the DES IPs who administer the checkrides will not know which type of primary training the students received.

#### **Data Analysis**

The objective of the data analysis is to determine the extent to which experimental subjects differ from control subjects in the level of proficiency achieved in the UH-1. The dependent measures to be analyzed include: daily grades on individual flight tasks/maneuvers, the flying time and number of practice iterations required to achieve proficiency, and checkride grades. Performance on each training task/maneuver will be analyzed separately.

Statistical analyses will be conducted to assess the magnitude and statistical differences in the skill acquisition rate and the post-training proficiency level of experimental- and control-group subjects. In addition, an analysis will be conducted to assess the relative cost effectiveness of the two training approaches.

## PROJECT STATUS

### Work Completed

A research plan has been developed and approved by ARI. The following activities have been completed in preparing for initiation of the THESIS training.

- A briefing to the Commanding General on the proposed research methodology,
- the formation of a JWG representing interested directorates,
- the selection of the AH1FS as the simulator to be used during the project,
- the revision of the IERW instructional material for the THESIS students, representing a shift of emphasis from the TH-55 to the UH-1 in six programmed texts, and
- the development of a special setback/elimination procedure for THESIS students, protecting their right to complete IERW should the project produce negative transfer effects.

### Projected Completion Date

The conduct of the THESIS project is dependent, in part, on the availability of the AH1FS. Under current forecasts, the AH1FS will be removed from service beginning in February 1984 for upgrading to a fully modernized version. To accomplish the THESIS training prior to February 1984, the project must commence in early November, 1983. Since THESIS students will be followed throughout their IERW training, work on the project will continue through the summer of 1984.

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**DEVELOPMENT OF A COMPREHENSIVE RESEARCH PLAN FOR ARMY  
FLIGHT SIMULATOR DESIGN AND USE**

Dr. Kenneth D. Cross, Project Director

**BACKGROUND**

In June 1982, the Assistant Secretary of the Army for Research, Development, and Acquisition, Dr. J. R. Sculley, requested that Commander, Development and Readiness Command (DARCOM), form a Flight Simulator Steering Group that was to map out the paths future Army flight simulator research and development should take. Gravely concerned about the escalating complexity and cost of simulators, the Assistant Secretary established as a primary objective "...the development and acquisition of only such simulator training capabilities as are absolutely essential."

At the outset, members of the Steering Group were directed to outline a program of research that addresses three broad questions:

- How much simulator fidelity is needed for effective training transfer?
- What paths should research and development follow to optimize future flight simulator development?
- What Army policies are needed to manage more effectively the simulator program?

The Group's membership was drawn from DARCOM, TRADOC, and ARI and has represented in it, from both the training and materiel communities, researchers, developers, and managers.

Primary responsibility for developing a comprehensive long-term research plan was assumed by Mr. Charles A. Gainer, the Steering Group representative from ARI. Mr. Gainer organized a local team to undertake the development of the plan and supervised the team's efforts from inception to completion. Both ARI and ASI personnel served on this team.

The research plan has four sections: an introduction, two proposed integrated research plans, and a discussion of research support issues. A detailed, but not exhaustive, literature review and a



bibliography are appended as background material for the introduction and the overall research plan.

After an overview, the introduction defines key terms as they are used in the research plan and then details basic assumptions and concepts that had a major impact on the formulation of the research plan. Then present constraints on flight-simulator research and development are identified and discussed. The introduction is concluded with a statement of the rationale underlying the proposed research approach.

The next two sections of the plan map out two paths of research: a long-term path and a short-term path. An overview of the two paths of research is presented below. The final section of the plan, yet to be written, will outline the support that is required to accomplish the proposed program of research. The final section of the plan will be written once all agencies involved have reviewed, refined, and approved the first three sections of the research plan.

#### **RESEARCH OBJECTIVES**

The broad objective of the program of research is to compile data needed to specify, for individual flight tasks, the fidelity of each simulator design parameter and training feature that will yield the most cost-effective training. To accomplish this objective, research must be conducted to quantify the relationship between fidelity and training effectiveness, and training-cost data must be collected or extrapolated to determine relative cost effectiveness of training alternatives. Thus, the specific objectives of this program are as follows:

- design and conduct research to obtain the data needed to quantify the relationship between training fidelity and training effectiveness,
- design and conduct research to obtain the data needed to define the relationship between flight simulator life-cycle costs and training fidelity, and
- design and conduct research to define the type, cost, and training effectiveness of training methods and media that represent alternatives to simulator training.

## OVERVIEW OF PROPOSED RESEARCH

A substantial amount of time and effort will be required to complete the research needed to quantify fully the relationship between training fidelity and training effectiveness. However, the aviator training problems that currently exist cannot be ignored while this research is being completed. One solution to this dilemma is to initiate long-term and short-term paths of research. This solution was adopted and has had a major influence on the proposed research plan.

The long-term path, which is to commence simultaneously with the short-term path, shall be a program of basic and exploratory research concentrating on training fidelity requirements and on the development of various training techniques. Training effectiveness and cost effectiveness of various training fidelity profiles will be evaluated to ensure that emerging/future training hardware capabilities can be exploited. Most importantly, the research program associated with the long-term path must remain flexible and responsive to both advances in technology and changes in operational requirements.

The long-term path is aimed at providing comprehensive data for future requirements and at utilizing future technology. Five research areas are identified as the primary domain of the long-term path: fidelity requirements for visual systems, fidelity requirements for motion systems, fidelity requirements for simulator displays and controls, fidelity requirements for simulator aerodynamic model, and requirements for support features. Secondary areas of required long-term supporting research are also identified.

The short-term path is based upon the premise that, with only a moderate amount of analytic study and research, it is possible to develop a high-technology, low-complexity, generic flight simulator that will prove far more cost effective than the high-fidelity flight simulators presently being procured by the Army. The short-term path has as its immediate goal the development and evaluation of a prototype high-technology, low-complexity, generic flight simulator. As presently conceived, the generic simulator would consist of a set of standardized

modules that can be easily and inexpensively tailored to accomplish training for any rotary-wing aircraft in the Army inventory. Using present or very-near-term hardware and training technology, the prototype simulator will be designed to accomplish individual and crew training. If the prototype device proves cost effective for individual and crew training, research will be conducted to identify the additional hardware and the training methods required to accomplish team and combined-arms training in the device. Evidence that the device is cost effective would lead to recommendations that the Army procure and field generic simulators for use until the optimal design and use of flight simulators is defined empirically through the long-term path research.

#### **PROJECT STATUS**

##### **Work Completed**

A draft of the first three sections of the research plan (a 184-page document) has been completed, reviewed by ARI and ASI personnel, and has been distributed for review by members of the Steering Group.

##### **Project Completion Date**

The draft of the research plan was delivered to ARI in August, 1983. The delivery of this draft fulfills the current tasking for this project. Further tasking and project milestones must await completion of the Steering Group's review and recommendations.

CONVERSION OF ADVANCED MAP INTERPRETATION AND TERRAIN ANALYSIS  
COURSE EXERCISES TO VIDEODISC FORMAT

Ms. Elinor Cunningham, Project Director

BACKGROUND

NOE flight is essential to the survivability and mission success of Army helicopters on the modern battlefield. One of the main requirements for the successful execution of an NOE mission is the ability to navigate accurately by means of visual pilotage. Early research by ARI personnel showed that a large proportion of Army aviators are unable to navigate at NOE altitudes with sufficient accuracy and that aviators' main skill deficiency is map interpretation (Fineberg, Meister, & Farrell, 1974). In response to this deficiency, ARI funded an effort to develop prototype training methods and materials. This effort resulted in the development of the basic Map Interpretation and Terrain Analysis Course (MITAC) (McGrath & Foster, 1975). The Basic MITAC focuses on the key principles of map interpretation that must be understood in order to navigate accurately when the view of the surrounding terrain is severely restricted by the masking effect of terrain, vegetation, and other obstacles.

