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Human Factors Research in Aircrew Performance and Training: Annual Summary Report

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Anacapa Sciences, Inc.

for

ARI Field Unit at Fort Rucker, Alabama
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Research Institute for the Behavioral and Social Sciences

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This research note presents summary descriptions of research projects performed for ARI at Fort Rucker, Alabama. During the period 18 February 1986 through 8 October 1987, contractor personnel worked on 17 research projects in the areas of emerging system design, manpower and personnel, aviation simulation, and aviator training. The summary description for each project contains a background section that describes the rationale for the project, and specifies the research objectives, a research approach section that describes the tasks and activities required to meet the project objectives, a results section describing the research findings (or, in the case of developmental activities, the research products), and, finally, a project status section that describes the work completed and projections for future research, if any.

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FOREWORD

The U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) at Fort Rucker, Alabama, is contributing to the effectiveness of Army aviation by conducting a comprehensive human factors research program in support of aircrew performance and training. The ARIARDA research program encompasses the full scope of Army aviation with projects in support of (a) emerging Army aviation weapon systems, (b) aviation manpower and personnel programs, and (c) aviator training programs.

This report summarizes research performed and products developed in all three of the above areas during the period between February 1986 and October 1987. Seventeen different projects are summarized; four describe research in support of emerging systems; five present research in support of manpower and personnel programs; and eight report accomplishments in support of aviator training programs.

This summary report is intended to meet two important objectives. First, it provides U.S. Army weapon system managers, manpower and personnel planners, and training system developers and managers with a readable summary of research progress and accomplishments in their respective areas of responsibility. Second, it provides summary information to behavioral scientists who may be working on similar applied research issues, either within the Department of Defense or within other governmental, industrial, or university organizations.

HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT

EXECUTIVE SUMMARY

Requirement:

Anacapa Sciences, Inc., has provided collocated research support to the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) at Fort Rucker, Alabama, since 1981. The ARIARDA program supports the full range of Army aviation research requirements with projects that address emerging aviation weapon systems, aviation manpower and personnel programs, and aviator training programs. This Annual Summary Report fulfills one of the requirements of Contract MDA903-87-C-0523. It describes the 17 research projects in the ARIARDA program conducted by Anacapa Sciences, Inc., researchers between February 1986 and October 1987. The specific requirements that led to the initiation of each research project is discussed in the individual summaries.

Methods:

There are substantial differences in the methods that were employed in the individual projects and in each of the three research areas. For some projects, the research approach was a scientific experiment in which selected variables were controlled, manipulated, and measured. For other projects, the research approach was a set of analytical or product development tasks. The research methods used in each project are described in moderate detail in the individual summaries.

Summary of Contents:

The research projects were conducted in all three areas of the ARIARDA program. Four of the projects were in the emerging systems area: LHX workload prediction, AH-64 workload prediction, MH-60K and MH-47E workload prediction, and the design of flight symbology. Five of the projects were in the manpower and personnel area: development of a new aviator selection test, evaluation of an enlisted aviator program, development of a peer assessment method, evaluation of the First Army Reserve aviation management method, and an evaluation of management policies for AH-64 aviators. The remaining eight projects were in the training area: evaluating the training requirements for National Guard and Army Reserve aviators, studying aviator skill decay and reacquisition, evaluating aviation gunnery training, evaluating flight simulator training in operational Army aviation units, upgrading the basic map interpretation and terrain analysis course to videodisc, developing an AH-64 symbology training program, and evaluating the effectiveness of aviation part-task trainers.

Utilization:

The results and recommendations of many of the 17 projects will be directly implemented in the design of new aviation systems, in the selection and management of aviation personnel, and in aviation training at the Aviation Center at Fort Rucker and in world-wide Army aviation units. This report provides Army weapon system managers, manpower and personnel planners, training system developers and managers, and other researchers working in related fields with a readable summary of the research activities in their respective areas of interest.

HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT

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GLOSSARY OF ACRONYMS

AA	Assembly Area
AAA	Army Audit Agency
A & G	Aviation Ammunition and Gunnery
AAPART	Annual Aviator Proficiency and Readiness Test
AC	Active Component
Adv-MITAC	Advanced Map Interpretation and Terrain Analysis Course
AFTP	Additional Flight Training Period
AH	Attack Helicopter
ALSE	Aviation Life Support Equipment
AQC	Aircraft Qualification Course
ARIARDA	Army Research Institute Aviation Research and Development Activity
ARMS	Aviation Resource Management Survey
ARNG	Army National Guard
ARTEP	Army Training and Evaluation Program
ASF	Aviation Support Facility
AT	Annual Training
ATC	Army Training Command
ATM	Aircrew Training Manual
AVG	Final Academic Averages
AVNOAC	Aviation Officer Advanced Course
AVSCOM	Aviation Systems Command
BOIP	Basis of Issue Plan
CH	Cargo Helicopter
CMS	Combat Mission Simulator
CO	Commissioned Officer
CONUSA	Continental United States Army
CCTR	Contracting Officer's Technical Representative
CPG	Copilot/Gunner
CRT	Cathode Ray Tube
CSRDF	Crew Station Research and Development Facility
CWEPT	Cockpit Weapons Emergency Procedures Trainer
CY	Calendar Year
DA	Department of the Army
DCD	Directorate of Combat Developments
DCST	Deputy Chief of Staff for Training
DGFS	Directorate of Gunnery and Flight Systems
DOTD	Directorate of Training and Doctrine
DPTMSEC	Directorate of Plans, Training, Mobilization, and Security
DTV	Day Television Viewing
DVO	Direct View Optics
EA	Enlisted Aviator
EGA	Enhanced Graphics Adapter
ETM	Emergency Touchdown Maneuvers
FAC	Flight Activity Category
FAR	Faculty Advisor Rating

GLOSSARY OF ACRONYMS (Continued)

FARP	Forward Area Arming and Refueling Point
FAST	Flight Aptitude Selection Test
FC	Field Circular
FLIR	Forward-Looking Infrared
FORSCOM	Forces Command
FRG	Federal Republic of Germany
FTTD	Full Time Training Duty
FWS	Flight and Weapons Simulator
FY	Fiscal Year
HMD	Helmet-Mounted Display
IERW	Initial Entry Rotary Wing
IHADSS	Integrated Helmet and Display Sight System
IP	Instructor Pilot
JWG	Joint Working Group
LHX	Light Helicopter Family
LZ	Landing Zone
MH	Mission Helicopter
MITAC	Map Interpretation and Terrain Analysis Course
MOS	Military Occupational Specialty
MUTA	Multiple Unit Training Assembly
NCO	Noncommissioned Officer
NFAST	New Flight Aptitude Selection Test
NGB	National Guard Bureau
NOE	Nap of the Earth
NVG	Night Vision Goggles
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
ORT	Optical Relay Tube
PC	Peer Comparison
PFTEA	Post-Fielding Training Effectiveness Analysis
PIP	Product Improvement Program
PNVS	Pilot Night Vision System
POL	Petroleum, Oil, Lubricants
PZ	Pick-Up Zone
RAM	Random Access Memory
RC	Reserve Component
RFAST	Revised Flight Aptitude Selection Test
SFTS	Synthetic Flight Training System
SME	Subject Matter Expert
SOF	Special Operations Forces
SOW	Statement of Work
STRAC	Standards in Training Commission
SWAT	Subjective Workload Assessment Technique
TADS	Target Acquisition and Detection System
TEA	Training Effectiveness Analysis
TRACWSMR	Training and Doctrine Command Analysis Center at White Sands Missile Range
TRADOC	Training and Doctrine Command

GLOSSARY OF ACRONYMS (Continued)

TSM	Training and Doctrine Command System Manager
TSTT	Target Acquisition and Detection System Selected Task Trainer
UH	Utility Helicopter
USAAVNC	United States Army Aviation Center
USAR	United States Army Reserve
USAREUR	United States Army, Europe
UTA	Unit Training Assembly
WOC	Warrant Officer Candidate

HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING: ANNUAL SUMMARY REPORT

INTRODUCTION

Anacapa Sciences, Inc., has provided collocated research support to the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) at Fort Rucker, Alabama, under a series of contracts that began 1 September 1981. One of the requirements of the current contract (No. MDA903-87-C-0523), which began on 9 October 1986, is to submit an Annual Summary Report of research project activities. To fulfill that requirement, this report describes the research projects on which Anacapa personnel have worked during the first year of the current contract. This report also describes research that was conducted under the immediately preceding contract (No. MDA903-86-C-0055) in effect between 18 February and 8 October 1986. The 29 research projects performed by Anacapa under the original contract (No. MDA903-81-C-0504), that terminated 31 December 1985, were described in a Final Summary Report (Cross & Szabo, 1986) that was submitted to ARIARDA in February of 1986.

This report contains summary descriptions of the 17 research projects that Anacapa personnel have worked on under both Contracts MDA903-81-C-0504 and MDA903-86-C-0055. Most of the project summaries follow the same general format. Each summary begins with a background section that presents information needed to understand the requirement for the project. The background may include a brief review of relevant research or describe the critical events that led to the project's initiation. When the need for the research cannot be clearly inferred from the background, a statement of need or definition of the problem is presented. The background section is followed by a concise statement of the project objectives.

Next, the research approach section presents a moderately detailed description of the activities that were performed to accomplish the project objectives. For some projects, the research approach is a scientific experiment in which selected variables are controlled, manipulated, and measured. For other projects, the research approach is a set of analytical or product development tasks. The research approach is followed by one or more sections that present the research findings or, in the case of product development efforts, a summary description of the research products.

The final section of each project summary, entitled "Project Status," describes the work accomplished and the work projected, if any. Where possible, this section also presents the current estimates of project milestones.

Anacapa personnel also provided temporary support on other projects that are the primary responsibility of ARIARDA personnel and are, consequently, not summarized in this report. Most notable among the support tasks is work being conducted to develop a training research simulator. It is also important to note that the projects summarized in this report represent only a portion of the research program at ARIARDA. Numerous projects are being conducted as the sole responsibility of ARIARDA personnel or under other contracts.

The project summaries are presented in three content categories that reflect the research emphases at ARIARDA. The categories are not rigidly defined because the content areas may overlap and the projects may belong to more than one category. Nonetheless, this organization is intended to assist the reader in locating a specific project summary within a research area or to find summaries that are closely related in terms of content.

The first four summaries describe research in the area of emerging systems. The next five summaries present work in the area of manpower and personnel research. The next eight summaries are in the training research area. The number of summaries assigned to the various categories is not necessarily in proportion to the emphasis that is placed by ARIARDA on each content area.

Although each summary identifies the project director(s), the Anacapa approach to our research efforts at Fort Rucker is a team concept. This approach permits the maximum utilization of the scientific staff members' skills and ensures coordination among closely related projects. The scientific staff are ably supported by an exceptionally efficient administrative and technical staff. All the work is, of course, closely coordinated with ARIARDA personnel.

VALIDATION OF THE LHX WORKLOAD PREDICTION MODEL

Mr. Theodore B. Aldrich, Project Director

Background

The Army's Air/Land Battle 2000 scenario represents a high-threat environment that will place heavy workload demands on Army aviators. Accordingly, future aircraft systems are being designed with advanced technology to automate many of the functions traditionally performed by crewmembers. Examples of the advanced technology include:

- an increased number of sensors and target acquisition aids,
- improved navigation and communication systems,
- advanced crew station design features,
- improved flight controls,
- exceptionally high avionics reliability, and
- subsystems that are automatically reconfigured if components fail.

Although advanced technology is typically designed to reduce aviator workload, the tasks required to use the technology may actually increase workload in some instances. For example, technology designed to reduce an aviator's need to maintain physical control of system functions often increases the aviator's role as a systems monitor or problem solver. Consequently, while psychomotor workload demands are decreased, sensory and cognitive attentional demands may be increased.

The development of new and improved aircraft systems also presents problems in the prediction and assessment of operator workload. Metrics that are appropriate for analyzing physical workload are inadequate for assessing sensory and cognitive workload. Accordingly, workload research has shifted from a focus on physical effort required to perform a task to an emphasis on the attentional demand associated with the sensory, cognitive, and psychomotor workload components of the tasks.

In response to the shifting emphasis, Anacapa Sciences, Inc., researchers, under a previous contract to the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA), developed a methodology for predicting aviator workload in advance of aircraft system design. The methodology features models that predict workload under varying automation configurations and for both single- and multi-crewmember system designs. The workload prediction methodology operationally defines workload in terms of attentional demand and predicts workload associated with task performance.

To apply the methodology to aircraft systems, three major phases of research must be performed. The three phases are:

- conduct mission and task analyses of critical mission segments and assign estimates of workload for the sensory, cognitive, and psychomotor workload components of each task;
- develop computer-based workload prediction models using the data produced by the task analyses; and
- exercise the computer models to produce predictions of crew workload under varying automation and crew configurations.

Under the previous ARIARDA contract, Anacapa researchers performed the task analyses, developed both one- and two-crewmember workload prediction models, and applied them to a proposed multipurpose, lightweight helicopter designated the LHX. A summary description of the work accomplished in each of the three phases is presented below. A more detailed description of the methodology and its applications to the LHX is presented in Aldrich, Szabo, and Craddock (1985)

Phase 1: Conduct a Mission and Task Analysis

During Phase 1, the Anacapa researchers conducted a mission and task analysis for the proposed LHX. The analysis used a top-down approach in which LHX mission profiles were subdivided into mission phases and, subsequently, into mission segments. A segment is defined as a major sequence of events that has a definite start and end point. The events in a segment may occur concurrently or sequentially.

Each segment was then divided into functions. A function is defined as a set of activities that must be performed either by an operator or by equipment to complete a portion of the mission segment. Functions were categorized as flight control, support, or mission, and placed on segment timelines.

Finally, the functions for each segment were divided into tasks. Each task is a specific crew activity that is essential to the successful performance of the function. The task consists of a verb and an object and was analyzed to:

- identify the crewmember(s) performing the task,
- identify the subsystem representing the primary man-machine interface,
- estimate the workload imposed on the crewmember(s), and
- estimate the time required to complete the task.

The crewmember(s) performing each task and the subsystems associated with each task were identified by examining the performance of similar tasks in existing Army helicopters. Short verbal descriptors of the attentional demand requirements for each task were written for each workload component. The descriptors were then compared with the verbal anchors on the visual, auditory, cognitive, and psychomotor workload component rating scales. The ratings associated with the anchors that best matched the verbal descriptors were assigned as the numerical estimates of workload. Two or more analysts performed the ratings independently and then reached a consensus on the final ratings for each task. Task time estimates were assigned on the basis of interviews with subject matter experts (SMEs).

Phase 2: Develop Computer-Based Workload Prediction Models

A bottom-up approach, in which the tasks identified in Phase 1 served as the basic elements of analysis, was used to develop the computer models for predicting workload. First, the analytic information for each task was entered into computer data files. Then, time-based decision rules were programmed to build functions from the tasks and, subsequently, to build segments from the functions. The decision rules define the temporal relationships among tasks and functions as determined in the Phase 1 mission and task analysis.

The computer models produce estimates of total workload at half-second intervals for each workload component (i.e. visual, auditory, cognitive and psychomotor). The estimates are derived by summing the ratings assigned to each workload component across concurrent tasks. A total value of "8" on any single half-second timeline constitutes the threshold for an overload within a given workload component.

Phase 3: Exercise the Computer Models

During Phase 3, the computer models were exercised to predict workload associated with individual automation options and combinations of options. Three steps were performed to produce the workload predictions:

- select the automation options to be exercised,
- revise the estimates of workload for each task, and
- exercise the models to produce new workload predictions.

The automation options were selected in consultation with SMEs from the LHX office within the Directorate of Combat Developments (DCD) at the U. S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama. The tasks were then reviewed to determine how each proposed automation option would change the workload estimated in the baseline analysis. For each task affected by automation, new descriptors of workload were written. These descriptors, in turn, were matched with the verbal anchors to assign new ratings to the workload components. Finally, the models were exercised with the revised ratings to predict workload for each automation option and the 26 combinations of automation options. The results of these exercises were used to evaluate the changes in pilot workload that would occur under the different automation and crewmember configurations.

Need

Neither the workload parameters used to develop the models nor the workload predictions yielded by the models have been validated. Consequently, this research project will consist of (a) a validation of the workload parameters used to develop the models, and (b) a validation of the workload predictions yielded by the models.

Workload parameters used to develop the models that require validation include the:

- workload ratings assigned to each task,
- total workload estimates for concurrent tasks,
- estimated time required to perform each task,
- threshold for excessive workload,
- temporal relationships among tasks, and
- procedural relationships among tasks.

Specific predictions yielded by the models that require validation include four indexes of excessive workload as listed below:

- overloads,
- overload conditions,
- overload density, and
- subsystem overloads.

Project Objectives

The specific objectives of this project are divided into three phases of research. The objective of Phase 1 is to evaluate the reliability of (a) the workload rating scales used to rate the workload components of each operator task, and (b) the estimates of the other workload parameters used to develop the LHX workload prediction model. The objective of Phase 2 is to obtain validation data on the workload predicted by the models through a series of studies employing part-mission and full-mission flight simulation. The objective of Phase 3 is to refine the workload prediction model using the results of the reliability and validation research.

Methodology

A research plan designed to meet the above objectives was produced early in this first contract year (Aldrich & Szabo, 1986). The research plan provides detailed descriptions of 18 tasks required to accomplish the three phases of the validation research. A summary of the research methodology for each of the three phases is described below.

Phase 1

Phase 1 consists of two surveys administered to human factors scientists who are SMEs in workload research. In the first survey, all combinations of paired comparisons of the verbal anchors for each workload rating scale are presented to the SMEs. The SMEs must choose which anchor in each pair imposes more attentional demand. The results of this survey will assess the degree of agreement among the SMEs on the workload scales. The data also will be used to produce equal-interval scales (Engen, 1971) to replace the ordinal scales that were used in the original workload analysis.

The second survey asks the same SMEs to use the workload scales to rate the short descriptors of visual, auditory, cognitive, and psychomotor workload for each task in the model. Correlational techniques will be used to evaluate the interrater reliability of the workload ratings.

Phase 2

Phase 2 consists of part-mission and full-mission simulation experiments to validate the workload estimates. For the part-mission simulation, mini-scenarios will be generated by selecting concurrent and sequential tasks from the mission and task analysis. For the full-mission simulation, a composite mission scenario will be developed by selecting segments from the mission and task analysis.

The part-mission simulation will be conducted using a repeated measures experimental design in which each subject will fly the mini-scenarios multiple times. Results will be analyzed to assess the correlation between the workload model predictions and measures of the operator's performance on the concurrent and sequential tasks. The correlation coefficients will serve as the primary measure of how accurately the workload predictions forecast excessive workload at the task level of specificity. To assess the validity of the time estimates used in the model, the actual amount of time required to perform the various tasks in the mini-scenarios will be compared with the times estimated during the task analysis. The procedural relationships among the tasks will be evaluated by noting the subjects' ability to progress through the mini-scenarios following the sequence of tasks specified by the model.

During the full-mission simulation experiments, each trial will start at the beginning of a composite scenario and continue without interruption to the end. Analysis of results from the full-mission simulation will include all of the analyses performed during the part-mission simulation data analysis. In addition, an analysis will be performed to assess the effects of inserting secondary tasks into the composite mission scenario.

The final task in Phase 2 will be to compare the results from the part-mission simulation research with results from the full-mission simulation research. Results in which workload is excessive during full-mission simulation, but is not excessive when the same concurrent tasks occur in part-mission simulation, will indicate whether the excessive workload results from the cumulative effects of high workload over longer periods of performance.

Phase 3

Phase 3 consists of the refinement of the workload prediction model based on the results of the first two phases. The first refinements will occur as the workload component rating scales are converted from ordinal to interval scales. Further refinements will be made to the workload model algorithms to reflect the empirical results of the part-mission and full-mission simulation.

Results

Phase 1

The paired comparison data from 30 completed surveys were used to develop each rater's rank order judgments of the verbal anchor attentional demand requirements for the four workload component scales. The rank ordered judgments were analyzed using Kendall's Coefficient of Concordance to assess the degree of agreement among the SMEs. The Coefficients of Concordance for the four scales are as follow:

- Visual - .40,
- Auditory - .49,
- Cognitive - .71, and
- Psychomotor - .49.

Phase 2

The initial task during Phase 2 is the selection of a flight simulation facility capable of supporting the part-mission and full-mission simulation studies required to validate the model. Tentatively, the new Crew Station Research and Development Facility (CSRDF) to be located at the Army's Aeroflightdynamics Laboratory, NASA Ames, California, was selected as the most appropriate site. A final selection cannot be made until the CSRDF research flight simulator is fabricated by the contractor (CAE Limited, Montreal, Canada), and is installed and operational at NASA Ames. Assurances that the simulation hardware (especially the visual system) and software will be adequate to perform the necessary research are required before a final decision can be made to utilize the CSRDF.