The Basic MITAC has three training elements: (a) a training text entitled Map Interpretation in Nap-of-the-Earth Flight, which summarizes the key principles of map interpretation applied to NOE navigation, (b) illustrated lectures that employ 35-mm color slides and recorded commentaries to discuss and illustrate the rules and practices cartographers follow in selecting and portraying topographic features on 1:50,000-scale topographic maps, and (c) navigation exercises which employ recorded commentaries and 16-mm movie film shot from the nose of a helicopter flying at NOE altitude. The navigation exercises require the student to perform a preflight map study of the area to be flown, listen to a commentary on preflight map study, view the filmed route while simultaneously marking the route on the map, check and score performance, and watch the film a second time while listening to an instructional debriefing.

The Basic MITAC was empirically evaluated by ARI in 1977. The evaluation revealed that MITAC-trained student aviators could navigate along NOE routes at twice the speed and with one-third the errors of normally trained students (Holman, 1977). The evaluation report recommended that all aviators with NOE flight requirements be given Basic MITAC training. At present, student aviators in the Army's IERW course receive Basic MITAC in the academic portion of their training.

The Basic MITAC was designed for administration by a trained instructor. A self-instructional version of the Basic MITAC subsequently was developed for use in unit training. The self-instructional version of Basic MITAC is referred to as MITAC-II. The MITAC-II package has been converted to the Training Extension Course (TEC) format, which consists of audio cassettes and 8-mm film cassettes designed for use in the Beseler Que/See.

In 1977, ASI was contracted to develop a set of Advanced MITAC exercises. The advanced lessons were designed to expose trainees to more difficult exercises and to a wider range of topography than they are exposed to in the Basic MITAC. The Advanced MITAC exercises also provide training on navigating over snow-covered terrain and navigating with maps compiled by foreign cartographers. The Advanced MITAC exercises cover the following types of topographical contexts in Arizona, Idaho, Kentucky, and Germany:

- foothills and mountainous upland--full foliage,
- foothills and mountainous upland--snow covered,
- high plains (steppe)--dry season,
- high plains (steppe)--wet season,
- lowland plains--rolling grassland, full foliage,
- lowland plains--rolling grassland, snow covered,
- rugged hills and valleys--full foliage,
- rugged hills and valleys--snow covered,
- desert foothills and mountains,
- desert basin, rocky terrain,
- European foothills--foreign-made maps, and
- European plains--foreign-made maps.

Thirteen Advanced MITAC exercises were developed. The materials developed for each exercise include: an annotated 16-mm color film,

preflight and postflight commentaries recorded on audio cassettes, a self-instruction manual, a map plate, and a map-plate overlay used for scoring performance. No attempt has been made to evaluate the training effectiveness of the advanced navigation exercises.

In 1982, interest was developing in laser videodiscs as a means of presenting MITAC training material. As a result, ARI assigned ASI personnel the task of producing a demonstration laser videodisc of one of the Advanced MITAC exercises as a method for demonstrating the capabilities and limitations of laser videodisc technology over alternative audio-visual systems. The demonstration disc was received and evaluated in May 1982. The main advantages of laser videodiscs are:

- high quality video and audio reproduction with no degradation with use,
- disc player (Pioneer) capabilities of chapter and picture automatic stops, freeze frame, slow or fast motion, frame-by-frame stepping forward or reverse, and rapid access to any frame or chapter on the disc,
- one-half hour of programming in the Constant Angular Velocity (CAV) mode or 54,000 individual frames per side,
- two audio tracks that can be used together, individually, or muted, and
- a limited interactive capability.

The evaluation revealed two important disadvantages of videodiscs. One disadvantage is the large investment in time and resources that are required to produce a videodisc. A considerable amount of time on expensive TV editing equipment is required to produce the master tape (one inch) from which the discs are produced. Furthermore, it is costly to produce the master disc from which reproductions are made. Because of the high developmental costs associated with videodisc production, the cost-effectiveness is influenced greatly by the number of copies that are to be produced and used. A second disadvantage is the inability to play audio at any speed other than the normal 30 frames per second. Even though the video image remains the same, frames are consumed at a rate of 30 frames per second during the time that the audio channels are used.

The evaluation of the prototype disc led to the conclusion that the advantages of laser discs more than offset the disadvantages and that videodisc constitutes an excellent medium for presenting the Advanced MITAC exercises. As a consequence, ARI directed ASI personnel to convert the 13 Advanced MITAC exercises to videodisc format.

#### **PROJECT OBJECTIVES**

The objective of this project is to convert the 13 Advanced MITAC exercises from 16-mm film to laser videodisc format. The deliverables to be produced for each Advanced MITAC exercise are listed below:

- 25 copies of a laminated map and legend plate,
- 25 copies of a map-plate overlay,
- 25 copies of a self-instructional manual,
- 25 laminated contour templates,
- 25 copies of a performance measurement chart master, and
- 50 copies of the videodiscs.

#### **APPROACH**

This project is a production effort rather than a research project. The conversion of the exercises to videodisc format is an exacting process that is accomplished in three phases.

##### **Phase I: Program Design/Production**

The tasks accomplished during the first phase include the definition of detailed program objectives, the development of storyboards that specify picture and sound sequences, and the production of video tapes (from 16-mm film) and audio tapes of program segments.

##### **Phase II: Premastering**

The objective of Phase II is to produce a one-inch, Type C video tape that is submitted for mastering and replication. Premastering includes the transfer of program material from tape, film, or slides onto one-inch tape. Color and contrast correction, cue insertion, and editing are accomplished during premastering.

### **Phase III: Mastering and Replication**

During Phase III, the company that is to produce the disc (in this case, Pioneer Video, Inc.) checks the master tape for adherence to specifications, makes a master disc from the tape, replicates the master disc in the quantity specified, and checks the discs for conformance to specifications.

### **Allocation of Tasks**

Because of the highly specialized knowledge and equipment necessary to produce the premaster, ASI will subcontract with AEROTEB, Inc., Santa Barbara, California, to accomplish some of the tasks in the conversion process. Table 1 lists the tasks to be performed by ASI and AEROTEB in producing the premaster tapes and in producing the associated peripheral materials for the Advanced MITAC exercises.

### **PROJECT STATUS**

#### **Tasks Completed**

The tasks that were completed by ASI and AEROTEB personnel during the second contract year are summarized below.

- The 325 map plates have been printed, the maps have been cut and pasted onto the printed plates, and the corridor outlines have been drawn onto the maps.
- Three routes have been verified and redrawn.
- Storyboards for the video taping of the preflight commentaries have been designed.
- The contour templates have been cut.
- Two preflight commentaries have been video taped onto one-inch, Type C video tape.
- The disc instructions and format have been developed.
- The audio recordings of the preflight and debriefing commentaries have been made.
- The 16-mm films of the exercises and debriefings have been transferred to tape.
- A 3/4-inch tape of Side 1 of the first disc has been produced for final review before mastering.



TABLE 1

VIDEODISC MITAC TASK LIST FOR CONVERSION OF ADVANCED MITAC  
(These tasks are not necessarily in the order of performance.)

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Tasks Performed by ASI

- Identify and order 1:50,000-scale topographic maps of the routes flown.
- Order the advanced MITAC 16-mm films.
- Order laminating film.
- Screen films for quality.
- Review the filmed routes, preflight and debriefing commentaries, map plates, and route overlays together for accuracy; make corrections.
- Type corrected commentaries for use in audio recording. Check recordings for accuracy.
- Correct route overlays. Redraw them and have copies photographically reproduced.
- Cut map plates. Draw the "corridors" on the maps. Add arrows for the initial starting points.
- Make up legend plates.
- Print the grid numbers, lesson titles, and legend information on "card" stock paper.
- Paste map and legend information onto the map plate. Laminate with three-mil laminating film.
- Cut and laminate the contour templates.
- Develop disc instructions and format.
- Develop storyboards for videotaping the preflight commentaries.
- Videotape the preflight commentaries on one-inch, Type C tape.
- Review 3/4-inch dub from AEROTEB for correction before mastering.
- Design disc labels and packaging.
- Rewrite self-instructional manuals.

Tasks Performed by AEROTEB, Inc.

- Develop disc instructions and put them on video tape using a character generator.
  - Have the preflight and debriefing commentaries professionally recorded.
  - Transfer the filmed 16-mm exercises to one-inch video tape.
  - Transfer the debriefing exercises to one-inch video tape and edit in the audio.
  - Edit the preflights into the exercises.
  - Perform all disc mastering requirements
-

### Tasks in Progress

The tasks yet to be completed include video taping and editing the remaining 11 preflights, premastering and mastering the tapes, and reproducing the videodiscs. While these tasks are being completed, work on the peripheral materials will continue. This work consists primarily of verifying and redrawing the route overlays, assembling and laminating the map plates, and rewriting the self-instructional manuals.