To evaluate the potential of the CSRDF to support the mission simulation experiments, Anacapa researchers conducted task analyses of three LHX mission scenarios using the specific CAE configuration for the two-crewmember simulation. The Anacapa analyses identified 126 unique crew functions that appear in 75 different mission segments from the three mission scenarios. Subsequently, Anacapa researchers identified 513 unique tasks in the 126 functions for the two-crewmember configuration. The task analysis was performed at the CAE plant in Montreal during the Army's acceptance testing of the simulation hardware and software. Anacapa researchers verified the mission analyses by personally performing the identified tasks in the flight simulator and by presenting the tasks and workload descriptors for review to (a) CSRDF and CAE SMEs, and (b) Army pilots serving as subjects during the simulator acceptance testing. Draft working papers of a two-crewmember task analysis were produced that include workload descriptors and subsystem descriptors for each of the 513 two-crewmember tasks.

Project Status

Phase 1

The next step in Phase 1 will be to use the pair comparison data to produce interval scales for each of the workload component rating scales. Then, the second survey described in the Phase 1 methodology section will be designed and administered to SMEs.

Phase 2

A final decision to use the CSRDF to conduct the flight simulation research is required before the Phase 2 research tasks can be scheduled. Meanwhile, work is continuing on the task analysis being conducted for the CSRDF two-crewmember configuration.

Phase 3

Refinement of the workload prediction model will start as soon as the interval scale values are produced during Phase 1. The new workload rating values for each of the verbal anchors will replace the ordinal scale values presently in the task data base. The model will be exercised to produce refined workload predictions based upon the new scale values.

As the part-mission and full-mission simulation results are analyzed during Phase 2, additional refinements will be made to the workload prediction model. The researchers will make necessary corrections to the workload estimates, time estimates, and decision rules. Refined workload predictions will be produced using the empirically derived workload estimates, time values and updated decision rules, computer files, and computer programs.

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DEVELOPMENT AND VALIDATION OF THE AH-64 WORKLOAD PREDICTION MODEL

Dr. Sandra M. Szabo, Project Director

Background

The Air/Land Battle 2000 scenario represents a high-threat environment that will place heavy workload demands on combat helicopter operators. Advanced technology in the latest generation of Army helicopters is designed to reduce crew workload; however, in some instances, the tasks required to use the technology have actually increased workload. The high workload, in turn, reduces mission effectiveness, increases system manning and personnel requirements, and increases the training necessary for acquiring and maintaining flight proficiency.

One of the primary reasons that technology has failed to reduce operator workload in current Army aircraft is that human factors concepts have not been adequately considered during the early stages of system design. In the past, no methodology existed for assessing the workload demands of emerging weapon systems prior to their development. Recently, however, the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) developed a methodology for evaluating the role of advanced technology in the development of the proposed light helicopter family (LHX) aircraft. The methodology for predicting LHX workload in advance of system development can be extended to other weapon systems.

As part of its aviation Product Improvement Program (PIP), the Army currently is developing an AH-64B helicopter. The Aviation Systems Command (AVSCOM) has requested that ARIARDA adapt the LHX workload prediction methodology to the AH-64A system to assist in determining the impact that proposed modifications for the AH-64B model will have on operator workload. The methodology provides a mechanism for avoiding human factors errors that previously have resulted in costly production changes and decreased operator performance.

In response to AVSCOM's request for research support, ARIARDA has conducted a comprehensive task analysis of the existing AH-64A mission. The task analysis data are currently being used to develop a computer model that can be exercised to yield predictions of workload associated with various configurations proposed for the emerging AH-64B helicopter.

Project Objectives

The primary objective of the AH-64 workload prediction research is to determine the impact that advanced technology is likely to have on the workload of AH-64 crewmembers. Specifically, the research is designed to:

- identify the AH-64A mission functions and subsystems for which design modifications will be most beneficial, and
- determine the predicted impact that various design modifications will have on AH-64B crew workload.

The systematic predictions of workload yielded by the methodology will provide valuable input into early human engineering design decisions for the AH-64B helicopter.

Methodology

The research approach for meeting the objectives consists of four phases. In Phase 1, the AH-64A helicopter was used to conduct a comprehensive mission/task/workload analysis for AH-64 crewmembers. In Phase 2, data provided by the mission/task/workload analysis are being used to develop a baseline computer model for predicting AH-64A crew workload. In Phase 3, the computer model will be exercised to predict the impact that design modifications are likely to have on crew workload for various AH-64B configurations. In Phase 4, the workload predictions yielded by the model will be validated. Each of the phases is described below.

Phase 1

Phase 1 of the research consists of a comprehensive task/workload analysis of all phases of the AH-64A attack mission. The research tasks performed during the conduct of the task analysis are listed below:

- develop a composite mission scenario,
- divide the composite scenario into mission phases,
- divide the mission phases into segments,
- identify the functions in the mission segments,
- identify the tasks for each function,
- identify the subsystem(s) associated with each task,
- identify the crewmember performing each task,
- estimate the workload for each task, and
- estimate the time required to perform each task.

Each of the research tasks is briefly summarized in the sections that follow.

Develop a composite mission scenario. Five AH-64A attack mission profiles, prepared by the Directorate of Combat Developments (DCD) at the U.S. Army Aviation Center (USAAVNC), were examined. The profiles were used to develop a composite scenario for the AH-64A attack mission. In the scenario, the mission begins with preflight and departure operations performed in the assembly area ; the pilot flies from the assembly area to the holding area, where mission coordination is conducted. From the holding area, the pilot flies to the battle area where target acquisition and engagement functions occur. When the weapons are expended, the pilot flies to the forward area arming and refueling point (FARP) to refuel and rearm the aircraft. Following refueling and rearming, the crew returns to the battle area and again expends the weapons. The pilot then returns, via the holding area, to the assembly area, where terminal operations and postflight procedures are performed.

Other assumptions characterized by the scenario include the following:

- the pilot's primary function is to fly the aircraft and the gunner's primary function is to acquire and engage targets,
- optimal flight conditions (e.g., excellent weather conditions, no aircraft emergencies) exist throughout the mission, and
- all reconnaissance and team leader functions are performed by the scout pilot.

Divide the scenario into mission phases. The composite scenario was divided into seven mission phases. The phases are:

- Preflight,
- Departure,
- Enroute,
- Target Servicing,
- FARP Operations,
- Terminal Operations, and
- Postflight.

Divide the mission phases into segments. Each of the seven mission phases was subsequently divided into mission segments. A mission segment is defined as a major group of events that have a definite start and end point during a mission phase. The number of segments identified in each phase is listed below:

- Preflight - 6,
- Departure - 2,
- Enroute - 8,

- Target Servicing - 33,
- FARP Operations - 4,
- Terminal Operations - 2, and
- Postflight - 2.

Of the 57 segments occurring throughout the mission, 52 segments are unique (i.e., segments that are distinctly different from all other segments).

Identify the functions in each segment. Each of the 52 unique segments was further divided into functions. A function is defined as a set of activities that must be performed either by an operator or by equipment to complete a portion of the mission segment. A total of 159 unique functions was identified for the segments.

Identify the tasks for each function. Each of the 159 unique functions was further divided into tasks considered critical to the successful performance of the function. Each task consists of a verb and an object; the verb describes the action, and the object describes the recipient of the action. The tasks are the basic units of the task analysis. A total of 688 unique tasks was identified for the mission functions.

Identify the subsystem(s) associated with each task. For each unique task, the subsystem associated with the performance of the task was identified. The subsystems represent the following major categories of equipment:

- Armament,
- Flight Control,
- Utility,
- Engine,
- Navigation,
- Safety, and
- Visual.

Identify the crewmember performing each task. The next task in the analysis was to identify the crewmember who performs each task. Using AH-64A checklists, operator's manuals, flight training guides, and subject matter experts (SMEs), the researchers assigned each task to the pilot, gunner, or both crewmembers. In general, the pilot was assigned all flight tasks, and the gunner was assigned target acquisition and engagement tasks.

Estimate the workload required for each task. Workload, as used in the present analysis, consists of three components: sensory, cognitive, and psychomotor. The sensory component refers to the complexity of the visual, auditory, and kinesthetic stimuli to which the operator must respond;

the cognitive component refers to the level of thinking required; and the psychomotor component refers to the complexity of the behavioral response required. A short verbal descriptor of each of the workload components was written for each task. The descriptors were then compared to verbal anchors contained in 7-point rating scales designed to measure workload for each of the five workload components. In each instance, a consensus was reached by the two analysts who had initially assigned the ratings independently; the consensual ratings were subsequently reviewed by three AH-64A SMEs.

Estimate the time to perform each task. To develop a timeline for the AH-64A mission, it was necessary to derive estimates of the time required to perform each task. Estimates for many of the tasks identified in the mission analysis were derived by timing the actual performance of the tasks in the Cockpit, Weapons, and Emergency Procedures Trainer (CWEPT). Estimates for the remaining tasks are based on the subjective judgments of SMEs.

Prior to assigning the task times, each task was categorized as discrete fixed, discrete random, or continuous. The three task categories are defined as follows:

- discrete fixed tasks--tasks that have definite start and end points in the function (e.g., setting switches);
- discrete random tasks--discrete tasks that occur intermittently or randomly during a portion of the function (e.g., checking flight instruments); and
- continuous tasks--tasks that occur continuously during a portion of the function (e.g., monitoring audio).

Following the completion of the task analysis, the data were summarized on function analysis worksheets. The function analysis worksheets were subsequently reviewed by three AH-64A SMEs.

Phase 2

Phase 2 of the research consists of the development of a baseline computer model to predict total workload for AH-64A crewmembers. The principal tasks in developing the model are listed below:

- establish computer files for the mission/task/workload analysis data,
- develop function and segment decision rules,

- write computer programs to implement the decision rules, and
- produce computer estimates of workload for the baseline AH-64A configuration.

Each of these tasks is described briefly below.

Establish computer files. The initial task in Phase 2 of the research was to enter the mission/task/workload analysis data, derived during Phase 1, into a computer data base. Information reported on the function analysis worksheets was used to create the following data files:

- a list of phases,
- a list of segments,
- a list of functions,
- a list of tasks,
- crewmember performing each task,
- estimates of workload for each task,
- estimates of time for each task,
- a list of subsystem identifiers, and
- a description of switches.

Develop function and segment decision rules. The mission/task analysis conducted during Phase 1 used a top-down approach in which the tasks were identified as the basic elements of the mission. The computer model developed during Phase 2 used a bottom-up approach in which the tasks contained in the computer files were combined to form functions which, in turn, were combined to form segments.

For each of the 159 unique functions identified in the Phase 1 analysis, a function summary sheet was developed to identify the specific tasks performed by each crewmember. Function decision rules were then written to identify the sequence and time for the performance of these tasks. Following the development of the function summary sheets and decision rules, segment summary sheets and decision rules were written. The segment decision rules specify the procedure (e.g., sequence and time) for combining the functions, created by the function decision rules, to form each mission segment.

Write computer programs. The time-based function and segment decision rules are the blueprints for placing the tasks performed by each crewmember at the appropriate point on the mission timeline. To permit an automated analysis of workload, computer programs will be developed to implement the decision rules. The computer programs will provide a means for identifying all the tasks performed by a given crewmember at any point within the mission. In addition, the programs will specify the procedure for summing the workload ratings for concurrent tasks to produce estimates of total workload for each crewmember.

Exercise the model to produce baseline estimates of workload. When the computer programs are written, the model can be exercised to produce estimates of total workload associated with the performance of concurrent, as well as sequential tasks in the baseline AH-64A configuration. The total workload for concurrent tasks will be computed by summing the ratings assigned during the task analysis to each workload component (i.e., visual, auditory, kinesthetic, cognitive, and psychomotor). By using the sums, the model will identify points on the mission timeline at which excessive workload, referred to as "overload," will occur. The four indexes of overload are listed and defined below.

- A component overload occurs whenever the sum of the ratings assigned to a given workload component for concurrent tasks equals "8" or higher. Thus, as many as five component overloads can occur at any point on the mission timeline.
- An overload condition occurs whenever an overload, as defined above, occurs in at least one component of two or more concurrent tasks. Thereafter, an overload condition is counted any time a change in the tasks and/or the components contributing to an overload occurs.
- Overload density is the percentage of time within a mission segment during which a component overload occurs.
- Subsystem overloads are computed by tallying the number of times each subsystem is associated with an overload.

Phase 3

During Phase 3 of the research, the computer model exercised in Phase 2 to provide a baseline analysis of AH-64A crew workload, will be exercised to predict how much crew workload might be reduced by proposed configurations for the AH-64B aircraft. The methodology consists of the following steps:

- identify the automation options proposed for the AH-64B model,
- conduct a task/workload analysis for each option,

- exercise the model to yield revised estimates of workload, and
- conduct a comparability analysis of the estimates of workload for the baseline and automated configurations.

The results of Phase 3 can be used to provide estimates of the potential impact of the proposed automation options on the workload of AH-64B crewmembers. These estimates, in turn, will assist design engineers in determining the optimal configuration for the AH-64B aircraft.

Phase 4

During Phase 4, the workload prediction model will be validated. Validation of the model will consist of two major steps:

- validation of the workload component rating scales, and
- validation of the workload predictions yielded by the model.

Validation of the workload component rating scales will be established by performing the following tasks:

- determine the interrater reliability for the rank order of the verbal anchors within each 7-point scale, and
- determine the interrater reliability for assigning the numerical ratings to the verbal descriptors of workload.

Validation of the workload predictions yielded by the model will be established by conducting part-mission and full-mission simulation studies. In each instance, predictions of workload for specific tasks will be compared with measures of primary and secondary task performance, as well as other subjective measures of workload, such as Subjective Workload Assessment Technique (SWAT) ratings (Reid, Shingledecker, & Eggemeier, 1981), taken during mission simulation. Correlation coefficients between the workload predictors and the criterion measures of workload (e.g., task performance and SWAT ratings) will be used to assess the validity of the model for predicting workload. The results of the validation studies of both the rating scales and the workload predictions will subsequently be used to refine the model.

Utilization

The workload prediction methodology developed by ARIARDA provides a systematic means for predicting human operator workload in advance of system design. The systematic predictions of workload, in turn, provide an excellent foundation for human engineering decisions early in the development process when decisions are made about the functions that should be assigned to machines. Thus, the model provides a decision-making tool that reduces costly changes associated with PIPs.

In addition, the methodology provides information for identifying emerging system personnel and training requirements. By assisting in the identification of these requirements, the methodology provides a means for factoring total system costs into trade-off studies conducted during the early stages of system development. Such a concept represents a dramatic change from the system development process used in the past.

Project Status

Work Completed

At the beginning of the current contract period,a preliminary mission/task/workload analysis had been completed and preliminary decision rules for the mission functions and segments had been developed. A draft technical report entitled, "A Comprehensive Task Analysis of the AH-64 Mission with Crew Workload Estimates and Preliminary Decision Rules for Developing an AH-64 Workload Prediction Model," (Szabo & Bierbaum, 1986) had been written and submitted to ARIARDA. The report describes the research methodology and presents appendixes containing the decision rules and the results of the task analysis.

During the first year of the current contract, both the mission/task/workload analysis and the decision rules have undergone extensive review and revision. In addition, a preliminary version of the computer model, using a Perkin-Elmer minicomputer and FORTRAN language, was developed. The model was exercised to produce a preliminary analysis of workload for each of the mission segments.

Work Projected

A final version of the computer model will be developed using a Zenith microcomputer and Turbo PASCAL software. The model will then be exercised to produce estimates of workload for each of the 52 unique mission segments. A technical report will be written to present the results of the segment analyses for the baseline configuration. As system design developments for the AH-64B aircraft occur, additional analyses will be conducted to determine the predicted impact of the proposed design configurations on crew workload.

Tentative plans have been made by ARIARDA to use either the AH-64 combat mission simulator at Fort Rucker, Alabama, or the AH-64B combat mission simulator at McDonnell-Douglas in Mesa, Arizona, to validate the computer model. Assuming the required support is provided, it is projected that (a) the model can be exercised to predict the impact of proposed AH-64B modifications in mid-FY 1988, and (b) the model can be validated in FY 1989.

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DEVELOPMENT OF A WORKLOAD PREDICTION MODEL FOR MH-60K AND MH-47E HELICOPTER MODIFICATIONS

Mr. Carl R. Bierbaum, Project Director

Background

The Special Operations Forces (SOF) Aviation Project Office at the Army's Aviation Systems Command (AVSCOM) has been tasked to modify existing UH-60A and CH-47D aircraft for SOF missions. To satisfy the tasking, AVSCOM is engaged in a large-scale modification program to develop the MH-60K and MH-47E aircraft.

The high technology modifications being proposed for the MH-60K and the MH-47E may increase workload by placing additional demands on the mental resources of the crewmembers. Anacapa Sciences, Inc., personnel, under contract to the Army Research Institute Aviation Research and Development Activity (ARIARDA), have developed a methodology for predicting operator workload in advance of system design. Initially, the workload prediction methodology was developed and applied to the design of the Army's light helicopter family (LHX) aircraft (Aldrich & McCracken, 1984). The LHX methodology was refined and used to develop a baseline model that predicts workload encountered by operators of the AH-64 aircraft (Szabo & Bierbaum, 1986). This research will apply the Anacapa/ARIARDA workload prediction methodology to the development of a model that will yield estimates of workload for proposed configurations of the MH-60K and MH-47E helicopters.

Need

To conduct an adequate assessment of MH-60K and MH-47E crew performance and workload, a mission/task/workload analysis is needed for the SOF scenario. Since ARIARDA has developed a methodology for conducting mission/task analysis and workload prediction (Aldrich, Szabo, & Craddock, 1985), the SOF Aviation Project Office requested ARIARDA to provide them with mission/task analyses and workload predictions for the MH-60K and MH-47E aircraft. The refined methodology used for the AH-64 mission/task analysis is being adapted and used to conduct the required mission/task analyses for the UH-60A and CH-47D and to yield workload predictions for the modified aircraft.

Project Objectives

The objective of this project is to determine the impact that high technology modifications are likely to have on the workload of UH-60A and CH-47D crewmembers. Specifically, the research is designed to:

- provide a mission/task analysis of the UH-60A in its present mission profile to form a baseline for determining the impact that the proposed MH-60K modifications will have on crew workload, and
- provide a mission/task analysis of the CH-47D in its present mission profile to form a baseline for determining the impact that the proposed MH-47E modifications will have on crew workload.

Methodology

The research approach adapted for meeting the objectives of this project is a refinement of the research conducted for the AH-64A (Szabo & Bierbaum, 1986). The research consists of six phases.

- Phase 1 is a baseline mission/task analysis of crew workload for the UH-60A helicopter.
- Phase 2 is the development of a computer model of UH-60A workload utilizing the data provided by the mission/task analysis conducted in Phase 1.
- Phase 3 is a baseline mission/task analysis of crew workload for the CH-47D helicopter.
- Phase 4 is the development of a computer model of CH-47D workload utilizing the data provided by the mission/task analysis conducted in Phase 3.
- Phase 5 is the exercise of the computer model to predict the impact that design modifications are likely to have on crew workload for various MH-60K configurations.
- Phase 6 is the exercise of the computer model to predict the impact that design modifications are likely to have on crew workload for various MH-47E configurations.

The methodology for each of the six phases is described below.

Phase 1

Phase 1 consists of a mission/task analysis of the UH-60A support mission. The tasks performed for the task analysis are listed below:

- develop a mission scenario,
- divide the mission scenario into mission phases,
- divide the mission phases into segments,
- divide the segments into functions,
- identify the specific tasks for each function,
- identify the subsystem associated with each task,
- estimate the workload for each task, and
- estimate the time required to perform each task.

A brief summary of each task is described in succeeding paragraphs.

Develop a mission scenario. The UH-60A mission scenario was developed by reviewing the Army Training and Education Programs (ARTEPs) and interviewing UH-60A subject matter experts (SMEs). The basic mission of the UH-60A aircraft is to provide air transportation of personnel and cargo in support of combat operations. The mission can be conducted either day or night, and may include both internal loads and external sling loads.

The following assumptions were made during development of the mission scenario:

- the pilot's primary role is to fly the aircraft, while the copilot's role is to assist the pilot and perform navigation functions; and
- the mission is flown under optimal day or night conditions (i.e., full moon and no degradation due to weather or emergencies).

Divide the mission scenario into mission phases. After the mission scenario is developed, the mission is divided into operational phases. The phases are major steps in the mission where similar operations and activities are performed. The beginning and end of phases are identified by configuration changes in the aircraft and new sets of activities by the crew. Groupings of activities and events associated with major mission segments, such as departure, enroute, and arrival constitute mission phases.

Divide the mission phases into segments. The mission phases selected for analysis are divided into segments. A mission segment is defined as a major sequence of events that has a definite start and end point during a mission phase.

Divide the segments into functions. A function is defined as a set of activities that must be performed by an operator to complete a portion of the segment. After all functions are identified, the unique functions are listed alphabetically in a computer data file. The ordinal position of each function within the alphabetical list is used to assign a numerical identification code to each function.

Identify the specific tasks for each function. Each function is further divided into tasks. Each task defines a specific crew activity that is essential to the successful performance of the functions. The task description consists of a verb and an object; the verb describes the action by the crewmember and the object describes the recipient of the action. The list of unique tasks are alphabetized by object and assigned a numerical identification code. The tasks are the basic unit of the mission analysis.

Identify the subsystem associated with each task. The subsystem associated with each task is identified. The identification of tasks with their respective subsystems facilitates future analysis of automation options and other aircraft system modifications.