### Projected Date of Completion

It is anticipated that all work on the videodiscs and peripheral materials will be completed by 1 February 1984.

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**ASSESSMENT OF FLIGHT APTITUDE SELECTION TEST SCORES AS  
PREDICTORS OF ACCIDENT INVOLVEMENT**

Dr. Robert E. Lockwood, Project Director

**BACKGROUND**

Historically, human error has been found to be a contributing factor in between one-half and two-thirds of all aviation accidents. A major portion of the accident-producing errors have been committed by the aircraft pilot (Zeller, 1978). In a review of Air Force accidents occurring in 1949, Thorndike (1951) reported that pilot error was a major contributing factor in 24.0% of the accidents listed; materiel failure was a contributing factor in only 26.2% of the accidents. A review of U.S. Army aircraft accidents by Ricketson, Johnson, Branham, and Dean (1973) revealed that pilot error was a factor in 80% of all accidents that occurred during the years between 1958 and 1972.

Sanders, Hofmann, Hunt, and Snow (1974) conducted an exploratory study to determine whether or not personality factors and/or decision-making skills are related to the likelihood of becoming involved in a human-error accident. Although it was found that three of Cattell's Sixteen Personality Factor Questionnaire factors discriminated between members of the accident group and members of the no-accident group (human-error accidents only), this finding was not supported by a subsequent study that employed a larger sample size (Sanders, Hofmann, & Neese, 1975). The authors conclude: "These data indicate that individual differences in personality characteristics of aviators prevent identification of personality traits associated with pilot-error accident-involved and pilot-error accident-free groups" (Sanders et al., 1975, p. 7). This study exemplifies the negative finding of numerous studies that have investigated the relationship between accident likelihood and scores on personality tests. Although it seems probable that personality factors influence flight performance, personality factors do not operate independently. Rather they interact with environmental factors, equipment design, training, and situational factors. Thus, research conducted on the attributes of aviators involved in pilot-error

accidents must, ultimately, deal with the interaction of many factors that contribute to an accident.

#### RESEARCH OBJECTIVE

The objective of this research is to determine whether or not FAST scores can be used to predict accident involvement. The FAST measures a number of abilities and personality factors that have been shown to predict success in the flight training program (Kaplan, 1965; Eastman & McMullen, 1978a). Two subtests from the FAST are of particular interest: Self-Description and Biographical Information. Both subtests have numerous items that assess personality factors. However, the research was designed to investigate all subtests.

#### RESEARCH APPROACH

The original tasking for this project was to investigate the relationship between performance on the RFAST and accident involvement. The RFAST, the test currently used to select applicants for flight school, is composed of seven of the 11 subtests from the original FAST, with each subtest containing approximately one-half of the items that appeared on the FAST. This shortened version was implemented in 1980. Since no accident data exist on pilots who were admitted to flight school with an RFAST score, it was necessary to use the older FAST scores. However, since the RFAST is essentially a shortened version of the FAST, analyses using FAST scores should provide a valid, albeit conservative, estimate of the relationship between RFAST subtest scores and accident involvement.

The approach used in this research requires the accomplishment of two analytic tasks:

- assess the relationship between test performance and accident involvement, and
- assess the relationship between test scores and accident type.

Total score, subtest scores, and individual item scores on the FAST were correlated with accident involvement in which pilot-error is a known or

suspected contributor. Accidents included in this study range from major accidents (Level A) to precautionary landings (Level E).

#### **STUDY SAMPLE**

The analyses were computed using a sample of 2,451 Army aviators: 1,026 who have been involved in a pilot-error accident and 1,425 who have not. The accident-involved group is composed of 275 Commissioned Officers and 750 Warrant Officers; the non-accident group has 460 Commissioned Officers and 965 Warrant Officers. The accident-involved group includes about 25% of all aviators who have been involved in pilot-error accidents since 1975. The non-accident-involved group was selected from the population of pilots who have graduated from IERW since January 1975 and who have not had an accident.

To assess the representativeness of the control group, an analysis was performed to compare the control group's scores on five FAST subtests with the corresponding scores of the sample of 7,007 aviators used to revalidate the FAST in 1978 (Eastman & McMullen, 1978b). Although significant differences between means were found for two of the five subtests, the differences were small (82.9 vs 79.7 for Self-Description subtest; 36.8 vs 35.0 for Biographical Information subtest). The statistical significance of such small differences is the result of the very large size of the samples. It was therefore concluded that using the current sample as representative of all IERW graduates in correlational analyses will not result in biased estimates of the relationship between test scores and accident involvement.

#### **DATA ANALYSES**

Data on FAST performance were obtained for all subjects from archival records. Accident data, including the type of accident, for the 1,026 aviators in the accident-involved group were obtained from accident-data files maintained by the U.S. Army Safety Center. These data were submitted to two types of analyses. First, Pearson Product-Moment correlation coefficients were computed to assess the magnitude of

the relationship between accident involvement and (a) total FAST score, (b) score on each of the 14 FAST subtests, and (c) score (correct/incorrect) on each of the 547 FAST items. The item level analysis was undertaken to investigate the possibility of recombining items, across subtests, into a meaningful predictor of accident involvement.

The second analysis consisted of a one-way analysis of variance to assess the relationship between FAST subtest scores and type of accident. This analysis included only the subtests that were found to have a correlation of .10 or greater with accident involvement.

#### RESULTS AND CONCLUSIONS

Statistically significant correlation coefficients ( $p < .05$ ) were found for the total test score and for 10 of the 14 subtest scores. Although statistically different from zero, all 11 correlation coefficients are very small--varying from .054 to .110. As stated earlier, samples as large as the ones used in this analysis often yield statistically significant correlation coefficients that are too small to be of practical significance. The weakness of the relationship between accident involvement and subtest score is illustrated by the fact that the subtest whose score is most highly correlated with accident involvement ( $r = .110$ ) accounts for only 1.2% of the variance associated with accident involvement.

An analysis limited to the FAST subtests that were retained on the RFAST showed that the highest correlation between accident involvement and any RFAST subtest is .082--the correlation coefficient obtained for the Mechanical Functions subtest. Correlation coefficients for the remaining RFAST subtests vary from .08 to near zero. These findings show that the subtests retained in the RFAST account for even less variance in accident involvement than the FAST subtests. Thus, it is clear that the relationship between the subtest scores and accident involvement is far too weak to be practically useful for identifying qualified IERW applicants who have a greater than average likelihood of becoming involved in an accident.

The results of the item-level analyses show a pattern similar to the one revealed by the subtest-level analyses. That is, although there are many statistically significant correlations between item scores and accident involvement, the magnitude of the correlations are too small to be practically useful. It was found that 342 items from the FAST had correlations with accident involvement between zero and  $\pm 0.03$ . The four highest correlations among the 547 items analyzed were in the range  $\pm 0.10$  to  $.12$ . These four items still have very little variance shared with accident involvement. A review of the items showed that most of the statistically significant items were from subtests that had not been retained in the RFAST. This finding, coupled with the small correlation coefficients found, suggests that a recombination of items to form a predictor is not a promising analytic procedure.

Following the correlational analysis, a series of one-way analyses of variance were computed using only the subtests with a correlation coefficient equal to or larger than  $.10$ . In addition, since Biographical Information and Self-Description subtests were of particular interest in this study, these subtests were included in the analysis of variance even though their correlations with accident involvement were less than  $.10$ .

The analyses showed that there are no statistically significant differences among accident category means for either the WOC Self-Description subtest or the Officer Biographical Information subtest. Statistically significant differences among category means were found for the remaining five subtests--all FAST subtests. However, the absolute magnitude of the differences are so small that they have little value for discriminating among categories of accidents. For example, using the Total Score, the largest mean,  $219.1$ , is for the Level A accident group; the smallest mean,  $208.4$ , is for the no-accident group. The standard deviations for these groups are  $28.7$  and  $29.8$ , respectively. The  $10.61$  point difference between the two means is about one-third of the standard deviation for each group. Therefore, the expected distribution of scores for the Level A accident group will

contain many of the scores expected for the no-accident group. Specifically, it can be shown that approximately 68% of the no-accident group will have scores between 178.64 and 238.24, and approximately 68% of the Level A accident group will have scores between 190.35 and 247.75.