Estimate the workload for each task. Workload, as the term is used in this research, is defined as the attentional demand placed on the operator(s) as they perform the mission tasks. The research methodology separately treats three components of workload: sensory, cognitive, and psychomotor. The sensory component refers to the complexity of the visual unaided, visual aided,* auditory, and kinesthetic stimuli to which an operator must attend; the cognitive component refers to the level of information processing required from the operator; and the psychomotor component refers to the complexity of the operator's behavioral responses.

To determine the workload, short verbal descriptors are written for each task. These descriptors are then matched with the verbal anchors on the workload component rating scales (Szabo & Bierbaum, 1986).

Estimate the time required to perform each task. To develop a timeline, each task is first identified as a discrete fixed, discrete random, or continuous task. The three categories of tasks are defined as follow:

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*Visual unaided refers to visual acuity with the naked eye. Visual aided is the visual acuity with the use of night vision goggles or other night vision devices.

- discrete fixed--tasks that have definite start and end points within the function,
- discrete random--discrete tasks that occur intermittently or randomly during a portion of the function, and
- continuous--tasks that occur continuously during a portion of the function.

Time is then assigned to each task by observations of performance time in simulators or by estimates provided by SMEs who have experience performing the tasks.

Phase 2

The development of the computer model for the workload in Phase 2 consists of the following tasks:

- develop preliminary decision rules,
- establish a series of data files from the information derived through the mission/task/workload analysis.
- develop computer programs to implement the decision rules,
- produce predicted workload for the baseline UH-60A configuration.

Each of these tasks is described briefly below.

Development of preliminary decision rules. The mission/task/workload analysis performed in Phase 1 uses a top-down approach to identify the tasks that must be performed. That is, the analysis starts with the mission and proceeds, top-down, through the phases, segments, and functions to the task level. In developing the crewmember workload model, a bottom-up approach is used. The specific tasks identified during the analysis are combined to form the unique functions; the functions are then combined to form the mission segments. Preliminary decision rules are written for combining (a) the tasks into functions, and (b) the functions into segments. The decision rules are designed to represent the expected behavior of the crewmembers as they perform mission tasks at each half-second interval on a timeline. By summing the estimates of workload associated with concurrent tasks within concurrent functions, estimates of total workload can be derived at each half-second interval for each crewmember.

Establish data files. A series of data files for the information derived through the mission/task/workload analysis is developed. The following specific files are established:

- a list of mission segments,
- a list of unique functions,
- a list of unique tasks,
- a list of subsystem identifiers,
- estimates of the sensory, cognitive, and psychomotor workload for each task,
- estimates of the duration of each task, and
- a list of types of switches.

Information contained in the files serve as the data base for developing the UH-60A crew workload estimation model.

Produce predicted workload for the baseline configuration. The total workload for concurrent tasks is computed by summing the ratings assigned during the task analysis to each workload component (i.e., visual, auditory, kinesthetic, cognitive, and psychomotor) for each concurrent task. By using these sums, the model identifies points on the timeline at which the performance of concurrent tasks results in predictions of excessive workload.

Phase 3 and Phase 4

The research approach adopted for the CH-47D during Phases 3 and 4 is identical to that used for the UH-60A in Phases 1 and 2 except for the differences in aircraft.

Phase 5

During Phase 5, the computer baseline model will be used to predict workload associated with the proposed configurations for the MH-60K aircraft. To accomplish this, new workload descriptors will be written for each of the mission tasks that will be affected by proposed modifications. New workload estimates will be generated by comparing the new descriptors to the verbal anchors on the workload component scales. Computer files will be established with the new information, and the model will be exercised to predict the impact that the proposed automation options are likely to have on pilot and/or copilot workload.

Phase 6

Once the computer baseline model has been developed for the CH-47D, the research approach described in Phase 5 will be used to predict workload associated with the proposed configurations for the MH-47E helicopter.

Project Status

Work Completed

Phase 1 of this research started in December 1986. Each of the completed tasks is described briefly below.

Develop a mission scenario. The UH-60A mission begins in an assembly area (AA). The pilot flies contour flight from the AA to a pick-up zone (PZ) where cargo and/or troops are assembled for pick up. After completing loading operations, the pilot flies nap-of-the-earth (NOE) to the landing zone (LZ) to insert the combat troops or deliver the cargo. After completing the delivery, the pilot flies NOE back to the PZ for another load. This pattern is continued until refueling is required. The pilot then flies NOE from the LZ to the forward area arming and refueling point (FARP), where refueling operations are conducted. Upon completion of the FARP operations, the crew returns to the PZ for continuation of the mission. When the mission is complete, the pilot flies contour back to the AA. Preflight and postflight activities are not included in the analysis.

Divide the mission scenario into mission phases. The mission scenario was divided into nine phases as follow:

- Departure (Assembly Area),
- Enroute (AA-PZ),
- Departure (PZ),
- Enroute (PZ-LZ),
- Departure (LZ),
- Enroute (LZ-PZ) [illegible] (LZ-FARP),
- FARP Operations,
- Enroute (FARP-PZ), and
- Enroute (PZ-AA).

Divide the mission phases into segments. The nine mission phases were divided into 34 unique segments. Some segments are used in more than one of the phases. The number of segments in each phase is listed below.

- Departure (Assembly Area) - 3,
- Enroute (AA-PZ) - 10,

- Departure (PZ) - 7,
- Enroute (PZ-LZ) - 12,
- Departure (LZ) - 3,
- Enroute (LZ-PZ) or (LZ-FARP) - 10,
- FARP Operations - 5,
- Enroute (FARP-PZ) - 10, and
- Enroute (PZ-AA) - 10.

Divide the segments into functions. Each of the 34 unique segments was divided into functions. A total of 48 unique functions was identified, alphabetized, and assigned a numerical identification code.

Identify the specific tasks for each function. Each of the 48 functions was divided into tasks. A total of 138 unique tasks was identified, alphabetized by object, and assigned a numerical identification code.

Identify the subsystem associated with each task. Seventeen subsystems were identified under five major categories. The major categories are listed below:

- Engine,
- Flight Control,
- Navigation,
- Utility, and
- Visual.

Estimate the workload for each task. The workload component scales previously used in the AH-64A workload analysis (Szabo & Bierbaum, 1986) were refined and used for this research. Two changes to the scales used by Szabo and Bierbaum were introduced. The 7-point ordinal scales used in the AH-64A research were converted to 7-point interval scales using the method of pair comparisons (Engen, 1971), and a visual aided (night vision goggles) workload component was added.

Two analysts reached consensus in selecting the verbal anchor that best matched the short verbal descriptor of workload for each task in the analysis. The consensual matches and accompanying ratings were subsequently reviewed by UH-60A SMEs.

Estimate the time required to perform each task. Each task was identified as discrete fixed, discrete random, or continuous by the researchers with the assistance of UH-60A SMEs. The UH-60A simulator was not available for research during the time of this project; therefore, the time assigned to each task was developed from SME estimates based on their experiences in performing the tasks.

Phase 2. In developing the UH-60A crewmember workload model, the specific tasks identified during the Phase 1 analysis were provided to the computer programmer to establish the data files. The researchers developed the decision rules required to combine specific tasks to form the unique functions. Decision rules were then written to combine the unique functions into segments. All decision rules were then programmed and the model exercised to provide estimates of workload at each half-second interval for each of the 34 segments in the analysis. A draft technical report entitled, "A Comprehensive Task Analysis of the UH-60A Mission With Crew Workload Estimates and Decision Rules for Developing a UH-60 Workload Prediction Model," has been completed and is being reviewed.

Phase. 3. A draft of the Phase 3 work required for the CH-47E mission/task analysis has been completed. Presently, the draft mission/task analysis is being reviewed for accuracy by CH-47D SMEs.

Work Projected

The work required to complete Phase 3 will be reviewed and modified to incorporate changes suggested as a result of the SME review. The decision rules required for Phase 4 will be written and programmed to develop the CH-47E workload prediction model.

Detailed descriptions of the proposed new MH-60K and MH-47E Integrated Avionics Subsystem have been received and are being reviewed. Upon completion of the review, an analysis of the new tasks will be performed. The UH-60A and CH-47D workload computer models will then be exercised in Phases 5 and 6 to predict the impact the design modifications are likely to have on the MH-60K and MH-47E crew workload.

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DESIGN AND APPLICATION OF FLIGHT SYMBOLOGY

Dr. Richard Weeter, Project Director

Background

The AH-64 attack helicopter is the first Army aircraft to feature flight and weapon systems designed to enable crewmembers to conduct missions at night and under adverse weather conditions. The two systems that provide these capabilities are the Pilot Night Vision System (PNVS) and the Target Acquisition and Designation System (TADS).

The PNVS is designed to provide the pilot with flight information needed to operate the helicopter at night and under degraded visibility conditions. The primary PNVS display is a one-inch diameter cathode ray tube (CRT) mounted on the pilot's helmet that projects a collimated image to a combiner lens in front of the pilot's right eye. Information presented on the display includes (a) infrared imagery from the night vision sensor with a 40° horizontal by 30° vertical field of view, and (b) flight or weapon systems symbology overlaid on the imagery.

The PNVS symbology set consists of 27 alphanumeric and shape-coded symbols. Many of the symbols are adaptations of traditional electromechanical instruments (e.g., the heading scale) and are located in fixed positions on the displays. Symbols representing aircraft heading, airspeed, altitude, engine torque, and certain other basic flight information are constantly available on the displays. Other symbols represent spatial locations such as the projected center line of the aircraft or the computed impact points of weapons. Such symbols may appear, disappear, and move on and off the displays, reflecting changes in helicopter or sensor orientation.

To reduce obscuration and make the information more task-specific, four subsets or modes of the PNVS symbology can be selected by the crewmember. Each mode adds symbology to the basic flight information that is critical for performing a flight or weapons task in that mode. For example, the hover mode adds a velocity vector and an acceleration cue to aid the pilot in maintaining a hover. Selection of the transition mode adds a horizon line to the hover mode subset; the transition mode is used when changing from a hover to cruise flight. Once cruise flight has been established, selection of the cruise mode removes the velocity vector and acceleration cue, adding only the horizon line to the basic flight information. To aid the pilot in returning to or remaining over a chosen location with a specific heading, the bob-up mode adds the velocity vector, acceleration cue, command heading, and hover position symbols to the basic flight information.

The TADS is designed to provide the copilot/gunner (CPG) with information needed for target search, detection, recognition, and designation. The primary TADS display is an optical relay tube (ORT) mounted on a support with hand controls located directly in front of the CPG crew position. The CPG may select targeting information in the form of imagery from a forward-looking infrared (FLIR) sensor, a daylight television (DTV) sensor, or from direct view optics (DVO). In the FLIR and DTV modes, flight and weapon symbology is superimposed on the display to provide additional information required by the CPG.

The TADS symbology set consists of 17 symbols. Fifteen of these are similar to symbols used in the PNVS set, but they may differ in size, location on the display, or exact meaning. Two additional symbols are unique to the TADS set. The selected sensor symbol is an alphanumeric descriptor of the sensor system (FLIR, DTV, or DVO) currently selected by the CPG. The field-of-view gates identify the area of the display that can be selected for the next higher level of magnification. In contrast to the PNVS, there are no symbol subsets or modes for the various functions performed by the TADS.

During the AH-64 development program, empirical research comparing different symbology formats was found to be "sorely lacking" (Buckler, 1978a). Furthermore, Buckler (1978b) noted that reconfigurable simulators on which to test alternative designs were of limited availability. As a result, the current AH-64 symbology was designed largely on the basis of subject matter expert (SME) opinion. Buckler (1978b) reported that SMEs conducted an analysis of the information needed by the crew to perform representative AH-64 flight and weapons tasks. Following the analysis, the SMEs recommended the existing symbology format.

No evaluation has been made to determine whether the existing AH-64 symbology enhances or degrades crew performance in critical helicopter flight and weapons tasks. Viable design alternatives for helicopter flight and weapons symbology have not been proposed and evaluated. Therefore, the standard for the design of symbology for future helicopters is being patterned after the existing AH-64 symbology (Department of Defense, 1984).

Need

A need exists to develop a methodology to empirically evaluate display symbology and to recommend optimal symbology suites for various Army helicopter systems. Critical design issues to be addressed during the research include:

- the appropriate use of coding,
- the degree that overlaid symbology obscures critical visual information,
- the appropriate symbol density, and
- the compatibility of proposed symbology with the cognitive processes of the crewmember.

Ideally, the application of the methodology will result in the design of symbology suites that reflect known capabilities and limitations of aviators, and provide relevant information in formats that foster accurate and efficient interpretation. In addition, the resultant symbology design should complement rather than degrade vital information available from either the natural external visual scene or sensor-provided imagery.

The Army Research Institute Aviation Research and Development Activity (ARIARDA) was tasked by the Army Aviation Systems Command (AVSCOM) to (a) develop the required research methodology, and (b) apply the methodology in the evaluation of existing helicopter display symbology. Anacapa Sciences, Inc., personnel began work on the project in February 1987.

Project Objectives

The three objectives of this project are: (a) conduct an empirical evaluation of the existing AH-64 symbology, (b) identify potential deficiencies and recommend improvements to the AH-64 symbology, and (c) develop a methodology for evaluating alternative symbology suites for future Army helicopters.

Project Status

Work Completed

Work on this project commenced with a comprehensive review of the aircraft display symbology literature. Special emphasis was placed on reviewing research that evaluated the effectiveness of symbology coding dimensions.

Project personnel also reviewed available technical documents and observed academic classes at the U.S. Army Aviation Center (USAAVNC). Videotapes were recorded from the AH-64 Combat Mission Simulator (CMS) displays, and the symbology and imagery available to AH-64 crewmembers during representative flight and weapons tasks were reviewed. Discrepancies discovered in these sources made it necessary to compile detailed and accurate technical descriptions of the existing AH-64 symbology. Information from the AH-64 CMS was established as most representative of the symbology set used in the actual aircraft.

Development of a comprehensive research plan is underway in which six tasks that must be accomplished to meet the project objectives have been identified. The tasks are listed below:

- identify flight tasks that depend on the symbolic information,
- develop flight scenarios containing flight tasks identified in the previous task,
- develop performance measures for the flight tasks identified,
- identify equipment and other support requirements for the research,
- select and train subjects, and
- perform the research needed to evaluate candidate symbology suites.

A preliminary review has been completed of the ARIARDA resources available to support the research. The resources include (a) a UH-1 Training Research Simulator (TRS) modified to provide simulated external visual scenes, (b) independent graphics workstations, (c) a crew station procedures trainer, and (d) microcomputer-based part-task training devices. The UH-1 TRS is expected to be operational by the end of calendar year 1987 and has been identified as the most suitable test-bed for the project. To maximize the availability of the TRS, it may be possible to train subjects on a microcomputer part-task training device presently being developed as part of a related research project (see Ruffner, 1987).

Work Projected

Once the research plan has been approved by the Contracting Officer's Technical Representative (COTR), work will begin on the tasks identified previously. It is anticipated that a series of experiments will be designed to evaluate candidate symbology suites.

The first experiments will evaluate simple flying task problems, with primary flight information presented through subsets of the AH-64 symbology suite. Basic subsets of alternative symbology will also be evaluated using the same simple flying task problems. As the research progresses, more complex experiments will be designed to include multiple flying tasks, with more information presented through symbology. The experiments will be designed such that performance measures can be used to compare the properties of the AH-64 symbology suite with alternative symbology suites.

The successful accomplishment of this research should result in the development and use of a prototype set of procedures, equipment, and software to evaluate AH-64 and alternative symbology sets. The methods developed and experience gained in performing this research can then be employed to evaluate proposed symbology for future aircraft systems.

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NEW FAST DEVELOPMENT AND VALIDATION

Dr. D. Michael McAnulty, Project Director

Background

The Army's original selection battery, the Flight Aptitude Selection Test (FAST), was developed in response to the unacceptably high attrition rates in the flight training program during the 1950s. There were actually two overlapping FAST batteries, one for officer applicants and one for enlisted and civilian applicants to the Warrant Officer Candidate (WOC) program. Each battery yielded a fixed wing and a rotary wing aptitude score for each applicant (Kaplan, 1965). The FAST, implemented in 1966, resulted in a substantial reduction in the flight training attrition rates.

In 1975, the U.S. Army Aviation Center requested a revision of the FAST due to (a) a decrease in the validity of the FAST, (b) the large number of errors in scoring the FAST, (c) the excessive amount of time (about 4 hours) required to administer the FAST, and (d) the elimination of fixed wing training for initial entry students. The goal of the revision was to develop a single, effective battery with fewer, shorter, and more reliably scored subtests (Eastman & McMullen, 1978).

The methodological approach chosen for the revision was to select the most effective subtests from the FAST and then to select the most effective items from each subtest for inclusion in a revised FAST (RFAST). Factor analyses and multiple regression analyses were used to select 7 of the 12 FAST subtests for retention. Subsequently, item difficulties and item discrimination coefficients were analyzed to select the specific items to be retained in each subtest. The RFAST, which is approximately one-half the length of the FAST, was implemented in 1980.

Subsequently, research was conducted to evaluate the reliability and validity of the RFAST and its subtests. Lockwood and Shipley (1984) found that six of the seven subtests had adequate internal consistency and that the correlation between the RFAST score and performance in initial entry rotary wing (IERW) training was statistically significant. They concluded, however, that the low percentage of variance accounted for by the RFAST indicates the battery has limited utility in predicting IERW performance. In addition, Smith and McAnulty (1985) found that the RFAST has marginal retest reliability and that there was a large increase in the average score on retesting, indicating a need for an equivalent form for use when retesting is required.

The first phase of research in the development of a new FAST (NFAST) was to identify the ability requirements for successful completion of IERW. Experienced IERW instructor pilots (IPs) were asked (a) to identify the tasks that are most indicative of successful performance in the primary and instrument phases of IERW, and (b) to judge the type and importance of the abilities that are required to perform each task. The task-ability ratings for each IP were then transformed to a normally distributed, equal-interval scale using the method of successive intervals (McAnulty & Jones, 1984). Analyses of the transformed ratings indicated that 24 abilities from the psychomotor, perceptual, language, and cognitive domains were required for successful performance in IERW. A test specifications matrix was then developed as a guide in developing the NFAST (McAnulty, Jones, Cohen, & Lockwood, 1984).

In the last phase of the previous research, a battery of nine tests was developed to measure 11 of the required cognitive and perceptual abilities. The seven-hour experimental battery was administered to 290 general population subjects at three military installations in the southeastern United States (McAnulty, 1986).

Need

The U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) has a continuing requirement to evaluate and improve the tests that are used to select applicants for the Army IERW training program. As indicated in the background section, a new FAST battery is needed to improve the reliability and validity of the IERW selection process and to develop an alternate form to retest IERW applicants.

Project Objectives

The general objective of this project is to develop, evaluate, and implement a more effective battery of IERW selection tests. The specific technical objectives of the research project are to:

- evaluate the performance of general population subjects on an experimental battery of tests designed to measure the abilities that are required for successful performance in IERW,

- develop two alternate forms of the NFAST battery,
- conduct research to validate and equate the alternate forms of the NFAST battery,
- revise, produce, and implement the operational versions of the NFAST battery, and
- evaluate the NFAST battery and administrative procedures in operational use.

Research Approach/Methodology

This project is a continuation of the ongoing ARIARDA research program in aviator selection and classification (McAnulty, 1986). The current research is being conducted in three phases. In Phase 1, the data collected during the experimental administration of the new battery will be analyzed to determine the psychometric characteristics of the nine tests and the interrelationships among the tests. The results of these analyses will be used to develop two equivalent forms of an NFAST validation battery.

Phase 2 of the research project is a traditional predictive validity study. The purposes of the validation study are (a) to determine the relationship between the NFAST tests, other predictor data, and performance in IERW training, and (b) to equate the alternate forms of the battery on a large sample drawn from the target population of flight students. Phase 2 of the research also requires the development and evaluation of measures of IERW performance. The results of the validation analyses will be used to produce two alternate forms of an operational NFAST battery.

Phase 3 of the research project will be the implementation of the NFAST. All ancillary materials (machine scorable answer sheets, administrative manuals, scoring and equating manuals, selection criteria) will be developed and delivered for operational use. After the NFAST is implemented, a sample of field data will be analyzed to ensure that the psychometric characteristics of the operational battery are not significantly different from the validation battery. Finally, data will be collected and analyzed to ensure that the tests are being properly administered and the test scores are being used appropriately in the selection process.

Project Status

Work Completed: Phase 1

The statistical analyses of the experimental NFAST battery have been completed. The experimental battery consisted of eight tests that were each designed to measure a unique ability and one test that was designed to measure a complex of abilities required for the successful completion of IERW training. The results indicate that the complex ability test and six of the unique ability tests assess reliable individual differences in the abilities of interest. The average difficulty levels of the seven tests are near the optimum level of .50; the test variances indicate the measurement of substantial individual differences; and the estimates of reliability are acceptable when test length and the design specifications are considered. The remaining two unique ability tests had undesirable psychometric characteristics or did not contribute any unique variance to the factor structure of the battery. A technical report (McAnulty, Cross, & Jones, 1986) that describes the results of this research was written and submitted to ARIARDA for review.

The results of the Phase 1 research were used to develop two alternate forms of the NFAST validation battery. Each form consists of modified versions of the complex test and the six unique ability tests with acceptable characteristics. In general, the validation battery tests are approximately two-thirds the length of the experimental battery tests. The alternate forms of five of the tests have approximately 50% of the items in common. The complex ability test forms and one of the unique ability test forms do not have any identical items. Finally, a knowledge test of helicopter operations and aerodynamic principles was adapted from the RFAST battery for inclusion in the validation battery. The items on the knowledge test are identical on both forms. Each form of the validation battery requires approximately four hours to administer.

Work Completed: Phase 2

The Phase 2 research activities are partially completed. Between March and September 1987, the NFAST battery was administered to approximately 95% of the entering commissioned officer (CO) and WOC flight students within the first two weeks of IERW training. When the test administration phase is terminated, complete test data will be collected from approximately 350 CO and 350 WOC students.

Preliminary test data analyses indicate that target population performance on the validation battery (excluding the helicopter knowledge test) is similar to the general population performance on the experimental battery: the average difficulty levels are near .50 despite the more restrictive time limits that were imposed on the validation tests, and the variances indicate that substantial individual differences in ability are being measured by the tests. Performance on the two forms of the battery are very similar except for one of the unique ability tests. Test performance by the CO and WOC students is also quite similar, although there are statistically significant differences between them: CO students score significantly higher on three of the tests and WOC students score significantly higher on one of the tests.

The preliminary test results on the helicopter knowledge test adapted from the RFAST indicate that the test is not difficult (the average difficulty level is .81) and there is limited variability in the scores. WOC students score significantly higher on the test than the CO students. However, there is no difference in performance by either student group on the two forms of the test. Since the test items are identical on both forms, this result indicates there was no systematic sampling bias in terms of aviation-related knowledge in the assignment of students to the alternate forms of the NFAST battery.

The collection of IERW performance measures has also started. Student grades on academic tests and end-of-IERW-phase flight checkrides are routinely reviewed as they are collected from the Aviation Management Information System. In addition, changes to the class rosters are monitored to identify tested students who have been eliminated from training or set back to a different class. The reasons for these administrative changes (e.g., some setbacks may be due to student flight deficiencies and others may be due to a shortage of IPs) are also obtained from the class rosters. Finally, efforts have been initiated to arrange for diagnostic interviews with tested students who have been eliminated from IERW training. The purpose of the interview is to explore, in-depth, the problems the student had during flight training so that specific deficiencies can be identified and related to individual test performance.

Work Projected: Phase 2

The NFAST battery will continue to be administered to incoming IERW students until the minimum number of complete test data sets is collected for each group and for each form. Past experience indicates that the data from approximately 10% of the subjects will be eliminated from the primary analyses because of mitigating subject factors (e.g., illness, lack of sleep due to standing duty watch, failure to follow directions or provide complete data, or observed or self-reported lack of effort). When the test data base has been established, statistical analyses will be conducted to determine the psychometric characteristics of the tests and test items, the equivalence of the alternate test forms, and the interrelationships among the tests and other predictor data (e.g., biographical information and RFAST scores).

IERW performance data will be collected until all the students in the test data base have either graduated or attrited from flight training (approximately 11 months after the last battery administration). The performance data will include academic grades, checkride scores, flight hours, administrative changes (e.g., setbacks, additional flight hour authorizations, mission track assignment), and terminal status (pass or fail and reason for failure). In addition, information obtained from the diagnostic interviews will be incorporated into the performance data base. When the performance data base has been established, appropriate statistical analyses will be conducted to determine the psychometric characteristics of the performance measures, the interrelationships among the performance measures, and the correlations between the predictor and performance measures.

The results of these analyses will be used to produce two alternate forms of the NFAST for operational use. The development of the operational batteries should be completed by March 1989.

Work Projected: Phase 3

Phase 3 activities have not been formally initiated, although a prototype administration manual has been developed for use with the validation battery and has been informally evaluated during the Phase 2 administrations. The administration manual will be modified for use with the operational battery. Additional ancillary materials, such as a scoring and equating manual and selection criteria guidelines, will be developed. The operational batteries and ancillary materials will be delivered to the U.S. Army Soldier Support Center for implementation.

After the NFAST is in operational use, follow-on research is planned to ensure that applicant performance on the batteries is within acceptable limits, that administrative procedures are being followed, and that the selection criteria are valid. Depending on the results of the preceding research, it may be necessary to conduct a second validation study using an unrestricted sample (i.e., not already selected for flight training) of IERW applicants.

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THE ENLISTED AVIATOR PROGRAM SURVEY

Dr. D. Michael McAnulty and Dr. John W. Ruffner,
Project Directors

Background

In February 1986, Anacapa Sciences, Inc., was tasked by the Army Research Institute Aviation Research and Development Activity (ARIARDA) to provide research support to a Joint Working Group (JWG) at the U.S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama. The JWG was established to meet a Department of the Army (DA) requirement to determine the feasibility and desirability of utilizing enlisted personnel as Army aviators.

The possibility of establishing an enlisted aviator (EA) career field was examined previously and rejected as not being a viable concept (DA Aviation Special Task Force, 1977). At the time the current project was initiated, however, the Army warrant officer force structure requirements for 1992 exceeded the budgeted end strength by more than 3,000 personnel. If feasible and desirable, the utilization of enlisted personnel as Army aviators would enable the Army to meet the budgeted end strength restrictions and to maintain adequate staffing of the aviation units.

Concern about the shortage of warrant officers in the 1990s and several apparent shortcomings in the previous EA research prompted the DA to direct that another comprehensive study be conducted to evaluate all the issues related to the implementation of an EA military occupational speciality (MOS). The JWG developed a multifaceted research approach to study the EA issues. First, information was collected from the U.S. Navy and Air Force, and from allied countries on their experience with enlisted aviators. Second, operations research analysts conducted a cost-benefit analysis of an EA MOS under varying assumptions of paygrade, flight pay, training attrition and remediation, and personnel retention rates. Third, members of the JWG examined the legal, regulatory, and conventional ramifications of utilizing EAs. Fourth, comparative information (e.g., on officers and enlisted personnel performing similar jobs in other career fields) was collected to make inferences about the potential for operational effectiveness and to evaluate the risks to safety that would result from utilizing EAs.

Finally, the JWG tasked ARIARDA and Anacapa with the development, administration, and analysis of a series of surveys designed to obtain broad-based subjective opinions about the feasibility and desirability of utilizing EAs in Army aviation. As guidance to the Anacapa research team, the JWG provided a matrix of respondent samples and management issues to be addressed by the surveys. The JWG also provided descriptions of three options for evaluation as an EA program. Under Option 1 (total conversion), the warrant officer corps would be completely replaced over a period of years by an EA MOS. Under Option 2 (partial conversion), new aviators would serve in enlisted paygrades for six years and then be eligible for promotion to warrant officer. Under Option 3 (Air Weapons Operator), EAs would augment the warrant officer corps by performing a limited range of aviation duties.

Project Objectives

The objectives of this project are to collect subjective opinions from various subject matter experts (SMEs) and potential EA participants to:

- evaluate the feasibility and desirability of an EA program,
- evaluate the advantages and disadvantages of each of the three EA options,
- develop the policies that should be adopted to manage an EA program,
- evaluate the interpersonal aspects that would affect an EA program,
- evaluate the impact of an EA program on aviation training, doctrine, and mission effectiveness, and
- evaluate the impact of an EA program on the accession and retention of aviators.

Research Approach

As directed by the JWG, all the opinion data were to be collected by surveying aviation SMEs and potential EAs about several issues related to the implementation of an EA program. Each survey was developed in a paper-and-pencil response format. The general approach to the development of each survey was to:

- identify the target population and develop a sampling plan,
- identify the issues to be addressed by the sample,
- draft items to collect the required data,

- pretest the items on a representative sample of respondents,
- revise the items and organize the survey form,
- obtain the approval of the Soldier Support Center to use the survey, and
- reproduce the survey for administration.

The surveys were constructed using a variety of item formats and response scaling techniques. To the extent possible, however, the items were constructed in a multiple choice or restricted fill-in-the-blank format that was computer coded to facilitate data processing. After each survey or set of surveys were developed, they were administered to the designated sample. Data entry and verification programs were developed and used to build a project data base. Finally, the data were analyzed and the results were submitted to the JWG for incorporation into their final report.

Survey Instruments

Eleven survey instruments were developed to collect the data required to meet the project objectives. Two of the surveys were independent and administered to all members of the respective samples. The remaining surveys were divided into three series of three surveys each; each survey in a series presented information about only one of the EA options and was administered to approximately one-third of the members in the respective series' sample. The survey instruments are described in the following sections.

Survey Form G-1

The primary research instrument (Form G-1) was a general survey of opinions about the feasibility and desirability of an EA program including all three of the EA options. Form G-1 was designed for administration to senior noncommissioned officers (NCOs), aviation warrant and commissioned officers, nonaviation warrant and commissioned officers, and National Guard state aviation officers. Form G-1 is divided into the following six parts.

- Part I contains 30 items requesting background information about the respondent's personal characteristics and military experience.
- Part II contains 44 items requesting opinions about EA policies and duties. The section on policy covers the

selection and training of EAs, the assignment and management of EAs, and variables to be considered in the promotion of EAs. The duties section covers opinions on the aviation and military responsibilities of EAs, the requisite conditions for assigning EAs to various aviation positions, and the types or decisions EAs would be authorized to make.

- Part III contains 50 items addressing the social aspects of an EA program. Part III is divided into six sections on authority, social status, social issues, morale, command relationships, and discipline.
- Part IV contains 20 items requesting opinions about the impact that an EA program would have on aviation unit training, doctrine, and mission effectiveness.
- Part V contains 9 items requiring 21 responses to questions about the retention of EAs beyond the period of initial obligated service under each of the three options that were identified previously.
- Part VI contains 9 items requesting information about the respondent's summary opinions of each EA option.

In addition, a 24-item supplement to Form G-1 was prepared for use with the National Guard state aviation officers. The supplement was designed to collect information on the training, recruitment, and retention of aviators that was specific to the National Guard.

Survey Form RQ-1

Survey Form RQ-1 was designed to collect information from Army recruiters about the potential for attracting qualified personnel for each of the EA options. The recruiter survey was originally designed to be in a telephone interview format, but was subsequently changed to a paper-and-pencil response format. Form RQ-1 is divided into five parts. Part I contains 7 items requesting general information about the individuals that the respondent currently counsels during a typical 12 month period. Parts II through IV contain 8 items requesting information on the recruitment of personnel under options 1, 2, and 3, respectively. Part V contains 5 items requesting demographic information about the respondent.

Series WO

Series WO comprises three surveys that were designed to collect opinion information from warrant officers and warrant officer candidates about the feasibility and desirability of an EA program. Each survey (OP-1, OP-2, and OP-3) in the series presents a description of only one of the three EA options. The respondents are asked to provide demographic information (18 items) about themselves, to study the description of the EA option, and to answer 12 questions about their opinions of the described option.

Series EP

Series EP comprises three surveys that were designed to collect opinion information from enlisted personnel who are in the potential flight school applicant pool about the feasibility and desirability of an EA program. Each survey (OP-1, OP-2, and OP-3) in the series presents a description of only one of the three EA options. The respondents are asked to provide demographic information (26 items) about themselves, to study the description of the EA option, and to answer 26 questions about their opinions of the described option.

Series HS

Series HS comprises three surveys that were designed to collect opinion information from high school students who are in the potential flight school applicant pool about the feasibility and desirability of an EA program. Each survey (OP-1, OP-2, and OP-3) in the series presents a description of only one of the three EA options. The respondents are asked to provide demographic information (21 items) about themselves, to study the description of the EA option, and to answer 23 questions about their opinions of the described option.

Respondent Samples

Form G-1

The general opinion survey (Form G-1) was administered to 297 senior NCOs, 193 nonaviation officers (163 commissioned and 30 warrant), and 291 aviation officers (169 active duty and 46 National Guard commissioned, and 76 warrant). The NCOs were in paygrades E6 through E9, the warrant officers were in paygrades WO1 through CW4, and the commissioned officers were in paygrades O2 through O6.

Form RQ-1

After Form RQ-1 was developed, the U.S. Army Recruiting Command declined to participate in the research. Instead, they agreed to submit a letter stating that they would have no difficulty in recruiting sufficient numbers of qualified personnel to meet the requirements of any of the three EA options. No further research was conducted using Form RQ-1.

Series WO

Series WO was administered to 180 warrant officer candidates enrolled in the Initial Entry Rotary Wing training course and to 69 aviation warrant officers attending the Warrant Officer Advanced Course. However, only the WO data collected from the warrant officer candidates were retained for analysis. The bias resulting from the warrant officers' vested interest in a continuing warrant officer force resulted in a uniform and extremely negative opinion toward any EA program. The 69 aviation warrant officers expressed their general opinions about an EA program by completing Form G-1.

Series EP

Series EP was administered to 619 enlisted personnel in paygrades E1 through E5. Most of the respondents had served less than one enlistment period. There were 251 newly inducted recruits included in the EP sample who had served less than one week in the Army. All the data were utilized in the analyses.

Series HS

Series HS was administered to 147 high school students in the Fort Rucker, Alabama, area. However, an evaluation of the demographic characteristics of the sample indicated that a majority of the respondents did not meet the sampling criteria. Specifically, many of the students were not graduating seniors, had no interest in learning to fly, or were ineligible for an EA program because of physical or academic deficiencies. Because of these problems and the inclusion of a large number of new recruits (many of whom were recent high school graduates) in the EP sample, the HS data were not analyzed further.

Results and Discussion

The results and conclusions of the EA surveys are based on the data from the 1580 respondents to Form G-1, Series WO, and Series EP. There were substantial differences in the opinions held by the various groups that were sampled. For example, the senior NCOs held more positive attitudes than officers about the capabilities of enlisted personnel performing as aviators. Similarly, aviation officers held more negative attitudes than nonaviation officers about the mission effectiveness and training requirements for EAs. On many issues, however, the respondent samples agree on the direction (e.g., positive or negative) of their collective opinions, although they may differ in degree (e.g., moderate or extreme in opinion). Therefore, there are several general conclusions that can be drawn from the combined data.

First, the concept of an EA program was judged to be moderately feasible but only marginally desirable. This result was interpreted to mean that an EA program could be effectively managed if required, but there would be detrimental consequences associated with the program. For example, the respondents estimated that the ability to meet mission requirements would not change if enlisted personnel were assigned as aviators, but the amount of time and resources required for training and the amount of supervision required in aviation units would increase. The respondents also estimated that the clarity of the command structure would be reduced if an EA program were implemented and that EAs would not have the necessary authority to meet their aviation responsibilities.

Second, approximately 75% of the respondents indicated that, compared to other aviators, EAs should have (a) the same entrance requirements for initial and advanced flight training, (b) the same performance standards in training, (c) the same training requirements for maintaining flight proficiency, and (d) the same standards for being selected as pilot-in-command. Essentially, the respondents indicated that the proficiency of aviation personnel should not be reduced because of the lower paygrades associated with an EA program.

Third, the respondents to all the surveys agreed that partial conversion was the most feasible and desirable EA option. The total conversion and Air Weapons Operator options were perceived as equally desirable by potential applicants. The EP and WO respondents rated the desire to fly and the excitement of the job as the primary reasons for applying to flight school. However, the G-1 respondents judged the total conversion option as only marginally feasible and not at all desirable. This result probably reflects the long-term management implications for a career program that has increasing levels of responsibility but only limited promotion potential. There was no generalized agreement on the feasibility and desirability of the Air Weapons Operator option by the G-1 respondents.

Finally, two conclusions can be drawn about EA recruitment and retention. The data support the opinion of the Army Recruiting Command that sufficient numbers of qualified personnel could be recruited for an EA MOS. A majority of the EP and WO respondents indicated that they would very likely apply for any one of the EA options if it was the only flight program currently available. Conversely, the G-1 data indicated that EAs would be more likely than current aviators to leave the Army after their initial obligated service. Pay and benefits, which were the primary reasons cited by enlisted personnel for remaining in the Army, would be lower in each of the three EA options.

Project Status

As indicated above, the survey instruments have been developed and administered, and the data have been analyzed. The results, including the individual item analyses and summary tables and figures, were submitted to the JWG for incorporation into their briefings and final report. The Anacapa researchers also provided consulting services to the JWG as the study was presented to various levels in the chain of command. The DA accepted the conclusion of the JWG that, although the EA program was feasible, the current aviation warrant officer force structure should be retained for the present time and that other alternatives should be pursued to meet the budgeted end strength restrictions. No further work by Anacapa is projected on the Enlisted Aviator Program.

Reference

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DEVELOPMENT OF A PEER COMPARISON PROGRAM

Dr. D. Michael McAnulty, Project Director

Background/Need

This project was initiated in response to a request from the School Secretary, U.S. Army Aviation Center, for support in developing an algorithm to select course honor graduates based on the "whole person" concept. The School Secretary wanted to augment the academic grade criterion used to select honor graduates in the Aviation Officer Advanced Course (AVNOAC), a five-month officer training course for captains and promotable first lieutenants. The purposes of the augmented program are:

- to motivate students to maximize their military as well as their academic efforts during the course, and
- to identify students who have high potential as Army aviation officers at an early stage of their careers.

Specifically, the School Secretary was interested in using peer assessments by the AVNOAC students as a component in the honor graduate selection algorithm. The peer assessments were to evaluate aspects of the students' performance that were not reflected in their academic scores. Instructor ratings were not considered because of the limited interaction between the school cadre and the students.

Project Objectives

Following a review of the peer assessment literature and the AVNOAC syllabus, a peer comparison (PC) methodology was proposed for use in the AVNOAC. The School Secretary agreed to support the following research objectives:

- identify the most important military qualities that could be assessed by peers during the AVNOAC,
- develop the PC instruments and procedures for use in the AVNOAC, and
- experimentally evaluate the PC technique prior to implementation.

Research Approach

The research approach was divided into three phases that correspond to the research objectives. Phase 1 involves the administration of a military qualities survey to identify the most important qualities that could be assessed by peers during the AVNOAC. The survey asks senior aviation officers to rate a list of primary military qualities as dimensions for evaluating student performance and for identifying students with high career potential. The survey data provides the information needed to develop the PC instruments.

Phase 2 involves the development of three project assessment instruments: the PC form to be completed by the class members to evaluate their peers, a faculty advisor rating form to be completed by each class member's training officer, and a student critique to be completed by the students to evaluate the PC instruments and procedures. Phase 3 involves the experimental administration and evaluation of the PC technique in the AVNOAC.

Project Status

Work Completed

Phase 1: Military qualities survey. Following a search of the literature and a review of current Army student evaluation dimensions, definitions of 14 primary military qualities (e.g., adaptability, initiative, judgment, leadership, and responsibility) were compiled for evaluation by senior aviation officers. Several important military qualities were excluded because they are evaluated by academic scores or are unlikely to be demonstrated during the AVNOAC. The military qualities survey was sent to 16 senior Army officers who were asked to rate each quality on the following four scales:

- importance to the performance of captains,
- importance to the performance of senior officers,
- probability of demonstration during the AVNOAC, and
- degree of overlap with the other qualities.

Eleven surveys were completed and returned. Three of the qualities (leadership, judgment, and responsibility) had consistently high ratings and were selected as PC dimensions. Seven of the qualities were clearly perceived as being inappropriate PC dimensions. Appearance and cooperation were selected from the remaining four qualities as two additional PC dimensions.

Phase 2: Form development. Three research forms were developed for use in this project. The PC form was developed from (a) the results of the military qualities survey, (b) a combination of the peer nomination and peer ranking techniques (e.g., Kane & Lawler, 1978), and (c) the psychophysical method of paired comparisons (Engen, 1971, pp. 51-54). On the PC form, each section member (a class is divided into two sections) is required to nominate and rank order five peers on the basis of their potential as Army aviation officers. The section member then makes paired comparisons of the nominees on the five military qualities that were selected from the military qualities survey.

PC scores are computed for each section member by first summing the rank score (five points for first rank, four points for second rank, . . ., one point for fifth rank) from each nominating peer. The summed rank scores are then added to the number of favorable comparisons the section member received on each military quality. The total is then divided by the maximum possible score to enable direct comparisons between sections with unequal numbers of students. The resulting PC scores could range from 0.0 (no nominations) to 1.0 (ranked first by all peers and always favorably compared with the other nominees).

A faculty advisor rating (FAR) form was developed to obtain independent evaluations of the students' potential as Army aviation officers. Each AVNOAC faculty advisor supervises approximately six students. The advisors use the FAR to estimate where each of their students would rank in terms of their officer potential in an average group of 100 captains. Finally, a student critique form was developed to ascertain student attitudes toward the peer comparison program. The students are asked to rate the fairness, utility, aversiveness, and difficulty of various aspects of the program. They are also asked to express their opinions about the implementation of the program and to offer recommendations for improving the program.

Phase 3: Experimental administration 1. Peer comparisons were collected on an experimental basis (i.e., the PC scores were not used to select honor graduates) from Sections 1 (n = 41) and 2 (n = 40) of AVNOAC 85-2 in July 1985. A second set of PC ratings and the student critiques were collected approximately one month later. The faculty advisors completed the FARs immediately after graduation. In addition, the final academic averages (AVGs) were obtained from the School Secretary's office.

The results of the first administration were mixed. The PC scores ranged from 0.0 to .92 in Section 1 and from 0.0 to .75 in Section 2. The scores indicate a high consensus among the members of the class in identifying peers with the highest potential as aviation officers. The scores for the first and second data collections were highly correlated (Section 1 = .96 and Section 2 = .86), indicating the stability of the ratings over time. Combining the scores from both data collections in both sections, the class members were in agreement on the top 10% and the lower 75% of the class.