In summary, the results of all analyses conducted show some statistical significance. However, because this statistical significance is largely a function of the large sample size used in the analyses, it is concluded that the relationships between FAST subtest scores and accident involvement are so weak that FAST scores cannot be considered even a marginally practical predictor of accident involvement. Also, since none of the subtests retained in the RFAST are correlated above .10 with accident involvement, the RFAST is an even less powerful predictor of accident involvement than the FAST.

#### PROJECT STATUS

##### Work Completed

Five copies of Working Paper #FR/FU-83-1, entitled FAST Scores as Predictors of Accident Involvement, were submitted to ARI personnel for review and approval on 29 March 1983. Approval of the Working Paper completes ASI's tasking on this project.

##### Projected Completion Date

All work on this project was completed on 29 March 1983.

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**INVESTIGATING THE FEASIBILITY OF USING VISUAL FLIGHT SIMULATORS  
FOR NIGHT VISION GOGGLE TRAINING**

Dr. Dennis H. Jones, Project Director

**BACKGROUND**

During the past two decades, there has been a major re-evaluation of traditional military strategies involving Army aviation. Specifically, recent military experience indicates that technological advances in aircraft detection and ground-to-air weaponry requires Army aviators to (a) employ low-altitude tactics, including NOE flight, as an integral part of their offensive and defensive strategies, and (b) expand their operational capabilities to include nighttime and adverse weather conditions. The combination of these two requirements--the performance of low-altitude tactics under low levels of illumination--may represent the greatest challenge to face Army aviation in its history.

The ability of Army aviators to perform terrain flight maneuvers and to navigate in unfamiliar environments at night using unaided scotopic vision is limited by the availability of ambient light. Without sufficient ambient light, the aviator simply cannot see the terrain clearly enough to fly safely or to navigate effectively. For more than a decade, the Department of the Army has sponsored research and development (R&D) aimed at producing a night vision device that facilitates the performance of terrain flight tactics under low levels of illumination.

The R&D effort began during the latter part of the Vietnam war when it became obvious that Army aviators must be capable of performing terrain-flight tactics during the day and at night in order to survive mid-intensity warfare. Based on a recommendation from a Modern Army System Test and Evaluation Review (MASSTER), an IPR committee directed that a low-cost night vision goggle (NVG) device, originally developed for use by ground personnel (Johnson, Tipton, Newman, Wood, & Intano, 1972), be adopted as an interim solution to terrain flight under low levels of illumination. Thus, the Army Navy/Pilot Visual System

(AN/PVS-5) NVG was procured and a Required Operational Capability (ROC) was issued without formal developmental testing or operational testing.

The standard AN/PVS-5 NVG is a binocular device with unity magnification. It is approximately 6½ inches square, weighs 28 ounces, and provides a 40° field-of-view with a visual acuity of approximately 20/50. The device contains two electro-optical systems designed to perform optimally under low levels of illumination. Each electro-optical system contains an image intensifier tube that increases the number of ambient light particles and utilizes fiber optics to project a visual image onto a green phosphorous plate.

The IPR committee accepted the AN/PVS-5 NVG as an "interim solution" to the requirement for a night vision device to facilitate performance of Army aviators. The committee members knew from the outset that the AN/PVS-5 NVG is not ideally designed for use in an aircraft cockpit. Therefore, it was not surprising that subsequent research and experience demonstrated that the standard AN/PVS-5 NVG is only a marginally acceptable night vision device (see Gunning, 1983). However, the problems revealed by the research and experience have guided the modifications of the standard AN/PVS-5 (McLean, 1982) as well as the design of the newest night vision device, the Aviator Night Vision Image System (ANVIS) (Richardson & Crew, 1981).

#### **NEED/PROBLEM**

Pursuant to the instructions of the IPR Committee ROC, NVG training requirements were established and detailed in the ATM for each Army aircraft. Each ATM specifies the prerequisites for NVG training, as well as the academic and flight training requirements for NVG qualification training, NVG continuation training, and NVG refresher training. For example, to become NVG qualified, an aviator must:

- receive 10.5 hours of academic instruction in night (unaided) flight and NVG flight procedures,
- demonstrate proficiency in the performance of all ATM tasks (except for the 5,000 series tasks) during night (unaided) flight,
- receive 1.5 hours of cockpit blackout training prior to beginning NVG flight training, and
- receive between 8.5 and 13.5 hours of NVG flight training prior to demonstrating proficiency to an NVG qualified IP.

The ATM requirements for NVG qualification training are representative of the training requirements for NVG continuation training and NVG refresher training. That is, except for 1.5 hours of cockpit blackout training, all flight training is conducted in the aircraft.

Given the safety problems associated with using night vision devices during rotary-wing flight, it is probable that accident risks can be reduced by accomplishing some portion of NVG training in visual flight simulators, prior to NVG training in the aircraft. Furthermore, if the NVG flight training currently being conducted in the aircraft can be augmented by training in visual flight simulators, there is a potential for enormous savings in manpower, aircraft time, and other resource requirements.

On 29 June 1983, ARI was tasked by DTD to "...conduct formal systematic testing, collect and evaluate empirical data, and determine the feasibility of night vision goggle (aided) training in visual flight simulators."

#### PROJECT OBJECTIVES

The specific objectives of this research project will be dictated by the research approach selected by the representatives from DTD. The general objectives are as follows:

- to identify the NVG tasks that can be trained in a visual flight simulator,
- to develop a POI to be used in training NVG tasks in a visual flight simulator, and

- to determine the feasibility of NVG training in visual flight simulators.

#### RESEARCH APPROACHES

On 22 July 1983, a meeting was held with representatives from various staff agencies to discuss issues surrounding the choice of an appropriate research design. Comments from the representatives were divided. Some representatives suggested that the feasibility question can be answered by obtaining judgments from several UH-60 NVG-qualified IPs after having performed relevant flight tasks with NVGs in the UH60FS. Other representatives argued that a feasibility study alone is not adequate and that nothing short of a full transfer-of-training study will provide the data needed to evaluate fully the cost-effectiveness of NVG training in simulators.

In view of the lack of consensus among agency representatives, ARI and ASI staff decided to develop three alternative research designs that vary in terms of (a) the type and magnitude of the resource requirements, (b) the amount of time (elapsed) required to complete the research, (c) the amount of support required from other agencies, and (d) the quantity and quality of data yielded by the research. The three research alternatives are discussed below.

The first research alternative is a skill acquisition study that could address the feasibility question in a short period of time and with a relatively small amount of resources. This research design provides information about the NVG skill acquisition of 10 UH-60 Aviation Qualification Course (AQC) graduates undergoing NVG training in the UH60FS. Each subject will be trained on relevant NVG tasks during five three-hour simulator sessions. By comparing each subject's performance on each ATM task during the fifth simulator session with his/her performance on the same ATM task during the first simulator session, it is possible to assess the extent to which performance of NVG tasks in the simulator improves with simulator training. However, since this research design does not assess subsequent performance of NVG tasks

in the aircraft, there is no way to assess the extent to which simulator training on NVG tasks transfers to the aircraft.

The second alternative is a transfer-of-training study that addresses the most important questions associated with NVG training in visual flight simulators. This study is designed to allow detailed comparisons of performance and skill acquisition of (a) a group of subjects trained to NVG qualification in the UH-60 aircraft (control group), and (b) a group of subjects who receive NVG training in the UH60FS prior to NVG qualification training in the UH-60 aircraft (experimental group). The results of this research design can be used to (a) assess the rate of skill acquisition during training in a visual flight simulator, (b) identify the transfer-of-training from the simulator to the aircraft by task, and (c) estimate the total savings in aircraft time, IP time, and other resources that can be realized from training in visual flight simulators. However, this design is resource intensive and requires extensive support by various Fort Rucker agencies.