The PC scores were then correlated with the FARs and AVGs. For Sections 1 and 2, respectively, the PC correlations are .45 and .33 with the FAR, and .55 and .29 with the AVG. These correlations are sufficiently high to show an expected relationship between observations of the same individuals. At the same time, the correlations are sufficiently low to indicate that the PC score is measuring a unique perspective of the class members. The correlations between the FAR and AVG are .74 and .58 in sections 1 and 2, respectively. This result probably indicates that the faculty advisors were depending upon the academic average as a primary source of information in making their ratings.

Finally, the responses to the PC critique were tabulated. The overall reaction of the class members to the PC program was negative: a majority indicated that the PC was very biased, slightly or not at all useful, and slightly or not at all predictive of future performance. Furthermore, 72% of the respondents were either very or extremely unfavorable toward the implementation of the program. The responses to the other critique items reflected combinations of positive, negative, and neutral attitudes, without any attitude representing a majority opinion.

The results of the first administration indicated that the PC technique was a potentially useful procedure for identifying the class members with the highest potential as Army aviation officers, although the students were generally critical of its use. There were, however, several problems with the first administration. First, the students were not advised in advance of the experimental administration. Second, a concurrent but surreptitious attempt by the class leaders to evaluate the section members was discovered just before the second data collection. Both of these problems may have affected the students' attitudes about class evaluations. Finally, the period of time that elapsed between the first and second PC administrations was too short to evaluate the stability of the peer assessments.

Phase 3: Experimental administration 2. The second experimental administration was designed as a replication of the first administration, with the following changes:

- students were advised in advance of the research,
- other non-academic evaluations were prohibited,
- three months elapsed between the initial and final data collection,
- the military quality definitions were modified slightly,
- the order of presentation of the military qualities and nominee pairs was completely counterbalanced, and
- a new roster coding system was instituted to protect student privacy.

The PC was administered to 49 students in Section 1 and 51 students in Section 2 of AVNOAC 86-1 in December 1985. In March 1986, 47 students in Section 1 and 49 students in Section 2 completed the PC ratings and student critiques. Preliminary analyses indicated an overall consensus in each section on the members having the highest potential as aviation officers, although there were some changes in the ratings over time. There was a longer interval between ratings in class 86-1 and the initial ratings may have been collected before peer opinions were fully formulated. Nonetheless, the correlations between the initial and final ratings are .79 in Section 1 and .93 in Section 2. Similar to class 85-2, the majority of class 86-1 were opposed to the implementation of the PC program in the AVNOAC.

Further analyses were not conducted pending the receipt of missing FAR and AVG data. In November 1986, the missing AVG data was finally obtained from the Academic Records office, but the Assistant School Secretary terminated attempts to obtain 16 missing FAR ratings; the faculty advisors who had not submitted complete FARs had changed assignments or could not recall their advisees' performance in sufficient detail to provide the ratings.

During June and July 1987, the data from both AVNOAC classes were prepared for analysis. First, the PC rating forms were reviewed for completeness and accuracy (e.g., following instructions in using the form). A small percentage of the ratings were deleted from the analyses. Second, the PC forms were rescored by Anacapa Sciences, Inc., personnel. The original scores had been tabulated by personnel in the School Secretary's office, but numerous errors were noted during the rating form reviews. In addition, the data for class 86-1 were scored so that split-half analyses could be conducted separately. Finally, the data were entered into a new computer data base.

Work Projected

Two activities remain to be completed on the PC project. First, the final data analyses will be conducted for Experimental Administrations 1 and 2. The analyses are designed to:

- evaluate the internal consistency and retest reliability of the PC ratings,
- determine the relationship between the PC ratings and other evaluations,
- evaluate the internal structure of the PC technique (e.g., are ratings on five military qualities needed),
- determine student reactions to the PC program, and
- evaluate various methods of combining the PC ratings with AVGs to select the course honor graduates.

Second, a report and a briefing will be prepared to present the results of the research to the School Secretary's office. The report will include recommendations on the implementation of the PC program.

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EVALUATION OF THE AVIATION RESOURCE MANAGEMENT SURVEY (ARMS) CHECKLIST

Dr. John W. Ruffner, Project Director

Background

According to the Army's "total force" concept, Reserve Component (RC) aviators serving in the U.S. Army Reserve (USAR) and the Army National Guard (ARNG) are required to train to the same standards and to maintain the same level of flight proficiency as aviators serving in the Active Component (AC). To meet these requirements, it is necessary for the managers responsible for the planning, implementation, and evaluation of RC training to utilize the available resources (e.g., aircraft, training time, flying hours, instructor pilots) as efficiently as possible. This is particularly important since the amount of time available for training RC aviators is much more limited than for AC aviators.

One of the ways in which the Army assists RC training managers in meeting these requirements is through the use of evaluation visits made by Aviation Resource Management Survey (ARMS) teams. Forces Command (FORSCOM) Regulation 350-3 (1984) states that the general purpose of the ARMS is to "evaluate the management of unit aviation programs, identify areas requiring additional emphasis, and provide staff assistance as necessary."

As defined by FORSCOM, the ARMS has four specific objectives:

- to assist commanders in identifying strengths and weaknesses in all aviation related programs;
- to assess the aviation support facility's (ASF) ability to support units assigned to train at the facility in accomplishing their mobilization mission;
- to assess the aviation unit's capability to operate safely, efficiently, and effectively, and to maintain aviation resources separate from the ASF; and
- to identify systematic problems and to provide assistance when the capability to solve the problems is beyond the installation commander's realm of influence.

The office of the Deputy Chief of Staff for Training (DCST) in each of the five Continental U.S. Armies (CONUSAs) is responsible for conducting ARMS evaluations. According to

FORSCOM Regulation 350-3 (1984), an ARMS is to be conducted at least once a year for each USAR facility and at least once every two years for each ARNG facility within the CONUSA.

Problem

Each CONUSA has its own procedure for carrying out the ARMS evaluation mission. There is a lack of standardization across the CONUSAs in (a) the functional areas (e.g., safety, standardization, and training) that are evaluated, (b) the procedures used by the ARMS teams to assess the facilities and units, and (c) the standards for acceptable performance.

The first U.S. Army DCST, Aviation Division, has developed a checklist to be used by the ARMS team during its evaluation visits. The checklist originally was published in October 1983, and subsequently was revised in August 1985, as DA Pamphlet 95-1, Reserve Component Commander's Guide - Aviation Standardization and Training Program Evaluation and Aviation Resource Management Survey. The checklist draws heavily from two sources: (a) FORSCOM Form 14-1-R Reserve Component Aviation Resource Management Checklist (1980), and (b) the U.S. Army Safety Center Guide to Aviation Resources Management for Aircraft Mishap Prevention (1984), but does not completely replicate either document.

The First Army checklist contains approximately 650 items divided into the following 11 major functional areas of evaluation:

- Aviation Safety Management,
- Facility/Unit Operations,
- Aviation Standardization and Training,
- Aircraft/Flightline Operations,
- Aeromedical Management,
- Aircraft Crash Rescue and Fire Fighting,
- Petroleum, Oil, Lubricants (POL) Facilities and Operations,
- Maintenance Management,
- Aviation Armament,
- Aviation Life Support Equipment (ALSE), and
- Physical Security.

The items within each of the functional areas describe a condition or state that the facility or the units must meet. The items were written by aviation subject matter experts (SMEs) who are knowledgeable about operational requirements

RC support facilities must support and about mobilization mission requirements RC units must fulfill.

The DCST, First U.S. Army, has expressed concern about several deficiencies in (a) the content and organization of the checklist, (b) the manner in which the checklist is used to evaluate the status of each RC facility and unit, and (c) the quality and utility of feedback provided to command personnel following the evaluations. Consequently, during the second quarter of FY 1985, the DCST requested that the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) provide research support to evaluate and revise the checklist. Anacapa Sciences, Inc., began work on the project on 3 June 1985.

Project Objectives

This project has two general objectives: (a) to perform a systematic evaluation of the content of the First Army ARMS Checklist, the procedures used to administer the checklist, and the procedures used to manage information from the ARMS visits; and (b) to make recommendations for improvements as necessary.

Research Approach

A preliminary evaluation of the ARMS Checklist indicated that several deficiencies existed in the checklist and administrative procedures:

- The ARMS Checklist is excessively long and contains many items that may not be highly related to mission success.
- The Checklist items are not organized so that an evaluator can proceed through the evaluation steps in an efficient manner.
- The items are not identified as applying specifically to a facility, to a unit or to both.
- It is difficult to detect the deficiencies described in many items during the time allocated for an ARMS evaluation.
- There is no systematic procedure for organizing or managing the information gathered during ARMS evaluation visits.

The preliminary evaluation led to the development of three criteria for determining if an item should be retained in the checklist. Specifically, an item should be retained in the checklist only if the attribute addressed in the item is: (a) easily detectable during an ARMS visit (Detectability), (b) important for judging the status of one of the functional areas (Importance), and (c) critical for mission success (Criticality). A survey questionnaire was developed to assess the extent to which the checklist items meet the three criteria for a support facility and for a unit. A separate version of the questionnaire was developed for each of the functional areas. The respondents for the questionnaire were aviators and aviation technicians from First Army National Guard and Reserve aviation support facilities and aviation units.

Project Status

Work Completed

Pretesting of the questionnaires was completed in November 1985. Following pretest and revision, the questionnaires were mailed to ARNG and USAR facilities in the First Army area. An average of 23 respondents completed a questionnaire in each functional area. Responses to the questionnaires were entered into a data base, verified, and analyzed. Preliminary results of the data analyses were briefed to staff members of the Aviation Division, DCST, First U.S. Army in March 1987.

In June 1987, a draft technical report describing the method and results was submitted to ARIARDA for formal review (Ruffner & McAnulty, 1987). The report is entitled "An Evaluation of the Aviation Resource Management Survey (ARMS) Checklist." The major results described in the report are summarized in the following paragraphs.

The respondents rated over one-half of the checklist items as moderately high on Detectability and Importance for both a facility and a unit. However, nearly all the items were rated low on Criticality. The low Criticality ratings suggest that most of the deficiencies described in the checklist items, in isolation, would not prevent an RC facility or unit from accomplishing its mission. The results also suggest that the Facility Detectability and Facility Importance summary scores, but not the Facility Criticality summary score, should be used to determine if items should be retained in their present form, revised, or deleted from the checklist. In addition, the results suggest that a single version of the checklist needs to be developed, with each item clearly annotated to indicate whether it applies to a facility or to a unit.

An information data base was developed as part of the project. The data base can be used to summarize (a) the average summary scores for the Detectability, Importance, and Criticality of the checklist items, and (b) the performance of RC units on specific checklist items and functional areas. The data base was designed to enable the First Army ARMS team to reorganize the checklist by identifying items with similar content and reference publications, and to utilize the data obtained from ARMS visits more effectively (e.g., to identify commonly occurring deficiencies).

Work Projected

Delivery of the report completes Anacapa's work on the project unless First Army requests further assistance.

References

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SUMMARY OF ACTIVITIES ON THE AH-64 REFORGER PROJECT

Dr. D. Michael McAnulty, Project Director

Background

On 6 August 1987, the Commander of the U.S. Army Aviation Center (USAAVNC) tasked the Directorate of Training and Doctrine (DOTD) to develop a survey and determine the data collector requirements needed "to resolve the AH-64 front seat/back seat issue." According to the tasking, the survey was to evaluate the following three options and to recommend the policy to be implemented. The three options are:

- no restrictions for AH-64 pilots switching seats,
- pilots changing seats with the approval of the unit commander, and
- pilots changing seats with the approval of the USAAVNC.

The survey information and other data were to be collected from squadrons of the 6th Cavalry Brigade from Fort Hood, Texas, at the REFORGER exercise in the Federal Republic of Germany (FRG) during September 1987. Upon the request of DOTD, the Army Research Institute Aviation Research and Development Activity (ARIARDA) agreed to develop the data collection instruments and to provide three data collectors during the REFORGER exercise.

Need

A series of meetings was held with representatives of several organizations at the USAAVNC and with the 6th Cavalry Brigade to define the research issues and to obtain relevant documents. Several interrelated training, system design, and aviator management issues were identified as pertinent to the project. In essence, however, the AH-64 front seat/back seat issue involves the effectiveness of an Aircrew Training Manual (Headquarters, U. S. Army Aviation Center: FC 1-214) policy that stipulates that AH-64 aviators, with certain exceptions, are to be designated as either front seat or back seat pilots. That is, most of the AH-64 aviators maintain currency in only one seat and receive annual familiarization training (approximately 10% of their annual flight training) in the opposite seat. The aviators must complete refresher training before switching seat assignments. In addition, FC 1-214 encourages the scheduling of fixed crews.

The purpose of these policies is to maximize the proficiency of each aviator and the effectiveness of each crew by training aviators in a single seat and with a single crewmate. Field units counter that (a) the policy limits the unit's flexibility in employing aviators and (b) aviators are more effective if they are fully current in both seats. Furthermore, the limitations of the Pilot Night Vision System (PNVS) under certain ambient conditions exacerbate the problems created by single-seat designations.

Therefore, the primary research needs are to determine (a) the effectiveness of the current training policies, (b) the degree to which the alternative seat-designation policies interfere with the management of the AH-64 aviators, (c) the frequency and nature of the operational problems that occur in using the PNVS system, and (d) the desirability of changing the current training and utilization policies.

Research Approach

Given the limited time available to prepare for the research effort, a three-phase data collection approach was developed. In Phase 1, a paper-and-pencil survey would be used to collect information about the REFORGER participants' training and experience in the AH-64 and their opinions about the training policies prior to the exercise. These data would provide (a) background data on the aviators, (b) baseline data on their opinions and preferences, and (c) a check on the type of training they had received since their arrival at their unit (i.e., to determine if their training had been in accordance with FC 1-214).

In Phase 2, structured interviews would be used to collect information about the aviators' experiences during the REFORGER sorties and to determine the types of optical system, crew coordination, and unit management problems that occurred. As often as possible, the aviators would be interviewed immediately after each flight. In Phase 3, a second paper-and-pencil survey would be used to collect information about the aviators' overall experience during REFORGER and to determine if that experience had changed their opinions about the most desirable training and management policies.

Project Status

Work Completed

Development of instruments and procedures. The three research instruments were developed and produced for use in the data collection effort. The data collection procedures were developed and coordinated with representatives of the 6th Cavalry Brigade. Both survey forms were produced in sufficient quantities to collect data from all the AH-64 aviators (1st and 2nd Squadrons of the 6th Cavalry Brigade) participating in REFORGER. The first survey was scheduled to be administered approximately two days before the exercise and the second questionnaire was scheduled to be administered approximately two days after the exercise. Because of time and resource limitations, the project staff decided to interview aviators from only one of the two squadrons participating in the REFORGER exercise. As previously indicated, the interviews were scheduled immediately after the crews returned from their latest flights.

The pre-REFORGER survey contains 81 items divided into three parts. Part A consists of 30 items requesting objective information about the respondents' personal, military, and aviation training background. Part B consists of 24 items requesting objective and subjective information about the respondents' experiences with the AH-64 optical systems. Part C consists of 27 items requesting information about the respondents' opinions and preferences related to their training as AH-64 aviators and the policies that are used to manage the AH-64 units.

The post-REFORGER survey consists of 25 items divided into two parts. Part A consists of 15 items that request objective information about the respondents' experiences during the REFORGER exercise. Part B consists of 10 items that request the respondents' personal opinions about the effects of the REFORGER experience on the aviator's capabilities and the effect of current management policies on the capabilities of the unit during the exercise. Some of the subjective items are the same on the pre- and post-REFORGER surveys to determine if the exercise experience had changed the respondents' opinions or preferences.

The structured interview schedule consists of 66 items divided into five sections. The first section contains 28 items requesting basic information (e.g., aircraft number, time since the flight ended) about the flight and background information about the two crewmembers. Many of the background items in this section are redundant with the pre-REFORGER survey and would not be asked if the aviators participated in the Phase 1 data collection. The second section consists of 11 items requesting general information (e.g., flight time, environmental conditions, mission objectives) about the most recent sortie the crew had flown.

The last three sections consist of items about specific aspects of the most recent sortie: Section 3 consists of 16 items about the PNVS capabilities during the sortie; Section 4 consists of 8 items about the crew coordination during the sortie; and Section 5 consists of 3 items about target engagements during the sortie. If the crew had flown more than one sortie since the last debriefing, the items in Sections 2 through 5 would be repeated for each sortie that had been flown, if time permitted.

Project coordination. By 4 September, arrangements were completed for the research team to depart for the FRG on 8 September, except for the receipt of a theatre clearance from the 7th Army Training Command (ATC). The principal problem in obtaining the clearance was that the AH-64 fleet had been grounded pending the investigation of a recent accident and the correction of any contributing mechanical problems. On 11 September, the project team was informed that the data collection effort had been cancelled, even though the grounding order had just been rescinded.

Product delivery. A brief summary (McAnulty, Kaempf, & Blackwell, 1987) of the project activities was prepared and submitted to ARIARDA in September 1987. Copies of the two surveys and the structured interview items were appended to the summary. The summary concluded that ARIARDA should:

- conduct no further work on the project until additional instructions are received from the USAAVNC,
- consider other methodologies in addition to the survey and interview approaches developed for REFORGER, if further research on the front seat/back seat issue is requested, and
- conduct any future research after a period of "normal training" has occurred following the recision of the AH-64 grounding order and completion of the REFORGER exercise.

Work Projected

No further work is planned on this project. If further research is required on the AH-64 front seat/back seat issue, a new project will be initiated.

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EVALUATION OF NATIONAL GUARD AVIATOR TRAINING REQUIREMENTS

Dr. John W. Ruffner and Dr. Sandra M. Szabo,
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 Aircrew Training Manuals (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 presently in the force were originally trained. Moreover, the ARNG aviation fleet has been modernized significantly since that time and several additional aviator training requirements have been added. The major requirements that have been added include the following:

- instrument qualification,
- nap-of-the-earth (NOE) qualification,
- unaided night tactical training,
- night vision goggle (NVG) qualification,
- qualification in ARNG-specific aircraft (e.g., CH-54, OH-6), and
- qualification in attack helicopter systems (e.g., AH-1G, AH-1S [MC], AH-1S [Mod]).

In some instances, the courses necessary to meet the additional qualifications are no longer offered by the U.S. Army Aviation Center (USAAVNC) at Fort Rucker, Alabama; in other instances, it is impractical for the ARNG aviators to attend the courses at USAAVNC. Therefore, the aviator must obtain the training necessary to meet the requirements by using National Guard support personnel and facilities during his or her available training time.

Despite the increase in the number and complexity of the training requirements that aviators must meet, the amount of time allocated for ARNG aviation training has remained relatively constant since the early 1970s. ARNG aviators currently must accomplish their annual training requirements during a combination of the three types of training periods described below.

Unit Training Assemblies (UTAs)

A UTA consists of a four-hour training period. Forty-eight UTAs are allocated annually to each ARNG aviator. Four UTAs typically are scheduled in succession to constitute a weekend drill period. There are 12 weekend drill periods during the year. The drill periods are referred to as Multiple Unit Training Assemblies (MUTAs). MUTAs are authorized for unit training.

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, a Full Time Training Duty (FTTD) day, can be scheduled for training in the Synthetic Flight Training System (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. In addition to the problem of limited training time, ARNG aviators experience a number of other factors that may make it difficult to meet the training requirements. Important factors other than limited training time include the following:

- the ARNG aviators' commitments to their civilian job responsibilities,
- the geographical distances between the ARNG aviators' homes or places of work and the aviation facilities where training is conducted, and

- the ARNG aviators' family and civic responsibilities.

These factors may limit the ARNG aviators' capacity to utilize the currently allocated time in an efficient and effective manner.

Difficulty in meeting the training requirements may seriously reduce the aviators' ability to achieve and maintain a safe level of aviator proficiency. An unsafe level of proficiency, in turn, may cause some of the aviators to leave the National Guard. The potential attrition of large numbers of ARNG aviators is especially critical in view of the "aging of the force." When the older, more experienced aviators leave the ARNG, a considerable amount of experience and expertise will be lost. Without the experience and expertise of the older aviators, unit commanders may find that it is more difficult for the younger, less experienced ARNG aviators to meet the training requirements.

The National Guard Bureau (NGB) recognizes that ARNG aviators may not be able to meet the training requirements in the amount of time currently allocated. To understand existing training time commitments, the NGB requested that the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) provide information about the ARNG aviators' ability to meet the training requirements in the amount of time that is presently allocated. The NGB requested that ARIARDA compile the information on seven 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.

The information provided by the aviators in these units will be used to determine if additional time is needed to meet ARNG aviation training requirements.

Project Objectives

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

- determine the demographic characteristics of the current ARNG aviator force (e.g., age, years of service, number of flight hours);

- determine if the amount of time that is spent to meet the current ARNG aviation training requirements exceeds the amount of time that is allocated to meet the requirements;
- identify factors that may affect the ARNG aviators' ability to utilize the allocated time to meet the requirements (e.g., training obstacles, family influences, time commitments to civilian job);
- determine the ARNG aviators' willingness to spend additional time to meet the training requirements;
- identify factors that may influence the ARNG aviators' willingness to spend additional time to meet the training requirements (e.g., attitudes, civilian job requirements, family influences, training obstacles);
- determine the current career intentions of ARNG aviators; and
- identify factors that may influence the career intentions of ARNG aviators (e.g., civilian job requirements, satisfaction with ARNG job).

The objectives were met by compiling data for the total ARNG aviator force and for each of the seven types of ARNG aviation units specified by the NGB.

Research Approach

The research approach developed to meet the project objectives has three phases. Phase 1 consists of a questionnaire survey of all ARNG aviators. The questionnaire is designed to collect information about the aviators' perceptions of the training time and training requirements. In addition, the questionnaire requests information about the aviators' demographic characteristics, their ARNG career intentions, and their willingness to spend additional time to meet the training requirements. Phase 2 consists of an optically scannable training log that the aviators completed each month for 12 months. The training log is designed to provide information about the actual amount of time the aviators spend meeting the training requirements. Phase 3 consists of the consolidation of the data obtained in Phase 1 and Phase 2. A more detailed account of the methodology developed for each of the three phases is given in the following sections.

Phase 1. ARNG Aviator Questionnaire

The questionnaire developed during Phase 1 consists of the three parts described below.

Part 1. Current training requirements. In Part 1 of the questionnaire, aviators rated each of the following variables concerning training requirements:

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

In addition, the aviators checked the factors that serve as obstacles to meeting the training requirements.

Part 2. Demographic characteristics. In Part 2 of the questionnaire, the aviators provided information about the following demographic characteristics:

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

Part 3. National Guard career intentions. Part 3 of the questionnaire required the 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.

Phase 2. ARNG Aviator Training Log

Phase 2 is designed to provide objective information concerning the amount of time that is necessary to meet existing ARNG aviation training requirements. Specifically, an optically scannable, computer-scored data collection form (training log) was developed to enable the ARNG aviators to report hours spent on flying and nonflying training activities during different types of training periods. The aviators reported the amount of time spent on 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.

The aviators also reported the amount of time spent on 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);
- performing preflight and postflight tasks (e.g., pre-postflight, weather/mission brief, flight records);
- preparing for, undergoing, and administering oral and written nonflying aviation evaluations (e.g., annual written exam, -10 test, flight physicals, checkrides), and
- performing miscellaneous nonflying activities (e.g, crew rest, dead time, inspections, meals, formations).

The aviators reported the amount of 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, and
- Split Unit Training Assembly.

In addition, aviators reported the amount of time spent on a nonpay status at the National Guard facility and on a nonpay status away from the National Guard facility (e.g., home, office).

Phase 3. Consolidation of Questionnaire and Training Log Data

Data obtained from the questionnaire and the training log were consolidated during Phase 3. Analysis of the consolidated data provided diagnostic information about the aviators' utilization of current training time and their need for additional training time.

Project Status

Work Completed: Phase 1

Pretesting of the questionnaire was completed in September 1983. Following revision of the questionnaire to incorporate feedback received during the pretest, the questionnaires were sent to the ARNG facilities. A total of 3,640 questionnaires, representing 77% of the ARNG aviator population, was completed and returned by the 31 July 1984 cutoff date. Data from the questionnaires were entered into a data base and verified. Preliminary results of the data analyses were briefed to the National Guard Bureau and to BG Richard Dean, Deputy Commander of the Army National Guard, in May 1984; final results were briefed in September 1984.

In June 1985, a draft technical report describing the method and results of the questionnaire was submitted to ARIARDA for formal review. A coordination copy of the draft report was sent to the NGB. The report is entitled "An Evaluation of the Training Requirements of Army National Guard Aviators. Phase 1: Analysis of Questionnaire Data" (Szabo, Ruffner, Cross, & Sanders, 1986) The report was published as ARI Technical Report 730 in November 1986. The major results described in the report are summarized in the paragraphs that follow.

Demographic characteristics. Fifty-five percent of the aviators have at least a four-year college degree. The aviators typically have professional/technical civilian jobs and earn a median civilian income of $32,500. The aviators spend a median of 50 hours per week on their civilian jobs.

The ARNG aviators have attained a high level of military experience. Eighty percent of the aviators have some type of prior military experience upon entering the National Guard.

The aviators have a median of 14 years of total military experience; 12 of these years have typically been spent on flight status. During their time in the military, the aviators have logged a median of 2,000 total flight hours.

Career intentions. Approximately 25% of the aviators have completed between 15 and 20 years of service and, consequently, will be eligible for retirement within the next five years. However, only 38% of the total force of aviators indicate that they plan to leave the ARNG as soon as they reach 20-year retirement eligibility; 52% indicate that they plan to remain until 30-year retirement.

The three most important reasons for both joining and remaining in the National Guard are the opportunity to fly, pay, and retirement benefits. Pay and retirement benefits are somewhat more important reasons for remaining in the National Guard than they are for initially joining the National Guard. The factor that is most likely to influence the aviators to leave the National Guard is loss of flight status. Unrealistic training goals and administrative details and politics were also cited by the majority of the aviators as reasons for possibly leaving the ARNG.

Training requirements. ARNG aviators judge the training time to be inadequate. The time is particularly inadequate for meeting night vision goggle (NVG), unaided night tactical, and tactical/special requirements; furthermore, the aviators judge that these requirements are inadequate for maintaining a safe level of aviator proficiency.

The aviators judge the training time to be marginally adequate for meeting all additional military requirements except inflight evaluation/training, for which the training time is judged to be inadequate. All of the additional military requirements are judged to be only marginally adequate for maintaining a safe level of aviator proficiency.

The aviators are very willing to spend additional paid time to meet all the continuation training requirements and the additional military requirements that are related to career progression and aviation. The aviators are very unwilling to spend additional nonpaid time to meet any of the training requirements.

Obstacles to training. The major obstacles that ARNG aviators encounter in meeting the continuation training requirements are an insufficient number of flight hours and the unavailability of instructor pilots (IPs). The major obstacle to meeting additional military requirements is an insufficient amount of personal time. The requirement whose accomplishment is impeded most by training obstacles is NVG training; unavailability of equipment is the major obstacle to meeting the requirement. In addition, unavailability of aircraft and unavailability of training support areas are obstacles to meeting specific requirements in specific types of units.

Work Completed: Phase 2 and Phase 3

Pretesting of the Phase 2 training log was conducted in September 1983, in conjunction with pretesting of the Phase 1 questionnaire. The training logs were mailed to the ARNG facilities in March 1984. The aviators completed the logs each month from June 1984 through May 1985. A total of 1,081 aviators completed training logs for at least 10 months during the 12-month data collection period. Missing data were estimated for aviators who had completed training logs for only 10 or 11 months. Data from the training log were entered into a data base and verified. Results of the data analysis were briefed to LTC Richard Braman, Standardization and Training Officer, Aviation Division, National Guard Bureau in March 1987.

In October 1986, a draft technical report describing the method and results of the training log project was submitted to ARIARDA for formal review. The report is entitled "An Evaluation of Army National Guard Aviator Training Time Utilization" (Ruffner & Szabo, 1986) The major results described in the report are summarized in the paragraphs that follow.

Utilization of time. The principal finding from Phase 2 is that the median total amount of time ARNG aviators spent meeting their requirements (546 hours) exceeds the amount of time they are allocated (428 hours). Forty-eight percent of the additional hours were spent while in a nonpaid status at a location away from the aviation support facility. Thirty-four percent of the hours were spent during AT. The remaining time was spent in UTAs and AFTPs.

Twenty percent of the total training time was spent meeting flight/simulator training requirements. Thirty percent of the flight/simulator hours was spent in UTAs, 40% in AFTPs, and 30% in AT. Over two-thirds of the flight/simulator hours in UTAs, AFTPs, and AT were spent meeting ATM requirements.

Eighty percent of the total time was spent meeting nonflying training requirements. Forty percent of the nonflying hours was spent in UTAs, 10% in AFTPs, and 35% in AT. The remaining 15% of the nonflying hours was spent meeting training requirements while in a nonpaid status at a location other than the aviation facility. Sixty percent of the nonflying hours in UTAs was spent on additional nonflying requirements and miscellaneous nontraining duties. Sixty percent of the nonflying hours in AFTPs was spent on pre- and postflight activities. Forty percent of the nonflying hours during AT was spent on additional nonflying duties.

Factors influencing the utilization of training time. Several demographic and rating scale variables from the Phase 1 questionnaire were examined in an attempt to determine the factors that influence the aviators' utilization of training time. Of the variables examined, statistically significant differences were found only between warrant officers and commissioned officers. Commissioned officers logged significantly fewer flight/simulator hours in UTAs and significantly more flight/simulator hours in AFTPs than did warrant officers. In addition, commissioned officers spent significantly more nonflying time during UTAs and ATs.

Operational Implications

The results indicate that the actual amount of time that ARNG aviators spend meeting aviation training requirements is greater than the amount of time currently allocated. Most of the additional time is spent on nonflying training activities conducted during AT and on military education activities conducted, without pay, away from the training facility. Therefore, an increase in the total amount of time allocated for ARNG aviation training activities may be necessary. With few exceptions, the results of the training log survey agree with the aviators' perceptions of the adequacy of the training time, as reported in the Phase 1 questionnaire survey.

Work Projected

Delivery of the report completes Anacapa's work on the project unless the ARNG requests additional assistance.

References

Ruffner, J. W., & Szabo, S. M. (1986). _An evaluation of Army National Guard aviator training time utilization_ (Technical Report ASI678-201-86[B]). Fort Rucker, AL: Anacapa Sciences, Inc.

Szabo, S. M., Ruffner, J. R., Cross, K. D., & Sanders, M. G. (1986). _An evaluation of training requirements of Army National Guard aviators. Phase 1: Analysis of questionnaire data_ (ARI Research Report 730). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

DETERMINATION OF ARMY RESERVE COMPONENT TRAINING REQUIREMENTS

Dr. John W. Ruffner, Project Director

Background

Anacapa Sciences, Inc., and U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) personnel recently have conducted research to determine the adequacy of time allocated to meet Army National Guard (ARNG) training requirements and to determine the military and civilian demographic characteristics of ARNG aviators. The results of the ARNG research are reported in detail by Szabo, Ruffner, Cross, and Sanders (1986) and Ruffner and Szabo (1986), and are summarized in this report in the section entitled "Evaluation of National Guard Aviator Training Requirements" (pp. 69 - 79).

Like their counterparts in the ARNG, aviators in the U.S. Army Reserve (USAR) Component must meet the same annual training requirements as aviators in the active Army. The types of information obtained during the ARNG study are equally valuable for addressing training and personnel management issues in the USAR. Therefore, the First Army Deputy Chief of Staff - Training (DCST) requested that ARIARDA and Anacapa obtain demographic data and information about the adequacy of training requirements and training time for USAR aviators in the First Army area.

Project Objectives

The USAR aviation training requirements research has six specific objectives. The objectives are listed below:

- determine the demographic characteristics of the current First Army USAR aviator force (e.g., age, years of service, number of flight hours);
- determine the current career intentions of First Army USAR aviators;
- identify the factors influencing First Army aviators' decision to join, remain in, and possibly leave the USAR;
- determine if the aviators consider the amount of time allocated for training to be adequate for meeting the requirements;

- determine the aviators' willingness to spend additional time to meet the training requirements; and
- identify the factors that may affect the First Army aviators' ability to utilize the allocated time to meet the training requirements (i.e., training obstacles).

Research Approach

The research approach adopted for this project is similar to that used for the ARNG project. The approach is described in detail in Szabo et al. (1986) and summarized on pages 54-64 in this report (Ruffner, 1987). Briefly, USAR aviators completed a questionnaire developed to assess demographic variables, adequacy of current training requirements, adequacy of the time allocated to meet the requirements, willingness to spend additional time to meet the requirements, and obstacles to training.

Project Status

Work Completed

Work began on the project in June, 1985. The aviator questionnaire that was used in the ARNG study was modified slightly to reflect minor differences that exist between the ARNG and USAR (e.g., types of units and aircraft). In addition, a few items were added to the USAR version of the questionnaire to obtain information of interest to the First Army DCST (e.g., extent of simulator utilization). The USAR aviator questionnaire was pretested in November 1985. The feedback obtained during the pretest visits was used to revise the questionnaire.

The questionnaire was distributed to the aviators in March 1986. A total of 139 questionnaires, representing 56% of the USAR aviators in the First Army area, was completed and returned by the 30 June 1986 cutoff date. Data from the questionnaires were entered into a data base and verified. Descriptive statistics (i.e., means, standard deviations, medians, and percentages) were generated for each questionnaire item for the total sample and for subsamples of commissioned officers and warrant officers.

A written summary of the data analysis results was submitted to ARIARDA in September, 1987. The major results of the questionnaire data analysis are the following:

- First Army USAR aviators have somewhat lower experience levels (e.g., flight hours, time in service, percent with combat experience) than aviators in the ARNG.
- Similar to ARNG aviators, First Army USAR aviators are generally satisfied with their civilian and USAR jobs and generally intend to stay in the USAR until they are eligible for at least a 20-year retirement. Factors that influence aviators to remain in the USAR include the opportunity to fly, pay, and retirement benefits. Factors that may influence aviators to leave the USAR include administrative details and politics, unrealistic training goals for the time and resources allocated, and loss of flight status.
- First Army USAR aviators generally rate the amount of time available to meet continuation training requirements as inadequate and are willing to spend additional paid time to meet the requirements. This finding is consistent with the results from the ARNG aviation survey.
- Similar to the ARNG aviators, First Army USAR aviators judged that the lack of instructor pilots, flight hours, training areas, and aircraft are the major obstacles to meeting continuation training requirements, and that an insufficient amount of personal time is a major obstacle to meeting additional military requirements. In contrast to ARNG aviators, First Army USAR aviators judged that the unavailability of aircraft is an obstacle to meeting most of the continuation training requirements. In general, the unavailability of resources appears to be a more serious problem for First Army USAR aviators than it is for ARNG aviators.

Work Projected

Delivery of the written summary of the data analysis results completed Anacapa's work on this project unless First Army requests additional assistance.

References

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Ruffner, J. W., & Szabo, S. M. (1986). An evaluation of Army National Guard aviator training time utilization (Technical Report ASI678-201-86[B]). Fort Rucker, AL: Anacapa Sciences, Inc.

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STUDY OF STAFF AVIATOR SKILL DECAY/REACQUISITION

Mr. Carl R. Bierbaum, Project Director

Background

All staff aviators stationed at the U.S. Army Aviation Center (USAAVNC) were prohibited from flying from March to October of 1986 to conserve limited flying resources. The prohibition was lifted in October 1986, reinstituted shortly thereafter, and continued until February 1987. As a consequence, a large population of staff aviators located at USAAVNC had not flown for 10 months or longer. When the prohibition was lifted in February, Army aviation officials directed that all staff aviators (a) be administered a commander's evaluation checkride, and (b) be trained to proficiency by instructor pilots (IPs) assigned to the Directorate of Plans, Training, Mobilization, and Security (DPT), Aviation Division, ATM Branch.

The extended period of grounding and subsequent requalification of staff aviators was recognized by the Army Research Institute Aviation Research and Development Activity (ARIARDA) as an opportunity to gather valuable data on the decay and reacquisition of flying skills. On 9 February 1987, ARIARDA submitted a written request to DPT, Aviation Division, asking permission to compile performance data on staff aviators during both the commander's evaluation and subsequent training flights. DPT agreed that the effort was worthwhile and pledged to provide the requisite support.

Need

Although a previous study of Army aviators was conducted to determine skill decay and reacquisition after six months of nonflying (Ruffner & Bickley, 1983), and a study was conducted of National Guard/Reserve aviators who had not flown for an extended period of time (up to five years) (Wick et al. 1984), a study had not been done of aviators who have not flown for a period of 10-13 months. The prohibition of staff aviator flying for the period from March 1986 to February 1987 thus provided an excellent opportunity to fill the gap between the previous studies.

Project Objectives

The primary objective of the staff aviator skill decay/reacquisition study was to determine the impact on aviator proficiency of not flying for a period of 10-13 months. Specifically, the research was designed to:

- determine the degree of skill decay by evaluating the aviators' level of proficiency during the commander's evaluation checkrides, and
- determine the amount of flight time required for reacquisition of skills that had decayed below acceptable standards.

Research Methodology

The research approach for meeting the project objectives was conducted in three phases. In Phase 1, Anacapa Sciences, Inc., researchers developed the test procedures and the necessary data collection instruments for conducting the study. During Phase 2, evaluators monitored the commander's evaluation checkrides to collect data and administered a staff aviator questionnaire during postflight debriefing. In Phase 3, the data collected during Phase 2 were analyzed and reported.

Project Status

Work Completed: Phase 1

A preliminary planning meeting was held with personnel from DPT, Aviation Division, ATM Branch; ARIARDA; and Anacapa to discuss the staff aviator study. The methods and procedures agreed upon are listed below:

- DPT personnel would furnish a list of the tasks to be evaluated during the staff aviators' commander's evaluation checkrides,
- Anacapa personnel would develop a 12-point rating scale with descriptive verbal anchors to standardize aviator performance ratings during the commander's evaluation checkrides,
- ARIARDA personnel would designate individuals as observers to collect data during the commander's evaluation checkrides and to administer a questionnaire for personal data, and

- DPT personnel would notify Anacapa when commander's evaluation checkrides were scheduled for aviators who had not flown for 10-13 months.

Anacapa personnel then developed the three data collection instruments described in the following paragraphs.

Commander's evaluation gradeslip. The commander's evaluation gradeslip was developed in coordination with the DPT IPs to evaluate the initial performance levels of the aviators who had not flown for 10-13 months. The gradeslip was divided into 24 discrete tasks to be performed during the evaluation flight. The gradeslip format required that the evaluator record (a) the order in which the tasks were performed, and (b) the numerical performance rating for each task on a 12-point scale.

Practice iteration data sheet. The practice iteration data sheet was developed to evaluate the flights required to retrain aviators who did not perform the commander's evaluation checkride tasks to established standards. The data sheet also was divided into 24 discrete tasks with columns for scoring each training iteration required until the aviator successfully performed the task to established standards.

Staff aviator questionnaire. The staff aviator questionnaire was developed to obtain personal information from each aviator. Questionnaire items were designed to collect information about:

- previous flight experience,
- recent academic study of flying material, and
- simulator training during the previous year.

Work Completed: Phase 2

The data collection commenced on 3 March 1987 and was completed on 12 August 1987. All IPs administering the commander's evaluation checkride were briefed on the use of the 12-point rating scale developed by Anacapa researchers. Observers were designated for each flight to reduce IP workload and to facilitate standardization of data collection. The observers monitored the task being performed and recorded the numerical performance rating given by the IP. The same procedure was followed for additional practice iteration flights. During postflight debriefings, the aviators were requested to complete the staff aviator questionnaire.

Work Completed: Phase 3

All commander's evaluation checkrides that met the criteria for the study were observed and data collection forms were completed. Although there had appeared to be a large number of aviators who had not flown for a period of one year, the total number of data collection flights was only 18. Only 2 of the 18 aviators required an additional practice iteration flight, averaging 1.5 hours. The 16 aviators who successfully completed the commander's evaluation checkride required an average of 1.6 hours to complete the checkride. The number of data collection flights completed did not provide sufficient data to perform a quantitative data analysis that would provide conclusive results; therefore, the study was terminated. All data collection forms have been submitted to ARIARDA.

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Wick, D. T., Millard, S. L., Cross, K. D., Ruffner, J. W., Keenan, J. B., Everhart, C. D., & Bickley, W. R. (1984). Evaluation of a revised individual ready reserve (IRR) aviator training program (Final Report ASI479-058-84). Fort Rucker, AL: Anacapa Sciences and ARIARDA.

DGFS AVIATION AMMUNITION AND GUNNERY SURVEY

Dr. D. Michael McAnulty, Project Director

Background

In January 1987, the Department of Gunnery and Flight Systems (DGFS) at the U.S. Army Aviation Center (USAAVNC), Fort Rucker, Alabama, requested that the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) provide research support in the development of an aviation ammunition and gunnery (A&G) survey. The A&G survey was scheduled to be distributed worldwide to approximately 170 Army and National Guard aviation units. ARIARDA agreed to assist in designing and pretesting the survey; to develop the data entry, verification, and analysis programs; to conduct the required data analyses; and to assist in the preparation of a technical report, if needed. All other project activities (e.g., administrative coordination, pretesting, data collection, data entry) were to remain the responsibility of the DGFS study group.

Problem

The survey research is designed to provide an empirical data base for addressing three major problem areas. First, the increasing cost of ammunition and the competition for Department of Defense funds have created pressure to reduce the annual allocation of ammunition for Army aviation gunnery training. The research is intended to document the current utilization of ammunition in aviation gunnery training and to compile estimates of the amount of ammunition required to maintain specified Standards in Training Commission (STRAC) readiness conditions. In addition to justifying the ammunition allocations, the resulting data base will be used to develop a new gunnery training manual.

The second major problem is the lack of adequate ranges on which to train and qualify unit aviators. Many of the ranges presently available lack the targetry, scoring devices, and space required for effective training. Furthermore, limited access to the ranges inhibit the gunnery training and make it difficult to maintain the required readiness conditions. The research is intended to document the availability, type, and utility of gunnery ranges currently in use by Army aviation units.