The third alternative is a transfer-of-training study designed to incorporate the experimental design into the NVG training currently being conducted at Fort Rucker. Currently, IERW students are receiving NVG qualification training in the UH-1 aircraft during the Combat Skills phase of their training. This study attempts to evaluate the effectiveness of using the UH60FS and the UH-1 Cockpit Procedural Trainer (CPT) to train UH-1 IERW students for NVG flight in the UH-1 aircraft. Although the resource and support requirements for this alternative are less than for the second alternative (UH-60 transfer-of-training study), the dissimilarity of the UH-60 and UH-1 cockpits, combined with marked differences in their flight handling characteristics, may seriously confound this research approach.

#### PROJECT STATUS

Since July 1983, a review of the literature involving NVGs has been completed. The research alternatives have been developed and a

report describing them has been forwarded to DTD for review and evaluation. Work on the project will resume once DTD personnel have completed their evaluation and selected the research approach that represents an appropriate response to the tasking.

#### Projected Completion Date

The length of time required to complete this research project will depend on the research approach selected by DTD. However, it is estimated that, regardless of the approach selected, the research will be completed no later than 1 September 1984.

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**DEVELOPMENT OF COMPUTER-BASED SYSTEM FOR CONDUCTING  
MISSION/TASK WORKLOAD ANALYSES FOR THE ARMY'S  
EXPERIMENTAL LIGHT HELICOPTER**

Mr. Theodore B. Aldrich, Project Director

**BACKGROUND**

The U.S. Army is in the concept evaluation phase of development for a multipurpose, lightweight helicopter family, termed the LHX. Two versions of the LHX are planned. The Scout-Attack (SCAT) version will perform the Army's scout and attack missions in the 1990s and beyond; another version will perform the utility missions. A lightweight LHX will provide several benefits, including:

- a smaller target profile,
- greater speed, agility, and maneuverability,
- lower cost per aircraft, and
- a greater number of aircraft for the fleet.

The emphasis upon light weight has created an ancillary design goal. The Army is investigating whether the LHX missions can be flown by a single aviator. Clearly, a single-aviator configuration would contribute greatly to the attainment of the lightweight design goal. Additional advantages of a single-aviator configuration include:

- fewer pilots required in the force,
- reduced training costs,
- reduced manpower costs, and
- increased number of flight hours available with a given aircraft to pilot ratio.

On 7 July 1983, the Commandant, Army Aviation Research and Development Command (AVRADCOM) tasked ARI to develop mission/timeline analyses for the SCAT version of the LHX. The tasking message stated that "the ARI analyses will provide a better understanding of the pilot workload requirements and provide an insight as to which technologies will be required to operate the aircraft effectively in the combat environment and whether these tasks can be successfully accomplished with one pilot or two." ASI personnel were tasked immediately to assist in the analyses.



## PROJECT OBJECTIVES

This project has two specific objectives. The first objective is to develop a methodology that enables evaluation of the feasibility of single pilot operation of the LHX during scout-attack missions. The second objective is to develop a methodology that enables identification of mission functions for which automation can reduce pilot workload. To be effective, the methodologies must enable mission timeline analyses to be performed prior to the time that system and subsystem designs have been formulated. Attainment of these specific objectives will contribute to the fulfillment of a broader objective--the compilation of a set of baseline data for use in LHX man-machine tradeoff determinations and a data base to be refined through iterative mission, function, and task analyses as LHX system definition proceeds.

## APPROACH

The approach adopted for these analyses is designed to provide approximate, first-iteration results at the function level. At the outset, a set of assumptions and procedural limitations were developed in order to delimit and provide focus for the analyses. They are listed below:

- subsystems, and procedures for their operation, will be in non-specific, generic terms;
- analyses will address only primary aeroscout and attack mission functions under normal operating conditions (degradation resulting from system failures, visual obscuration, or enemy countermeasures will not be addressed in the initial analyses);
- validation will be limited to content review by SMEs;
- the general level of subsystem and weapon technologies will be assumed to be comparable to those provided in the OH-58D and AH-64A;
- time estimates, cognition requirements, and other parameters of mission functions will be based on current Army doctrine;
- performance elements within functions will be adjusted on the timeline to minimize operator overload resulting from concurrent attentional demands; and
- the analyses will be subject to change and further refinement as equipment configuration is identified.

DCD, Fort Rucker, provided 24 mission profiles for the SCAT. They consisted of 12 missions in a European scenario and the same 12 missions in a Middle Eastern scenario. The 24 LHX SCAT mission profiles will be the starting point for the analyses. The missions will be subdivided into phases and segments. Segments will be selected for analyses if they are common throughout several missions. Segments involving target acquisition, engagement, and handoff will be selected because they are likely to require high operator workload. Routine mission segments, such as preflight, takeoff, cruise, approach, and landing will not be analyzed in the first iteration.

Once mission segments are identified, they will be subdivided into functions. Functions required to complete each mission will be identified and the duration for each will be estimated. When the functions are organized into a segment timeline, the estimated function times will enable identification of functions performed concurrently.. Functions will be included in the analyses only if they are considered critical for accomplishing the specified mission activity or if they must be performed frequently, independent of mission activity. Finally, the functions will be subdivided into performance elements.

Performance elements will be analyzed as needed to determine: the equipment/subsystem involved, the attentional demands on the operator, and the duration of the performance element. The attentional demand analyses will address visual, auditory, cognitive, and psychomotor activities. A scaling system will be devised for rating the attentional demand associated with each of these activities. The amount of time required to complete each performance element will also be estimated. Task analysis data cited in the literature will be used as a reference in formulating these time estimates.

## **PROJECT STATUS**

### **Work Completed**

ARI assembled an analysis team consisting of Dr. Jack McCracken (ARI), Mr. Ted Aldrich (ASI), Mr. Harry Reed (Human Engineering

Laboratory [HEL], Aberdeen Proving Grounds), and Mr. Bob McMullen (ARI). Two highly experienced aviators--an attack pilot and a scout pilot--were assigned to the analysis team as SMEs. Work started on 12 July 1983. Mr. Aldrich drafted a list of assumptions that set the boundaries for the analyses at a level consistent with the objectives but constrained by the 1 September 1983 completion date. Work during 13-18 July consisted of defining standard verbs and object nouns to be used in the analyses. Team members were assigned mission segments for analysis.

From 18-31 July, the ASI analysis team member identified functions to be performed during the Target Service phase of the LHX mission. Eighty-five functions were identified for seven mission segments: holding area, acquisition, engagement, handoff, adjustment, team coordination, and maneuver in the target area. Performance elements were listed for each of the functions.

The 85 mission functions were reviewed by the team leader, Dr. McCracken, and two SMEs. Duplicate functions and functions deemed to be not mission critical were eliminated, resulting in 58 mission functions for further analyses. At this point, the analysis team was reduced to two members, Dr. McCracken (ARI) and Mr. Aldrich (ASI)

Performance elements for each of the functions were listed and defined using the standard verbs and objects defined earlier. The aircraft subsystem(s) involved in accomplishing the performance elements also were identified. Dr. McCracken estimated the sensory discriminations, decision requirements, and activation/control demands for each of the performance elements. The ASI team member estimated time to perform each of the performance elements and developed a set of decision rules for estimating the total time required to perform each function. References with helicopter crew task analysis data were used to formulate the time estimates. Time estimates were reviewed by Dr. McCracken and the SMEs and were modified to reflect the consensus of the mission analysis team.

A draft report was produced during August. The report provides approximate, first iteration estimates of the attentional demands and

time requirements for each of the 58 crew functions judged most critical for 12 major missions envisioned for the LHX. On 31 August, the results of the mission analyses were briefed to AVRADCOM. AVRADCOM personnel fully endorsed the results of the mission analyses.

#### **Projected Completion Date**

The delivery of a draft report and a briefing to AVRADCOM on 31 August represents achievement of the basic objectives as outlined by AVRADCOM and would be tantamount to completion of the project. However, additional work subsequently was requested by AVRADCOM officials. On 1 September, AVRADCOM officials requested that ARI perform two sets of additional analyses:

- analyses to assess the impact of a high degree of automation for flight control functions, target search and acquisition functions, navigation functions, and weapons delivery functions (to be completed by 23 September); and
- analyses for a two-man configuration to be completed by 7 October 1983.

Thus, work on this project will continue at least through 7 October 1983. Other tasks may be assigned at that time.