The final major problem is the lack of empirical data on the utility of flight simulators for weapon systems training. Theoretically, flight simulators can reduce the impact of the first two problems. That is, weapons training can be conducted without physical ranges and without incurring ammunition costs. However, there are no systematic data about what should be trained in simulators, the amount of training that is most cost-effective, or the extent that flight simulator training may offset the need for weapon firing in the aircraft. This problem is compounded by the single configuration of the AH-1 attack helicopter flight simulator (AH1SFWS) that is used by unit aviators who fly different configurations of AH-1 attack helicopters (e.g., AH-1G, AH-1M, AH-1S Modified, AH-1S Production, and AH-1S ECAS).

Research Approach

In January 1987, the Commanding General of the USAAVNC directed that a survey of field unit aviators and aviation unit commanders be conducted to compile the research data required to:

- formulate an accurate ammunition procurement request,
- support revisions of the Army's aerial gunnery training programs, and
- evaluate the training value of flight simulators for aerial gunnery.

The survey is designed to be administered worldwide to all active Army and National Guard attack helicopter aviators and unit commanders. Despite the extensive nature of the project, reporting commitments dictate that the survey be developed and administered, and the data analyzed by December 1987.

The research activities are divided into three phases. Phase 1 involves the development of the A&G survey and the required ancillary materials. Phase 2 involves the administration of the A&G survey to the unit aviators and unit commanders. Phase 3 involves the processing, analysis, and reporting of the survey data.

Project Status

Work Completed

Phase 1: Survey development. Following a review of the relevant literature, the current aerial gunnery training manual (Headquarters, Department of the Army Field Manual FM 1-140, 1986), a previous STRAC questionnaire, and the Essential Elements of Analysis delineated by the DGFS Study Group, approximately 100 preliminary survey items were drafted that covered the following ten topics:

- personal data about the respondent,
- military experience of the respondent,
- flight experience of the respondent,
- present duty assignment of the respondent,
- suitability of current gunnery training publications,
- weapon systems on the aviator's primary aircraft,
- ammunition allocated and fired during the 1987 training year,
- utilization of gunnery range facilities,
- utility of flight simulators for gunnery training and qualification, and
- door gunnery training.

The preliminary survey items were administered to approximately 50 attack helicopter aviators by DGFS personnel. The results of this pretest were used to produce a second draft of the A&G survey. The second draft was divided into two forms: Form A for the unit aviators and Form B for the unit commanders. Many of the items on the two forms are similar in content, but the unit aviator responds to the items with respect to himself and the unit commander responds to the items with respect to the entire unit.

The second draft of the survey was not pretested because of administrative problems at the participating installations. DGFS personnel, acting as aviator subject matter experts (SMEs), and Anacapa Sciences, Inc., personnel reviewed and edited the final versions of the survey forms and prepared the required ancillary materials (e.g., letters of instruction). The surveys were subsequently approved for use by the U.S. Army Soldier Support Center and then reproduced for administration by DGFS.

Form A contains 68 items divided into nine of the ten topic areas listed above; no questions are posed to the unit aviators about door gunnery. Form B contains 78 items divided into all ten topic areas. The surveys are much more comprehensive than the number of items indicates. That is, many items have multiple sections or require a succession of responses. Although no respondent would complete all the items, there are 472 codable responses on Form A and 644 codable responses on Form B. In addition, both forms have several open-ended response items that cannot be coded for entry into the computer data base.

Phase 2: Survey data collection. DGFS personnel have distributed the two survey forms and ancillary materials to all active Army and National Guard aviation units that have attack helicopter missions. During August 1987, approximately 300 commander forms and 2000 aviator forms were distributed to the active Army and National Guard units. At the end of September 1987, approximately 80 unit commander forms and 400 unit aviator forms had been completed and returned to DGFS for processing.

Phase 3: Data processing and analysis. ARIARDA personnel have developed computer programs to enter and verify the data collected by the A&G survey. The survey responses were entered and verified by DGFS personnel as the forms were returned from the aviators and commanders.

Several meetings were held with DGFS personnel to enumerate the most important research issues, to identify the subset of survey items that most directly address those issues, and to develop a statistical approach for analyzing the items. Subsequently, computer programs were prepared to analyze approximately one-third of the items on each form, and a preliminary analysis was conducted on the data that had been entered and verified. The results of the preliminary analyses are not presented in this report because the current sample is not representative of the population (i.e., most of the survey responses to date have been received from units in the Federal Republic of Germany).

Work Projected

Phase 2: Survey data collection. Approximately 25% of the surveys that were distributed have been completed and returned for processing. Data collection efforts will continue until the end of October 1987. In particular, efforts will be made to improve the representativeness of the sample by encouraging unit aviators and commanders in the United States and Korea to respond to the surveys.

Phase 3: Data processing and analysis. Data processing will continue until the data collection effort is terminated. When all the survey responses are entered and verified, the primary data will be analyzed and briefings will be prepared for conferences that are scheduled for November and December 1987. Subsequently, secondary analyses will be conducted and a final report will be prepared in collaboration with DGFS personnel.

Reference

Helicopter Gunnery (FM 1-140) (1986, October). Washington, DC: Headquarters, Department of the Army.

UTILIZATION/EFFECTIVENESS OF FLIGHT SIMULATORS FOR FIELD UNIT TRAINING

Dr. George L. Kaempf, Project Director

Background

The Army's Synthetic Flight Training System (SFTS) has been audited by the Army Audit Agency (AAA) on two occasions, first in 1981 and again in 1984. The results of the first audit are described in AAA Audit Report SO 82-6, (U.S. Army Audit Agency, 1982); the results of the second are described in AAA Audit Report SO 85-18 (U.S. Army Audit Agency, 1985). The primary issue in both audit reports is the number of flight simulators required to support the training of field unit aviators. Specifically, both reports concluded that the Army had not adequately quantified the return on its investment in flight simulators dedicated to field unit training. The potential returns include benefits such as reductions in the number of aircraft flight hours and increases in the training effectiveness and combat readiness level of the Army's aviator force.

The AAA reports also admonished the Army for the manner in which operational tests had been conducted on the SFTS. The reports stated that (a) the operational tests should have been conducted in a realistic operational environment with unit aviators, (b) the Army made unwarranted assumptions during the analyses of the operational test data, (c) appropriate methods and controls were not employed during operational testing, and (d) certain training capabilities required by the simulator specifications were not evaluated in the operational tests (e.g. nap-of-the-earth and night flight). In short, the AAA concluded that adequate operational tests had not been performed to verify the putative benefits of using flight simulators as part of continuation training. Following the 1981 audit, AAA concluded that, although flight simulators had reduced the training costs and improved training at the U.S. Army Aviation Center (USAAVNC), the Army had not determined the effects that employment of the flight simulators would have on training in aviation field units.

The purpose of the follow-up audit in 1984 was to determine whether appropriate corrective actions had been taken in response to the recommendations of the previous report. During the second audit, AAA recognized that the Army had changed its basis for justification of flight simulation. Previously, the Army had based its development of the SFTS program on the premise that simulators pay for themselves by reducing flight hour costs. Subsequently, the Army took the position that the number of hours flown in Army aircraft had been reduced to the absolute minimum and that flight simulators should be justified by their ability to enhance training effectiveness and combat readiness. However, the 1985 audit report concluded that the Army had not implemented the previous recommendations to quantify these benefits.

The overriding issue in both audit reports was the number of flight simulators that are required to support the training of field unit aviators; specifically, whether unit training requirements can be met with fewer flight simulators than are specified in the Army's Basis of Issue Plans (BOIPs). In their audit reports, the AAA strongly emphasized that both the BOIPs and the AAA analyses of flight simulator requirements are based on vague information about the roles that flight simulators are to play in field unit training. The AAA strongly urged the Army to undertake research needed to quantify the return on the Army's investment in flight simulators that are to be employed in operational field units.

In response to the recommendations from AAA, Anacapa Sciences, Inc., researchers have accomplished work during the first contract year under two separate but related taskings. The first tasking was received from the U.S. Army Aviation Center's (USAAVNC) Directorate of Training and Doctrine (DOTD) in June, 1984. The second tasking was received from the Department of the Army (DA) in June, 1986. The remainder of this section presents the background for each of these taskings.

DOTD Tasking

The DOTD formally tasked the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) to provide research support that would address the issues raised about the Army's SFTS training program. Specifically, DOTD requested that ARIARDA conduct research to answer such questions as:

- What tasks can best be trained in the flight simulators?
- What rate of practice in the flight simulators best enables aviators to maintain proficiency?
- How can the flight simulators be used to maintain proficiency on cognitive skills that are not routinely used in the aircraft?

- What impact does ammunition reduction have on training programs, aviator proficiency, and unit readiness?
- How can the flight simulators be used to provide night vision goggle (NVG) training?

Furthermore, it is generally recognized that the following five factors must be considered in assessing the return on the investment in flight simulators:

- the cost of acquiring, housing, operating, and maintaining the flight simulators;
- the cost of transporting unit aviators to the flight simulators;
- the number of aviators to be trained in the flight simulators;
- the amount of flight simulator training each aviator will receive; and
- the benefits of the flight simulator training.

Information on the first three factors is available or can easily be obtained. However, little information is available on the last two factors. The current research is designed to determine empirically the type and amount of training unit aviators should receive in flight simulators, and, to the extent possible, quantify the benefits of this training.

DA Tasking

Early in 1986, the Office of the Deputy Chief of Staff, Operations (ODCSOPS) reviewed the issues concerning the development of training programs that utilize flight simulation and the fielding of the Army's flight simulators. DA determined that training effectiveness analyses should be conducted for each of the Army's flight simulation systems to serve as the basis for the development of effective training strategies. Accordingly, DA tasked the Training and Doctrine Command (TRADOC) to develop and implement, with the assistance of ARIARDA, post-fielding training effectiveness analyses (PFTEA) of the AH-1, AH-64, UH-60, and the CH-47 flight simulator systems.

Representatives from ARIARDA, Anacapa, DOTD, and the TRADOC Analysis Center at White Sands Missile Range (TRACWSMR) met on 1 July 1986 to review the tasking and identify a course of action. The group members found that the issues involved in determining the effectiveness of simulators for training aviators at the USAAVNC were substantially different from the issues involved in determining the effectiveness of simulators for training aviators in operational field units. Therefore, the group members agreed that TRACWSMR would develop and implement a research plan to address the issues of employing simulation within the institutional environment and that ARIARDA would develop and implement a plan to address the utilization of flight simulators in field environments.

Problem

The Army has purchased and installed five AH-1 Flight and Weapons Simulators (FWSs) at Forces Command (FORSCOM) and U.S. Army, Europe (USAREUR) sites; three additional AH1FWSs are scheduled for installation prior to 1990. In addition, the Army plans to deploy seven AH-64 Combat Mission Simulators (CMSs), six CH-47D Flight Simulators (CH47FSs), and sixteen UH-60 Flight Simulators (UH60FSs) to various field locations. With the exception of the few flight simulators located at Fort Rucker, the Army has earmarked its flight simulators for use by operational field units.

The Army is deploying its flight simulators with the primary intention of providing operational field units with training devices in which aviators may sustain their flight and tactical skills. However, very little empirical data currently exist (a) to support the notion that flight simulators effectively and efficiently provide this type of training, and (b) to guide the Army in developing training programs that include a satisfactory mix of training conducted in the aircraft and flight simulator.

Project Objectives

The objectives of the research resulting from the DOTD and the DA taskings are to:

- identify those tasks that can be sustained/maintained effectively and efficiently in the AH1FWS;
- provide data of sufficient quality to serve as a basis for the development of training strategies that incorporate a sound mix of flight simulator and aircraft flight training within an operational field unit environment; and
- identify, to the extent possible, training techniques and strategies appropriate for aviators to maintain their flight and tactical skills in flight simulators.

Research Approach

DOTD Tasking

In response to the DOTD tasking, ARIARDA assembled a team consisting of research psychologists, aviators, and simulation experts to address the research questions. The team developed a research plan designed to answer the issues raised by the first AAA audit as well as additional issues identified by other simulation experts. This plan is presented in detail by Cross et al (1984) and Cross and Gainer (1985). The research plan calls for a series of studies at the USAAVNC and in operational field units. The results of some of these studies have been reported previously (see Kaempf, 1986). The current study in the series is a transfer of training study in the AH1FWS for emergency touchdown maneuvers (ETMs).

DA Tasking

In support of the DA tasking, Anacapa researchers developed a plan that addresses the issues identified by DA and submitted the document to DOTD, TRADOC, and DA for approval. The plan proposes a single research strategy that can be applied to each of the four simulator systems with minor modifications to provide for the unique characteristics of each system. The PFTEA overview section below briefly discusses the proposed approach.

PFTEA overview. The PFTEA is intended to generate empirical data needed to make decisions about the employment of Army flight simulators to train and sustain the flying skills of field unit aviators. The program will generate the data to support management decisions on the optimal mix of aircraft and simulator training for skill sustainment including, where appropriate, the substitution of simulator hours for aircraft hours.

The PFTEA proposes to investigate the effectiveness of each simulator system to sustain aviator flight skills on groups of selected flight tasks. Several groups of flight tasks will be investigated for each different simulator system; each task group investigated will require a separate sample of subjects. The task groups include:

- emergency touchdown maneuvers,
- basic flight tasks,
- flight with night vision systems, and
- tactical and weapons tasks.

The PFTEA calls for a one-year study of each task group for each simulator system. Aircraft checkrides on the tasks of interest will be given at the beginning of the year. A control group of ten aviators will continue their normal training routine in the aircraft and will not practice in the flight simulator. Three experimental groups of ten aviators each will practice the same tasks under controlled training conditions in the simulator for a period of one year. The three experimental groups will differ only in the frequency of simulator training. That is, they will receive training to proficiency in the flight simulator either monthly, quarterly, or semiannually. Except for the limited group of tasks under investigation, the experimental groups will continue with their normal aircraft flying routine throughout the period of the study. At the end of the year, each subject will be administered another aircraft checkride on the tasks of interest.

The sustainment effectiveness of the simulator will be determined by comparing the aircraft checkride performance of the experimental groups with that of the control group. Aviators in any of the four groups found to perform below standards on these tasks during the end-of-year checkride will receive additional aircraft training until they reach proficiency, and the amount of such supplemental training will be measured.

In addition, the training effectiveness of the flight simulators will be investigated by using groups of aviators who are completely restricted from aircraft flying for a period of one year. For each aircraft system, sixty rated and current Flight Activity Category (FAC) 2 aviators will be selected to serve as subjects. The subjects will be given a pretest checkride in the aircraft on all FAC 2 Aircrew Training Manual (ATM) tasks and then assigned to groups in a manner that produces four groups (three experimental groups of 10 aviators each and one control group of 30 aviators) matched on their baseline levels of performance and flight experience. After the pretest checkride, the control group will be prohibited from all flying for a period of one year, and then administered another aircraft checkride at the end of that period.

Following the pretest checkride, the experimental groups will begin a one-year training program that consists only of periodic training to proficiency in the flight simulator. The subjects will be prohibited from flying in the aircraft. The three experimental groups will differ only in the frequency of simulator training. That is, they will receive training to proficiency in the flight simulator either monthly, quarterly, or semiannually. At the end of the one-year period, the subjects in the experimental groups will be administered another checkride in the aircraft. All skill deficiencies identified during the second checkride in either group will be corrected through additional training in the aircraft.

Project Status

DOTD Tasking: Work Completed

During coordination to secure resources for the AH-1 transfer of training study of emergency touchdown maneuvers, FORSCOM stated that the study required more resources than any one location or unit could provide. At FORSCOM's request, ARIARDA conducted the study at two locations: Fort Campbell, Kentucky, and Fort Lewis, Washington. Therefore, the researchers first collected data at Fort Campbell on half of the subjects (five control group subjects and five experimental group subjects) and then replicated the procedures with another ten subjects at Fort Lewis.

Maneuvers. The researchers identified five emergency touchdown maneuvers for investigation. Full descriptions of each maneuver and their performance standards can be found in the AH-1 ATM (Department of the Army, 1984). The five maneuvers were:

- Standard Autorotation (ATM Task 3001),
- Low-Level Autorotation (ATM Task 3002),
- Low-Level High-Speed Autorotation (ATM Task 3005),
- Simulated Right Antitorque Failure (ATM Task 3004), and
- Simulated Dual Hydraulics Failure (ATM Task 3003).

Subjects. Twenty qualified and current AH-1 pilots served as subjects for the study. Demographic information was collected for the control and experimental group subjects. No significant differences existed between the two groups on any of the demographic variables reported.

Evaluators. Three current and highly experienced AH-1 instructor pilots (IPs) performed all of the evaluations and training conducted in the aircraft at Fort Campbell and Fort Lewis. Six trained evaluators conducted all of the checkrides and training in the AH1FWS at both sites. All of the evaluators and IPs were provided a minimum of ten hours of training to learn how to use the gradeslips and evaluation procedures employed in this study.

Performance measures. The evaluators completed a two part gradeslip for each trial attempted during checkrides and training. A series of descriptive rating scales compose the first portion of each gradeslip. The descriptive scales are 13-point bidirectional scales designed to indicate the magnitude and direction of deviations from ideal performance on a number of parameters relevant to each maneuver. The scales are anchored to established standards and performance tolerances for each parameter. The evaluators completed the descriptive scales as the trial was in progress. The descriptive scales serve three purposes. First, they identify the aspects of each maneuver that are most difficult for the subjects. Second, the scales serve as guides for the evaluators to rate the overall performance for each maneuver. Finally, the scales provide information about the criteria the evaluators employ when assessing overall aviator performance.

On the second portion of each gradeslip, the IPs provided subjective evaluations of overall pilot performance that were the principal performance measures for this study. Observers evaluated all trials attempted by each subject in the aircraft and the AH1FWS. The evaluators derived subjective ratings of overall performance on each trial from a 15-point scale. Six values (1-6) on the scale represent unsatisfactory performance and nine values (7-15) represent varying degrees of satisfactory performance. Immediately following completion of a trial, the evaluator subjectively determined whether performance had been satisfactory or unsatisfactory, and then assigned a value within the range of the subscale.

Procedures. As indicated previously, Anacapa conducted the study at two sites. Subjects always flew the maneuvers from the pilot's station in both the aircraft and the AH1FWS. Unless otherwise noted in this section, the researchers followed identical procedures at both sites. The researchers collected data for ten days at each site in the following steps:

- Prior to the beginning of the study, the researchers briefed all participants about the purpose and procedures of the study. Then, the subjects completed a written test of their knowledge of the procedures and standards for the five maneuvers being investigated.
- Each subject completed an initial checkride in the aircraft on Day 1 of the study. The checkride consisted of one trial of each of the five maneuvers, with the order of maneuvers counterbalanced across subjects.

- Following the aircraft checkride, each subject was administered an initial checkride in the AH1FWS on Day 1. The simulator checkride was identical to the aircraft checkride in terms of content and order of maneuvers.
- The researchers assigned subjects to control and experimental groups (five subjects per group at each site) based on the overall performance ratings awarded during the initial aircraft checkrides. The assignment of subjects to groups equated the two groups on the baseline level of performance in the aircraft for the five maneuvers.
- The IPs trained each of the subjects in the control group to proficiency on all five maneuvers in the aircraft, beginning on Day 2.
- The evaluators trained each subject in the experimental group to proficiency on all five maneuvers in the AH1FWS, beginning on Day 2.
- Following training in either the aircraft or the AH1FWS, each subject received a second checkride in the AH1FWS. The second checkride in the AH1FWS was identical to the subject's first simulator checkride, and it occurred no later than three days following completion of initial training.
- The IPs trained each of the experimental group subjects to proficiency on all five maneuvers in the aircraft. This training began no later than the day following completion of the subject's second checkride in the AH1FWS.

The rating procedures followed in the aircraft and the AH1FWS were not identical. Due to space limitations, only one evaluator could observe, evaluate, and instruct aviator performance on any given trial in the aircraft. The lone evaluator in the aircraft occupied the copilot/gunner (CPG) station and completed the descriptive scales of the gradeslip during and immediately following each trial.

Two evaluators observed and evaluated all trials completed in the AH1FWS. One evaluator occupied the operator's console at the pilot's station to operate the simulator and to evaluate the subjects' performance. The other evaluator occupied the simulator's CPG station to monitor the flight controls and other parameters. Both evaluators completed separate gradeslips for each trial. Following completion of each trial, they collaborated to derive one gradeslip that was used for data analysis. This collaboration included discussions between the evaluators, references to the gradeslips they had completed individually, and observations of replays of the trial to ensure that the gradeslips were completed as accurately as possible. All data collected during the transfer of training study of ETMs were entered into a computer data base and verified for accuracy.

During the training portions of the study, the evaluators trained the subjects to proficiency on each of the five maneuvers. No effort was made to control the order in which the maneuvers were trained. The researchers defined proficiency as two consecutive trials of a given maneuver on which the subject received a satisfactory overall performance rating. As a subject reached proficiency on a maneuver, that maneuver was dropped while training continued on the remaining maneuvers. During their last training sessions, the subjects may have practiced only one or two maneuvers.

Work Projected

Analyses of the ETM data will be conducted and reported. In addition, the results of the ETM study and ARIARDA's recommendations will be briefed to interested Army agencies at USAAVNC, Fort Campbell, and Fort Lewis.