#### **Forecast of Additional Work**

There are two other areas in which additional LHX work may be required. First, ARI has suggested to AVRADCOM that the baseline analyses data produced by this project be computerized and that a computer model be developed for use in additional analyses. AVRADCOM has reacted positively to this suggestion. It is estimated that one year will be required to complete this work. Therefore, it is probable that the LHX mission analyses project will extend to September 1984.

Another area of work under discussion is LHX system simulation. The attentional demand and performance time estimates in the mission analyses could be refined considerably through system simulation as design alternatives are evaluated. AVRADCOM is addressing their total system simulation requirements, including the requirement to validate

the mission analyses. At year's end, there have been no decisions that provide a basis for projecting how long such a simulation development program may extend this project.

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## ANALYTIC ASSESSMENT OF NATIONAL GUARD AVIATOR TRAINING REQUIREMENTS

Dr. John W. Ruffner, Dr. Sandra S. Martin, Project Directors

### BACKGROUND

An aviator in the Army National Guard (ARNG) must fulfill the same annual training requirements as an aviator in the Active Army. The requirements are outlined in the ATMs for individual training and in the Army Training and Evaluation Program (ARTEP) manuals for collective unit/combined-arms training. Both ATM and ARTEP requirements have changed significantly since the early 1970s, when most ARNG aviators were originally trained. Moreover, the aircraft fleet has been modernized significantly since that time and several additional aviator training requirements have been added. The major requirements that have been added are the following:

- instrument qualification,
- NOE qualification,
- unaided night tactical training,
- NVG qualification
- qualification in aircraft specific to the ARNG (e.g., CH-54, OH-6), and
- attack helicopter systems qualification (e.g., UH-1M, AH-1G).

The USAAVNC at Fort Rucker, Alabama, no longer offers any of the additional qualifications as a specific course. Therefore, the aviator must obtain the training necessary to meet the requirements by using National Guard support personnel and facilities during his/her available training time. Yet, the amount of authorized paid training time that is available to the ARNG aviator has remained constant since the early 1970s.

Authorized training time for ARNG aviators may be categorized into three major types of training periods.

- **Unit Training Assemblies (UTAs).** A UTA consists of a four-hour training period. Four UTAs are typically scheduled consecutively to constitute a weekend drill period. In this case, they are referred to as Multiple Unit Training Assemblies (MUTAs). MUTAs typically are used for collective unit (ARTEP) training, rather than individual training. ARNG aviators are authorized 48 UTAs per calendar year.

- **Additional Flight Training Periods (AFTPs).** An AFTP consists of a four-hour period that is typically used to maintain individual crewmember skills and to accomplish the hands-on flight components of the Annual Aviator Proficiency and Readiness Test (AAPART). ARNG aviators are authorized 24 AFTPs per calendar year.
- **Annual Training (AT).** Annual training periods typically are used for collective unit and combined-arms training employing a threat-oriented scenario. Emphasis is placed upon unit operations tasks to ensure effective internal command, control, and communications, as well as external coordination with higher headquarters or supported units. ARNG aviators are authorized 15 days of AT.

In addition, another type of training period, Full Time Training Duty (FTTD) day, can be scheduled for training in the SFTS and for special missions. FTTDs are scheduled and approved on a case-by-case basis.

#### **NEED**

The training requirements that the ARNG aviator must meet have significantly increased over the last ten years, while the training time available to the ARNG aviator has remained constant. Therefore, a need exists to determine if the current training requirements can be met in the amount of training time presently available to the ARNG aviator.

Informal observation has indicated that the increase in training requirements may be a major factor influencing the decision of ARNG aviators to leave the National Guard. The potential effect of the additional training requirements on the attrition of ARNG aviators is especially critical in view of the "aging of the force." Approximately 55% of the ARNG aviators are between 34 and 39 years of age. In addition, within the next five years, about 15% of the ARNG aviators will be eligible for retirement with 20 years of military service. When these aviators leave the ARNG, a considerable amount of experience and expertise will be lost. Without this experience and expertise, unit commanders may find that it is increasingly difficult for the younger, less experienced ARNG aviators to meet current training requirements.

The National Guard Bureau has tasked ARI to provide information about (a) the ARNG aviators' ability to meet current training requirements in the amount of time presently allocated for meeting the requirements, (b) demographic and attitudinal factors that affect the ARNG aviators' ability to meet the requirements during the allocated training time, and (c) the ARNG aviators' willingness to spend additional time to meet the training requirements. The information will be provided for each of the following types of ARNG aviation units:

- Attack Helicopter Company/Troop,
- Air Cavalry Troop,
- Combat Support Aviation Company,
- Aviation General Support Company,
- Aerial Surveillance Aviation Company,
- Air Ambulance Detachment, and
- Transportation Company (Heavy Helicopter).

#### PROJECT OBJECTIVES

The ARNG aviation training requirements research has five specific objectives. The objectives are listed below:

- to determine the ARNG aviators' ability to meet the current training requirements in the amount of training time that is presently allocated;
- to determine the ARNG aviators' willingness to spend additional time to meet the training requirements;
- to identify specific factors--e.g., demographic characteristics, attitudes, civilian job requirements, family influences, and training obstacles--that affect the ARNG aviators' ability to utilize the currently allocated training time for meeting the training requirements;
- to identify specific factors--e.g., demographic characteristics, attitudes, civilian job requirements, family influences, and training obstacles--that affect the ARNG aviators' willingness to spend additional time to meet the training requirements;
- to determine the relationship between the ARNG aviators' career intentions and each of the following factors: ability to meet the training requirements in the allocated training time, willingness to spend additional time to meet the training requirements, total time spent in meeting the training requirements, demographic characteristics, civilian job requirements, and family influences; and



- to determine the relationship between the amount of time that is allocated to meet the training requirements and the amount of time that is actually spent in meeting the requirements.

These objectives will be met for each of the seven major types of ARNG units, as well as for the total ARNG force.

#### **RESEARCH APPROACH**

The research approach developed to meet the project objectives consists of three phases. In Phase I, information concerning career intentions and demographic and attitudinal variables will be obtained by means of a questionnaire to be completed by ARNG aviators. In Phase II, information concerning time required to meet ARNG training requirements will be obtained using an optically scannable data collection form. In Part III, analysis of data obtained in Phase I and Phase II will be conducted. A more detailed account of the methodology developed for each of the three phases is given in the following sections.

#### **Phase I. Assessment of Demographic and Attitudinal Variables**

A questionnaire is being developed to assess demographic and attitudinal variables that may affect the capability and willingness of ARNG aviators to meet current training requirements in the time available. The questionnaire consists of the three parts described below.

**Part I. Current Training Requirements.** In Part I of the questionnaire, aviators are required to rate the following variables concerning training requirements:

- adequacy of the current training requirements for maintaining a safe level of proficiency,
- adequacy of the time allocated for meeting the training requirements,
- willingness to spend additional paid time to meet the training requirements,
- willingness to spend additional nonpaid time to meet the training requirements, and

- factors that serve as obstacles to meeting the training requirements.

**Part II. Demographic Characteristics.** In Part II of the questionnaire, the aviators are required to provide information about the following demographic characteristics:

- personal characteristics (e.g., age, education),
- military characteristics (e.g., aircraft qualifications, military experience),
- civilian employment (e.g., income, supervisor's attitude toward ARNG), and
- family factors (e.g., employment of spouse, family attitudes toward ARNG).

**Part III. National Guard Career Intentions.** Part III of the questionnaire requires aviators to provide information about the following aspects of their career intentions:

- intentions to stay in or leave the ARNG,
- factors influencing the intention to remain in or leave the ARNG,
- satisfaction with the ARNG, and
- general comments about the ARNG.

The questionnaire will be mailed to ARNG units during October and November, 1983, completed by the aviators during a weekend drill, and returned to ARI for data processing and analysis.

#### **Phase II. Assessment of Training Time**

In Phase II, information will be obtained concerning the time necessary to meet the existing training requirements. An optically scanable, computer-scored data collection form (Training Log) is being designed to provide ARNG aviators the opportunity to report hours spent on flying and nonflying activities during different types of training periods. The aviators will report the time spent in each of the following flying activities:

- meeting ATM minimum iteration requirements and checkrides not as part of ARTEP training (Combined Arms/Collective),

- meeting ATM minimum iteration requirements during ARTEP training,
- meeting ARTEP training requirements exclusive of ATM minimum iteration requirements,
- inflight training and/or evaluation of other aviators exclusive of ATM minimum iteration requirements, and
- performing miscellaneous flight activities exclusive of ATM minimum iteration requirements.