Anacapa will continue to address issues specified by the tasking received from DOTD in 1984. Accordingly, ARIARDA submitted requests for FORSCOM support for four research projects during the fiscal year 1988. Pending FORSCOM approval, these projects will be conducted during the next contract year. The four proposed projects are:

- observe training sessions conducted in the AH1FWS to identify simulator specific training strategies currently employed by AH-1 field units;
- observe AH-1 field units during field exercises to determine the coordination and skills required for attack crews and teams to operate in a combat environment;
- conduct structured interviews with AH-64 IPs and commanders to identify field units' training requirements and the techniques currently employed to train AH-64 aviators; and
- conduct a transfer of training study in the AH1FWS and AH-1 aircraft for gunnery tasks.

DA Tasking: Work Completed

ARIARDA submitted the PFTEA research plan, Flight Simulator Skill Sustainment Training Effectiveness Research Plan (ARIARDA, 1986), to DOTD, TRADOC, and DA for approval. DOTD and TRADOC approved the plan with relatively minor changes, and, in June 1987, DA approved the PFTEA research plan.

Due to the projected distribution of aviators in the various Army commands and the simulator fielding schedules, DA determined that the AH-1 portion of the PFTEA should be implemented first and that the remaining studies should be conducted as the aviator, aircraft, and simulator resources become available. Anacapa prepared and submitted to TRADOC a list of the resources required to implement the AH-1 portion of the PFTEA and a table of milestones for the entire project (ARIARDA, 1987). ARIARDA predicted that the AH-1 PFTEA would require 28 months and the entire PFTEA would require 62 months to complete. At the end of the first contract year, neither TRADOC nor DA had responded to the list of resource requirements and milestones.

DA sent to USAREUR an information copy of the original PFTEA tasking. USAREUR responded with a message dated 31 July 1986 expressing its support for the proposed project. ARIARDA researchers acknowledged USAREUR's support by message and travelled to Germany to brief USAREUR officials on the PFTEA plan. Representatives of the USAREUR Aviation Safety and Standardization Board and the 7th Army Training Command (ATC) indicated strong interest in the gunnery segments of the PFTEA and a willingness to coordinate the resources required to conduct the study of AH-1 gunnery tasks. USAREUR is particularly anxious (a) to evaluate the effectiveness of the AH1FWS for sustaining gunnery skills, (b) to establish an optimal mix of simulator and aircraft training for gunnery tasks, and (c) to determine the number of rounds of ammunition required for aviators to maintain their proficiency in the aircraft.

Subsequently, the 7th ATC began coordinating the resources required to conduct the PFTEA in USAREUR, but two obstacles remain. First, the 7th ATC must staff the entire project by identifying and scheduling specific units to participate. At the end of the first contract year, the 7th ATC is working on the coordination task, with a suspense date of 13 November 1987. Second, the Directorate of Gunnery and Flight Systems (DGFS) at the USAAVNC must develop new prescriptive gunnery qualification tables for the AH-1. These tables will replace the tables in the manual Helicopter

Gunnery (Department of the Army, 1986) and will serve as the bases for performance evaluation and training in the PFTEA. DGFS has agreed to provide draft tables no later than 16 November 1987.

Work Projected

Planning and coordination for the PFTEA will continue. Pending completion of the support requirements being coordinated by the 7th ATC, Anacapa tentatively plans to begin data collection in Germany for the AH-1 gunnery PFTEA during February, 1988.

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DEVELOPMENT OF AN UPGRADED BASIC MITAC USING AN INTERACTIVE VIDEODISC FORMAT

Mr. Claude O. Miles, Project Director

Background

During nap-of-the-earth (NOE) flight, an aviator flies at varying speeds as close as possible to the earth's surface--preferably flying around obstacles instead of over them--to escape radar or visual detection by a potential enemy. Among the factors that make NOE navigation different from and more difficult than navigating at higher altitudes are:

- a limited viewing distance when operating in close proximity to the ground,
- the perspective at which checkpoint features are viewed,
- the difference in perspective between the map representation and the point of regard of the NOE navigator,
- the need for more precise navigation and map interpretation, and
- the need for rapid association of map features with their real-world counterparts.

Previous studies indicate that most difficulties faced by Army aviators trained in NOE navigation are due to a lack of map interpretation and terrain analysis skills. At the low altitudes of terrain flight, map interpretation and terrain analysis skills are critical for maintaining orientation (Holman, 1978).

Therefore, specialized training is needed to ensure proficiency and mission success in NOE navigation (Fineberg, Meister, & Farrell, 1978). In response to this need, the U.S. Army Research Institute Aviation Research and Development Activity (ARIARDA) developed and implemented a system for training Army aviators in the critical skills required to navigate successfully and to maintain NOE orientation in a high threat environment. This training course, referred to as the Map Interpretation and Terrain Analysis Course (MITAC), was designed to teach students to interpret 1:50,000-scale topographic maps and to use this knowledge to maintain accurate geographic orientation when flying at NOE altitudes (Bickley, 1978). Specifically, MITAC teaches students the cartographic principles governing map compilation, the symbols used to portray features on the map, and the methods used to associate topographic features with their counterparts on the map. Cinematic exercises are used to train students to navigate at NOE altitude, taking advantage of concealment or "masking" of the aircraft afforded by vegetation and terrain.

The MITAC program is presented in 13 instructional units. The course begins with an introductory lesson, in which students are taught the basic principles of cartography and map reading, and continues through more complex exercises that improve the students' NOE navigation skills. A series of color 35-mm slides is provided to teach the conventions and selection criteria that cartographers use in creating 1:50,000-scale topographic maps, as well as fundamental map reading. A special text entitled "Map Interpretation in NOE Flight" is provided to supplement the course material. The features covered by the slides and text include:

- hydrography
- vegetation,
- transportation lines,
- buildings,
- miscellaneous cultural features, and
- terrain relief.

A narration recorded on cassette tapes is provided to supplement the slides. In this portion of the program, the student is taught:

- the basis for the classification of roads,
- the coding criteria for vegetation,
- the methods and rules employed in delineating relief and drainage,
- the conventions used when portraying cultural features, and
- generalization and displacement practices in cartographic drafting (Cross & Rugge, 1980).

Additional performance oriented exercises that emphasize analysis of terrain features and their representation on the map are presented to the students on film. The students conduct NOE mission planning, identify checkpoints, and assess terrain masking. The filmed scenarios enable the students to apply the principles they are being taught. The exercises begin with a preflight briefing; students then perform navigation training exercises. The navigation training exercises require students to maintain orientation and mark checkpoints on a map while viewing a motion picture film of routes flown at NOE. The units include:

- a contour analysis exercise,
- preflight terrain exercises,
- along-track orientation exercises,
- cross-track orientation exercises, and
- corridor orientation exercises.

All navigation exercises are followed by a postflight debriefing that requires students to view the filmed route a second time while listening to a prerecorded commentary that describes the topographic features along the filmed route that are most useful for maintaining geographic orientation.

MITAC is presently being utilized at the U.S. Army Aviation Center (USAAVNC) for NOE training of initial entry rotary wing (IERW) students and some unit aviators. MITAC was evaluated at USAAVNC and found to be effective in teaching the skills required for NOE navigation (Holman, 1978). Holman's study revealed that a group of IERW students trained with MITAC navigated NOE routes with twice the speed and one-third the errors when compared with an equivalent group of IERW students not trained with MITAC.

Project Objectives

In September 1983, ARIARDA requested that the basic MITAC course be revised and converted to an interactive videodisc format. The objectives of this effort are to expand and improve the quality of the original course and to provide a more effective and sophisticated medium for presenting the training. Since videodisc technology affords many capabilities not available with the presently used audio/visual equipment, a decision was made to convert the entire course to the videodisc format.

Project Status

Work Completed

The MITAC Illustrated Lectures Manual for Infantrymen was used as a guide in developing a comprehensive series of illustrated lectures for Basic MITAC. The information contained in the manual has been rewritten, making it applicable to Army aviator training. The lesson material has undergone several revisions and is now completed. Following the revision of the illustrated lecture series, an exhaustive list of slides needed to supplement the lectures was compiled. Some slides in stock were used; however, it was necessary to conduct several photographic missions to obtain many new slides. New maps were obtained and additional slides were produced to illustrate the different terrain features on the new maps. All of the usable slides have been coordinated with the script.

Storyboards have been written to specify the key technical information necessary to develop the videodisc products. Thus, the Basic MITAC course materials have been upgraded and the production phase of this project is ready to begin.

Work Projected

The following tasks must be performed during the final phase of production:

- transfer slides to tape,
- transfer slides and maps to a digital data base,
- generate text and computer graphics,
- provide special effects (e.g., highlight features and create graphic overlays),
- narrate scripts,
- perform off-line edit of videotapes, and
- perform on-line final edit of videotapes.

Some of the production tasks will be performed in-house and some will be performed under contract by a production studio. The specific tasks to be performed in-house will be determined and the needed equipment to support their production will be obtained. The remaining tasks will be conducted under contract by a production studio.

During the post-production phase, all materials will be transferred to a one-inch master videotape format. The videotapes will be edited for adherence to specifications. The edited videotapes will be converted to a videodisc format, and videodisc masters will be produced. Replication videodiscs will be pressed from the master videodiscs in sufficient quantities to support Army training needs. Computer programs will be written so that the videodisc format can be used in an interactive level III training system comprised of a microcomputer, videodisc player, and monitor. The completed interactive videodisc MITAC training system will then be ready for training effectiveness evaluation prior to implementation to support Army aviation training.

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DEVELOPMENT AND EVALUATION OF THE AH-64 SYMBOLOGY TRAINING PROGRAM

Dr. John W. Ruffner, Project Director

Background

The AH-64 attack helicopter is a two-crewmember aircraft designed to fly nap-of-the-earth (NOE) missions, day or night in all weather conditions, and to detect, engage, and destroy enemy armor. To provide this capability, the AH-64 is equipped with several complex flight and weapons delivery systems. Successful operation of some of these systems requires that the pilot and copilot/gunner (CPG) be able to observe, interpret, and integrate both visual imagery and symbolic information presented on visual displays.

The AH-64 visual display systems that provide information to the pilot and/or the CPG are the Target Acquisition and Detection System (TADS), the Pilot Night Vision System (PNVS), and the Fire Control Symbol Generator. The TADS is used by the CPG for target search, detection, recognition, and designation. Three sensors--the forward-looking infrared (FLIR), the day television viewing system (DTV), and direct view optics (DVO)--provide the CPG with visual information to detect and engage targets at standoff ranges during the day or night and in adverse weather conditions. The PNVS provides FLIR imagery that enables the pilot to fly the aircraft at night and during degraded visibility conditions. The fire control symbol generator superimposes flight and weapons symbology on the imagery displayed by the TADS and PNVS.

Visual imagery and symbology from the TADS and the PNVS can be presented to either crewmember through the Helmet-Mounted Display (HMD) and on the panel-mounted cathode ray tube (CRT) displays. The HMD, which is part of the Integrated Helmet and Display Sight System (IHADSS), presents visual information to the crewmember on a one-inch diameter screen attached to the helmet, providing a 30° (vertical) by 40° (horizontal) field of view. The HMD enables the crewmember to cross-check flight and weapons information while viewing the external visual scene.

The 27 different symbols that compose the flight symbol set can be presented to assist the crewmember in flying the aircraft. A slightly different subset of the symbols is presented during hover, transition, cruise, and bob-up modes of symbology. The 17 different symbols that compose the weapons symbol set can be presented to assist the crewmember in operating the weapons system. Fourteen symbols are common to both the flight and weapons symbol sets. The symbols vary in size, shape, location, and the manner in which they functionally represent the status of the aircraft or weapons system elements. Information about the aircraft or weapons systems may be represented by changes in symbol size, position, or rate of movement. The number of symbols displayed at any given time varies, depending on the nature of the flight or weapons task and the selected symbology mode.

Need

To become fully qualified in the AH-64 attack helicopter, a student aviator must learn to recognize, understand, and interpret the symbology presented on the helicopter's visual displays, and to integrate multiple sources of information appearing on the displays. During the AH-64 Aircraft Qualification Course (AQC), student aviators are taught to use the symbology through classroom lectures, videotape presentations, self-study handouts, and technical manuals containing static diagrams of the symbology. Opportunities for additional practice with the display symbology are available on three training devices: (a) the TADS Selected Task Trainer (TSTT), (b) the Cockpit Weapons Emergency Procedures Trainer (CWEPT), and (c) the Combat Mission Simulator (CMS).

The TSTT is a part-task trainer designed to support initial CPG qualification and refresher training in the AH-64, and to support TADS skill sustainment during mission and continuation training in field units. It provides practice only with weapons symbology. The CWEPT is a full-scale crew station procedures trainer. It is designed to provide training to the pilot and the CPG in both normal and emergency flight procedures and normal and emergency mission and avionics equipment operation. The CMS is a six degree-of-freedom motion-based simulator designed to simulate the flight and weapons capabilities of the AH-64 aircraft. It currently is used to provide training in combat mission scenarios during the Combat Skills phase of the AH-64 AQC and during operational field unit training.

The training designs of the TSTT, CWEPT, and CMS do not include training on basic symbology identification and interpretation. They assume a substantial degree of familiarity with flight and weapons symbology. Training basic symbology skills in the available devices consumes an unacceptably large amount of time that could be spent more productively on specialized training. Furthermore, when training in the TSTT, CWEPT, or CMS, the students typically do not have an opportunity to use the AH-64 display symbology under the full range of missions, modes, weapons, systems options, and system failures.

Therefore, the Training and Doctrine Command (TRADOC) System Manager (TSM) for the AH-64 requested that the Army Research Institute Aviation Research and Development Activity (ARIARDA) develop and evaluate a training module to train AH-64 student aviators to understand and interpret flight and weapons symbology.

Project Objectives

The Statement of Work (SOW) for this project sets forth six specific requirements for the training module. Briefly, the training module should:

- be designed in a self-instructional format (i.e., not require an instructor pilot (IP) or other instructional personnel) and enable training to be conducted in a classroom setting;
- cover the full range of aircraft missions and weapons system options;
- be capable of storing performance data and providing one or more indexes of performance at the end of each training exercise;
- provide immediate feedback and remedial instruction when errors occur,
- be suitable for both initial skill acquisition in an institutional training setting and skill sustainment training in a unit training setting; and
- be flexible enough to allow revisions resulting from (a) changes in the aircraft, (b) changes in the avionics system, or (c) deficiencies in the training module revealed by formal evaluation and feedback from the user.

In addition, the SOW specifies that the training module should be designed to augment, but not replace existing training devices, and should not require the fabrication and use of mockups or other costly training aids.

Accordingly, the first project objective is to develop a training module suitable for (a) training AH-64 AQC student aviators to identify and interpret flight and weapons symbology, and (b) providing skill sustainment training to aviators in a field unit setting. The second objective is to design and conduct an empirical evaluation of the training module in both an institutional and a field unit setting.

Research Approach

Ten research tasks are required to accomplish the project objectives. The research tasks are the following:

- review the relevant literature,
- identify the flight and weapons tasks requiring the use of symbology,
- interview subject matter experts (SMEs),
- identify the capabilities and limitations of existing training devices,
- define the scope of training,
- define the training approaches and settings,
- define the terminal learning objectives,
- identify and evaluate the training media,
- design the prototype training module, and
- evaluate the prototype training module.

Project Status

Work Completed

Work began on the project in December 1986. Discussions with SMEs suggested that performance deficiencies in symbology usage exist in the following areas:

- recognizing and interpreting the meaning of symbols presented alone and in the context of other symbols,
- interpreting the meaning of symbology movement,
- correctly associating switch actions and control movements with static or dynamic symbology, and
- selectively attending to and interpreting display symbology when the symbology is superimposed on a dynamic external visual scene.

At the end of the first contract year, the general content and organization of the training module has been determined. A preliminary decision was made to organize the symbology training module into two parts. Part I covers basic symbology usage skills and addresses the first two deficiencies cited above; Part II covers advanced symbology usage skills and addresses the last two deficiencies.

Part I of the training module is organized into five separate lessons. Each lesson is designed to be self-contained and presents instructional material and quizzes on the following groups of related symbols:

- position/movement symbols,
- attitude/altitude symbols,
- heading/navigation symbols,
- cueing/reference symbols, and
- weapons delivery symbols.

Work currently is underway to develop instructional materials, quizzes, performance measures, and software branching logic necessary for the student to progress smoothly and effectively through the lessons and quizzes. The software and hardware required to deliver the instructional material in an efficient and effective manner has been identified. The training module is being written in compiled BASIC and is designed to run on a Zenith PC AT-compatible microcomputer equipped with one megabyte of random access memory (RAM), a 20 megabyte internal hard disk, an Enhanced Graphics Adapter (EGA), and a high resolution EGA color monitor. Additional software and hardware enhancements will be considered as the goals of the training module become more clearly defined.

At the end of the contract year, preliminary storyboards for the first three lessons in Part I have been developed. Software routines for presenting symbols on the computer screen, individually and in combination, and for accurately depicting symbology movement are being developed and tested. An operational version of the first lesson has been developed and is being reviewed by selected aviation SMEs.

Work Projected

Part I of the training module is scheduled to be completed and ready for evaluation by the end of December 1987, and Part II is scheduled to be completed and ready for evaluation by the end of February 1988. The training effectiveness of the module in an institutional training environment will be evaluated at Fort Rucker during the second and third quarters of calendar year (CY) 1988. The training effectiveness of the module in a field unit training environment will be evaluated at selected field unit sites during the third and fourth quarters of CY 1988. The final version of the training module and the final project report is projected to be completed and submitted to ARIARDA during the second quarter of CY 1989.

EFFECTIVENESS ANALYSES OF AVIATION PART-TASK TRAINERS

Dr. Dudley J. Terrell, Project Director

Background

To address identified training deficiencies, the Army Research Institute Aviation Research and Development Activity (ARIARDA) is conducting research to develop part-task trainers that provide instruction in navigation, weapons systems operations, preflight inspections, and other aviation subjects. As these trainers are developed, final training effectiveness analyses (TEAs) are needed to ensure the trainers are successful in meeting the training objectives. The final operational tests are usually in the form of a transfer of training study and serve several purposes. First, TEA results will determine if the part-task trainers are effective as designed or if changes are required before implementation. Second, TEA results can be used to prescribe optimal strategies for using the training systems. Finally, the TEA provides a methodology for the continuous evaluation and maintenance of training effectiveness after the full-scale implementation of the part-task trainer.

One part-task trainer that is ready for a TEA is the Advanced Map Interpretation and Terrain Analysis Course (Adv-MITAC) developed by Anacapa Sciences, Inc. (Miles & LaPointe, 1986). The Adv-MITAC program is designed to supplement classroom and inflight training in terrain navigation at nap-of-the-earth altitudes. The equipment consists of a micro-computer, videodisc player, color monitor, seven videodiscs, and a set of maps. The training program is divided into 13 lessons, each designed to be slightly more difficult than the previous one.

Each lesson begins with a preflight map study of the area of operations. The student then views a film taken from the front window of a helicopter flying a route at low altitude. At various points in the film, the action stops and the student must enter the map coordinates for that point. If the student's coordinates are within 200 meters of the correct location, the action continues until the next checkpoint. If the student's coordinates are more than 200 meters from the correct location, a narrated review of the route from the last checkpoint is played. After the review, the action continues until the next checkpoint. Each route includes seven checkpoints. The computer calculates the amount of error at each point and presents the results to the student at the end of the lesson.

Need

The Adv-MITAC package is ready for implementation except for an evaluation of its effectiveness. This evaluation must either provide data supporting the program's efficacy or provide recommendations for improvements in the program. In addition, the evaluation must provide a basis for recommending the optimal strategy for using Adv-MITAC in the current aviation training program.

Project Objectives

The purpose of this project is to evaluate the effectiveness of the Adv-MITAC part-task trainer prior to its implementation. This project has three specific objectives:

- develop a suitable navigation performance measurement technique,
- provide an operational test of the Adv-MITAC trainer, and
- develop recommendations for the optimal utilization of the Adv-MITAC program in the initial entry rotary wing (IERW) course.

Research Approach

The Adv-MITAC TEA will be conducted in the following four phases:

- Phase 1: Conduct a literature review of existing navigation training programs and accompanying evaluations, and develop a research plan to evaluate the effectiveness of the Adv-MITAC program.
- Phase 2: Develop a technique for measuring navigation performance before and after exposure to the Adv-MITAC program.
- Phase 3: Collect TEA data during the OH-58C Combat Skills section of the IERW course.
- Phase 4: Analyze the data collected during Phase 3 and write a report describing the research methodology, measurement techniques, results, and recommendations for the use of Adv-MITAC.

Project Status

Work Completed

Anacapa researchers began work on the project in September, 1987. At the end of the first contract year a preliminary review of the TEA literature and methodology had been completed. The project director attended the Terrain Flight Operations Class of the IERW course and has started developing the performance measurement techniques and the research plan.

Work Projected

The technical details of the Adv-MITAC TEA research plan are presently being developed, but the steps outlined in Phases 2-4 of the research approach remain to be completed. In addition, other part-task trainers (e.g., Basic-MITAC and the AH-1S Preflight Inspection Trainer) will be subjected to TEA research when the product development is completed.

Reference

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