Aviators will also report time spent in each of the following nonflying activities:

- performing required additional duties (e.g., supply officer, motor officer, administrative duties),
- completing and administering military education, common soldier skills, and career development training (e.g., correspondence courses, academic aspects of aviation qualifications/transitions),
- performing pre-post flight tasks (e.g., pre-post flight, planning, weather/mission briefs, flight records, etc.),
- preparing for, undergoing, and administering oral and written nonflying aviation evaluations (e.g., annual writ, -10 test, flight physicals, checkrides, etc.), and
- performing miscellaneous nonflying activities (e.g., crew rest, dead time, inspections, meals, formations, etc.).

The aviators will report the time spent on each of the activities described above during the following types of training periods:

- Unit Training Assembly,
- Additional Flight Training Period,
- Full Time Training Duty,
- Annual Training,
- Year Round Annual Training,
- Additional Training Assembly,
- Split Unit Training Assembly,
- Nonpay Status at National Guard Facility, and
- nonpay status away from National Guard facility (e.g., home, office)

Copies of the Training Log will be sent to ARNG aviators in December, 1983 to allow familiarization with the form and the reporting procedure. Beginning in February 1984, the Training Log will be completed by ARNG aviators, once a month for a year, and returned to ARI for data processing and analysis.

### **Phase III. Analysis of Demographic, Attitudinal, and Training Log Data**

Data obtained from the questionnaire and the Training Log will be analyzed during Phase III. The primary products from the analysis of the questionnaire data will be the following:

- a summary of descriptive statistics and one-way frequency distributions for questionnaire items,
- cross-tabulation tables for selected combinations of categorical variables (e.g., career intentions vs. income level), and
- correlations between selected pairs of continuous variables (e.g., adequacy of time allocated vs. willingness to spend additional nonpaid time).

Analyses will be performed separately for each of the seven types of ARNG units described previously.

The primary products from the analysis of the Training Log data will be a summary of descriptive statistics for each of the flying and nonflying categories, classified by type of training period. The descriptive statistics will be calculated after the sixth and twelfth months of Training Log data collection and will be reported separately for each of the seven types of ARNG units.

### **PROJECT STATUS**

#### **Work Completed**

At the end of the contract year, both data collection forms had been developed and pretested during field visits to each of the seven types of ARNG units identified above. The forms were revised based on feedback obtained during the pretest visits. Two additional sites have been selected for final pretesting during the first part of the next contract year. After the site visits are completed, the forms will be finalized, printed, and distributed to the units.

#### **Projected Completion Date**

Data collection forms will be mailed to ARNG aviators during October through December 1983. Draft results for Phase I will be

available about 15 April 1984. It is anticipated that an interim report describing Phase I activities and results will be available about 15 June 1984.

Data collection for Phase II will continue throughout the next contract year. Draft results for Phase II will be available in March 1985. It is anticipated that the final project report will be available in August 1985.

**PROCEDURES AND TERMS FOR INTRA-COCKPIT COMMUNICATION  
FOR TERRAIN-FLIGHT NAVIGATION**

Dr. Kathleen A. O'Donnell, Project Director

**BACKGROUND**

Recent advances in weapons and detection systems of the enemy forces have necessitated the use of new tactics to survive and accomplish a combat mission. Tactics that Army aviation units will use to minimize detection by enemy forces include terrain flight, night operations, limited communications, tactical instrument flight, and frequent movement (Department of the Army, 1979). Of these tactics, terrain flight will probably be the most widely utilized.

There are three levels of terrain flight: low-level, contour, and NOE. The three levels of terrain flight are defined as follows (FM 1-51, p. 5-4):

- **Low-level flight**--Flight carried out above obstacles, but at an altitude at which detection by threat forces is avoided or minimized. It is usually performed at a constant indicated altitude and airspeed.
- **Contour flight**--Flight at low altitude conforming to, and in close proximity to, the contours of the earth. Although heading remains relatively constant, airspeed and altitude are varied as needed to remain at the lowest possible altitude.
- **Nap-of-the-earth flight**--Flight at varying airspeeds as close to the earth's surface as vegetation, obstacles, and ambient light will permit. Airspeed, altitude, and heading are varied as needed to take full advantage of the masking afforded by terrain relief, vegetation, and man-made features.

Accurate navigation at terrain flight altitudes requires a higher level of proficiency in map interpretation and terrain analysis than is required to navigate at higher altitudes. Factors contributing to the difficulty of terrain flight navigation include (a) the restricted geographic area of view, (b) the obstruction of view by terrain relief and vegetation, (c) the limited vertical development of some types of topographic features (roads, streams, etc.), and the limited amount of time topographic features remain in view, and (d) the large amount of time and effort the pilot must devote to controlling the aircraft when flying at extremely low altitudes.

Successful terrain flight navigation requires a continuous exchange of information between the crewmember functioning as pilot and the crewmember functioning as navigator. The navigator must furnish the pilot with information that is required to remain on course. The pilot, in turn, must report approaching terrain features and acknowledge the navigator's communication (usually by repeating it). Confusion between the crewmembers often arises because the crewmembers use different terms to refer to topographic features. Obviously, this confusion of terms decreases navigation efficiency and increases the chances of becoming geographically disoriented. Use of standardized procedures when communicating navigational instructions is certain to facilitate accuracy in the exchange of information between pilot and navigator. Furthermore, the use of a standardized vocabulary to describe topographic features is certain to reduce misinterpretation, confusion, and unnecessary intra-cockpit communication.

In 1980, Dunlap and Associates, Inc., provided ARI with a POI entitled *Nap-of-the-Earth Flight: Intra-Cockpit Communications Terms and Procedures*. This POI, designed to be incorporated into the IERW training program, has the objective of standardizing intra-cockpit communication procedures and vocabulary during NOE flight.

The POI has two parts. One part presents guidelines and procedures for communicating navigational instructions and describing topographic features. This provides both the pilot and navigator with a standardized cockpit procedure to be used during terrain flight navigation. The other part presents a dictionary of topographic features. The dictionary includes:

- a verbal description of each topographic feature,
- a standardized descriptor for the topographic feature,
- a color photograph that illustrates the appearance of each topographic feature, and
- a map segment that illustrates the map portrayal of each topographic feature.

Use of this part of the POI will serve to standardize the vocabulary the pilot and navigator use to describe topographic features. In addition, it familiarizes them with how the feature appears at NOE altitude and enhances their ability to identify topographic features rapidly and accurately.

#### **NEED/PROBLEM**

Personnel from operational aviation units were requested to evaluate the usefulness of the POI as a navigation training tool. One complaint was pervasive in the evaluations received from the operational units. The map representation of a terrain feature presented in the POI rarely corresponded to the color photograph of the terrain feature. In other words, the map representation did not depict the location at which the color photograph of the terrain feature was taken. This confused the aviators and interfered with the learning process. Therefore, it was concluded that a new set of color photographs with corresponding map representations are needed.

Since the POI was being revised for the aforementioned purpose anyway, ARI personnel decided to maximize the training utility of the POI by including two additional photographs of the terrain features. Three photographs will be presented in all. One photograph will depict the terrain feature in the summer; another photograph will depict the terrain feature in the winter. The third photograph will depict the terrain feature as viewed through the AN/PVS-5 NVGs. The scenes photographed under these three conditions will be exactly the same.

#### **PROJECT OBJECTIVES**

The specific objectives of this project are as follows:

- to obtain summer photographs of the terrain features listed in the POI,
- to obtain a corresponding map representation of the terrain features that are photographed,
- to obtain winter photographs that correspond exactly to the scenes depicted in the summer photographs, and



- to obtain photographs that appear to be taken through NVGs and correspond exactly to the scenes depicted in the summer and winter photographs.

#### APPROACH

Local map sheets will be checked for the terrain features presented in the POI. Three locations will be identified for each terrain feature and the map coordinates will be recorded. A number of UH-1 missions will be scheduled to investigate the terrain feature locations identified on the map sheets. If the first location visited presents a good example of the terrain feature, a summer photograph will be taken and the other two locations identified for that terrain feature will be ignored. If the first location visited is not a good example of the terrain feature, the second location will be visited, followed by the third location if necessary. If all three locations prove to be poor examples of the terrain feature, additional locations will be identified on the map sheets. The map coordinates and helicopter headings will be recorded for each summer photograph that is taken.

Another set of missions will be scheduled during the winter months. The helicopter will return to the locations photographed in the summer so that the winter photographs can be obtained.

Two procedures will be investigated for obtaining the NVG photographs. The photos can be simulated using the summer photograph negatives or they can be photographed directly using a camera with an NVG goggle tube mounted to the lens. The products of these two procedures will be compared and evaluated for cost effectiveness and fidelity. Project personnel will decide which procedure to use when obtaining the NVG photographs of the terrain features.

The map representations of the terrain features will be obtained by photographing the appropriate location on the map sheets. A small black arrow pointing to the terrain feature symbology will be placed on the map sheet before the photograph is taken.

A new format will be designed for presenting the photographs and written material on a single page of the POI. All essential materials will be forwarded to the printer for publication.

## **PROJECT STATUS**

### **Work Completed**

ASI personnel have been assigned responsibility for compiling a list of topographic features to be photographed, for developing the photographic procedures and techniques to be employed, and for taking a set of photographs that show the appearance of topographic features during the summer season. Thereafter, ARI personnel will assume responsibility for photographing the features, reproducing the photographs, and using them to modify the original POI. The portion of the work assigned to ASI personnel is described in the following paragraphs.

Based upon a careful study of the original POI, a list of the types of topographic features to be photographed was compiled. Then, 1:50,000-scale topographic maps of areas within close proximity to Fort Rucker were searched to identify three candidates for each type topographic feature of interest; eight-digit coordinates were recorded for each candidate feature selected. Two flights were made to confirm the suitability of a sample of the topographic features selected, to develop efficient photographic procedures, and to shoot the summer-season photographs. The procedures in question include pilot-photographer coordination in navigating to the feature, taking the photographs, and maintaining a detailed and accurate photo log. The photographs taken during the two flights were catalogued in terms of (a) the type of topographic feature shown in the photograph, (b) the name and number of the map sheet (1:50,000-scale topographic map) on which the feature is portrayed, (c) the Universal Transverse Mercator (UTM) grid coordinates of the feature, and (d) the heading of the aircraft at the moment the photograph was taken.

The second major task was to develop an efficient technique for illustrating the appearance of topographic features when viewed through NVGs. One approach evaluated consisted of modifying daytime photographs of topographic features. Copies of daytime photographs were reproduced using filters to reproduce the green coloration characteristic of NVG images and defocusing the image slightly to degrade resolution to a level characteristic of NVG images. A careful study of the modified photographs led to the conclusion that they may differ significantly from NVG imagery in resolution and contrast. For this reason, a decision was made to generate a set of comparison photographs by shooting the same topographic features through an NVG tube during darkness. To develop optimal procedures, a series of photographs was taken through an NVG tube attached to a wide-angle lens of a 35-mm camera. The photographs were taken on the ground, during darkness, at locations well away from cultural lighting of any consequence. Camera direction, shutter speed, and aperture setting were varied systematically. This procedure enabled project personnel to (a) confirm that suitable photographs can be taken with the equipment employed, and (b) identify the shutter speeds and aperture settings that yield the best quality photographs.

Finally, four new page formats for the POI were designed and forwarded to ARI. They will decide which format should be used by the printer.

#### **Projected Completion Date**

The portion of the work allocated to ASI personnel was completed in August 1983.

#### **REFERENCE**

Department of the Army. Rotary wing flight. (April 1979). FM 1-51.

**ASSESSMENT OF THE RELATIONSHIP BETWEEN ANTOROPOMETRIC SIZE OF  
ARMY HELICOPTER PILOTS AND PILOTS' ABILITY TO PERFORM  
VARIOUS FLIGHT TASKS/MANEUVERS**

Dr. Kathleen A. O'Donnell, Project Director

**BACKGROUND**

The cockpit of an aircraft provides a finite amount of space in which a person must successfully perform all necessary operations. Because the amount of space is finite, minimum and maximum standards of operator body size must exist for operational efficiency, comfort, and injury avoidance. A single measure of size (such as height) is not sufficient for determining whether a person's body size is acceptable for safe and comfortable control of an aircraft. For example, it is possible that a person will meet the minimum height requirement for an aircraft, but not have the leg or arm length necessary to accomplish full control movements in the aircraft. This possibility led to a change in the standards required for entry into the Army flight training program.

In May 1980, the Surgeon General's Office issued a change to the Medical Fitness Standards for Flying Duty Classes. This change replaced the minimum height criterion of 64 inches with the following anthropometric standards:

- 68 to 76 inches in height, or
- less than 68 inches in height with a minimum leg length (LL) of 70.75 cm and a combined measure of sitting height (SH) and functional arm reach (FAR) of 150.5 cm.

These standards were developed by the HEL and the U.S. Army Aeromedical Research Laboratory (USAARL). They are based on static measurements taken in aircraft mockups and in stationary aircraft cockpits of the UH-1, OH-58, and AH-1 aircraft.

**NEED/PROBLEM**

The alteration of flight school selection standards was based on the minimum anthropometric measurements necessary to manipulate aircraft

controls in a static situation. In addition, the minimum acceptable measurements were assessed separately for each control. There is a need to ensure that the new selection standards are adequate when the subject is placed in a dynamic situation (i.e., a flight situation in which the controls must be integrated).

#### PROJECT OBJECTIVES

The specific objective of this project is to ensure that student aviators who meet the new Army anthropometric standards are capable of operating all Army aircraft.

#### RESEARCH APPROACH

Subjects will be divided into three groups. The short group will include all IERW students with a height of 64 inches and below or with anthropometric measurements less than the following: 74.8 cm for LL, 158.9 cm for combined SH and FAR (SH + FAR). The control group will include a random sample of IERW students with a height between 64.1 inches and 72.9 inches or with anthropometric measurements between the following: 74.8 and 89.3 cm for LL, 158.9 and 182.9 + SH and FAR. The tall group will consist of a random sample of IERW students with a height of 73 inches and above or with anthropometric measurements greater than the following: 89.3 cm for LL, 182.9 for SH + FAR.

A group of IPs will be asked to identify any aircraft maneuvers and/or procedures on which short or tall students would be likely to experience difficulty due to their size. In addition, they will be asked to provide an hour-level range, for each maneuver, within which poor performance might indicate a special difficulty. This will be accomplished for four different aircraft--the TH-55, UH-1, OH-58 and AH-1.

All performance grades received within the identified hour-level range will be recorded for each identified maneuver. An average performance grade will be computed for each maneuver on a single student. These averages will be entered into the computer for analyses.

## Data Analyses

An analysis of variance will be performed on the data. If significance is found, post hoc tests will be used to identify the sources of variation.

A simple regression of performance on height will be plotted for each maneuver. This will yield information about the accuracy of where the groups were divided as well as the effect of height on performance. A test for parallelism will determine if height affects performance differentially on the various maneuvers.

In an effort to eliminate variance between the three groups that is not due to height differences, an analysis of covariance and/or an analysis on matched samples will be performed. These methods will be used to eliminate variance due to age and ability or knowledge.

## PROJECT STATUS

Initial work on this project, completed mainly by ARI personnel, includes the following:

- maneuvers and hour-level ranges for all the aforementioned aircraft were identified by IPs, and
- performance grades of IERW students who graduated or were eliminated in 1980 and 1981 were recorded and entered into the computer.

A preliminary analysis of the 1980 data showed that the number of subjects in the short group was too small for accurate statistical analysis. As a consequence, a decision was made to wait approximately one year to allow more short students to enter the flight training program.

On 10 August 1983, the project was transferred to ASI personnel for completion. Tasking included an update of the data base, data analysis, and a technical report discussing the results. Work completed on this project by ASI personnel includes the following:

- performance grades of IERW students who graduated or were eliminated in 1982 and 1983 were recorded and entered into the computer, and

- data analyses to be performed have been outlined and the computer programs are now being written.

#### **Projected Completion Date**

By the end of October, the data base should be fully updated and part of the analyses should be completed. All analyses and interpretations should be completed by the end of November. The final technical report, then, is expected to be available by the end of December or middle of January.