Technical Report 68-14

Evaluation of Synthetic Instrument Flight Training in the Officer/Warrant Officer Rotary Wing Aviator Course

by

Robert N. Isley, Paul W. Caro, Jr., and Oran B. Jolley

HumRRO Division No. 6 (Aviation)

November 1968

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Office, Chief of
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Contract DA 44-188-ARO-2

HumRRO

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE

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Fort Rucker, Alabama
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Technical Report 68-14
Work Unit ECHO
Sub-Unit III

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FOREWORD

The overall objectives of Work Unit ECHO are to survey and evaluate current synthetic flight training in Army aviation; to determine experimentally the value of selected flight training devices; and to establish guidance for the development and effective utilization of flight training devices in present and future aviation training curricula. Activities directed toward these objectives were begun by the Human Resources Research Office in FY 1964 at Fort Rucker, Alabama.

In ECHO Sub-Unit I, a survey of synthetic flight training equipment and practices was conducted at the U.S. Army Aviation School and at aviation field units within the continental United States. In ECHO II, the training value of a device embodying the captive helicopter concept was evaluated. The present Technical Report describes research conducted under ECHO III. Additional research under Sub-Units III and IV concerns optimum utilization of present and future training devices.

An interim report of ECHO III work was delivered to the U.S. Army Aviation School in November 1966. The interim report is superseded by this Technical Report, which presents additional material not previously reported.

The cooperation of the U.S. Army Aviation School was an important factor in the conduct of this research. Of special value was the guidance provided by COL D.C. Cabell in the initial planning of the study. COL Cabell, at that time, was responsible for synthetic training in the Department of Rotary Wing Training, U.S. Army Aviation School.

The ECHO research is being performed by HumRRO Division No. 6 (Aviation) at Fort Rucker. The Director of Research is Dr. Wallace W. Prophet; Dr. Paul W. Caro, Jr., is the Work Unit Leader. In addition to those listed as authors, Dr. T. Harrison Gray, Dr. Robert A. Alkov, and Mr. John O. Duffy of HumRRO Division No. 6 (Aviation), and SP 4 Ronald J. Townsend and SP 4 Donald R. McKenna of the U.S. Army Aviation Human Research Unit made significant contributions to the research effort.

Military support for the study was provided by the U.S. Army Aviation Human Research Unit, Fort Rucker. LTC Berkeley D. More was the Unit Chief at the time the research was conducted. LTC Edward B. Covington, III, is the present Unit Chief.

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Meredith P. Crawford
Director
Human Resources Research Office

SUMMARY AND CONCLUSIONS

Military Problem

Recent expansion of Army aviation and emphasis upon helicopter operations have increased the load on the Army's rotary wing training capability. These greater aviator training requirements have led to adoption of training concepts and techniques that reasonably can be expected to increase the efficiency of rotary wing training. Synthetic flight training devices, for example, have been found beneficial in fixed wing instrument training programs, and similar benefits might be expected to accrue from their use in rotary wing training. The value of synthetic flight training must, however, be evaluated in terms of its contribution to the specific flight training program in which it is used.

Device 1-CA-1 was developed as a fixed wing instrument training device. Seventy-eight of these devices have been modified at the U.S. Army Aviation School to a quasi-rotary-wing configuration for use in rotary wing training. These devices are used to provide training in the skills required for instrument flight to warrant officer candidates enrolled in the Tactical Instrument Phase of the Officer Rotary Wing Aviator Course and the Warrant Officer Rotary Wing Aviator Course (O/WORWAC). Prior to the present research, Device 1-CA-1 had not been evaluated experimentally to determine its suitability for rotary wing training.

Research Problem

Training device effectiveness is a function of both the characteristics of the device and the manner in which it is used in a training program. The present research was an experimental evaluation of the modified 1-CA-1 devices as they were used at the U.S. Army Aviation School during FY 1967. Trainees who received the prescribed training in these devices were compared with other trainees who received only half as much device training, or none at all. The differences in flight performance among groups, if any, would be indicative of the training contribution of the device under study.

Approach

Prior to the Tactical Instrument Phase, 60 Warrant Officer Candidates were randomly selected from the rosters of each of three O/WORWAC classes and assigned to one of three groups. Two of these groups, designated the Zero-Hour Group and the Ten-Hour Group, received zero or 10 hours of synthetic device training, respectively. The third group, designated the Twenty-Hour Group, received the full 20 hours of synthetic training routinely administered to all WORWAC students. The Twenty-Hour Group served as a control group for this study.

Measures of the relative performance of the three groups on the end-of-phase checkride routinely administered to all WORWAC students constituted the major criteria for determining the value of the synthetic training received by the groups. Other criteria employed were grades during training, time to checkride, and checkride grades.

Results

Overall, there were no consistent indications that the device-trained groups differed from the groups without such training. The few significant differences among groups were irregular in direction of differences and few enough to suggest they were chance findings.

Conclusions

It was concluded that the synthetic device instruction given in the Officer/Warrant Officer Rotary Wing Aviator Course at the time of this study:

(1) Did not increase trainee proficiency in terms of aircraft control and procedural skills on the end-of-phase checkride, did not decrease the amount of flight time required to pass the checkride, and had no significant effect on checkride grade.

(2) Had no significant effect on attrition.

(3) Had no significant effect on instructor-assigned daily grades during training.

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Evaluation of Synthetic Instrument Flight Training in the Officer/Warrant Officer Rotary Wing Aviator Course

INTRODUCTION

Background

The use of synthetic flight training devices in aviator training programs has become a widely accepted practice in both military and civilian organizations. Their use is predicated on the assumption that training given in the device (a) will transfer to the aircraft, and (b) is more efficient and/or less expensive than equivalent training given in the aircraft. The importance attached to synthetic flight training in meeting training goals is reflected in papers presented by both government and nongovernment participants in a recent international simulation and training conference (1).

Instrument flight trainers, one of the more common types of synthetic flight training devices, have played a significant role in military aviation for over three decades. The first "Link Trainer" was obtained by the U.S. Government in 1934, and "instrument trainers" have been used since that time by the Army, Navy, and Air Force in their fixed wing instrument training courses. The recent introduction of instrument flight[1] in rotary wing aircraft and the expansion of rotary wing aviation by the Army have led to a requirement for rotary wing instrument training devices.

Although the contribution of synthetic instrument training to fixed wing aviator training courses has long been recognized and empirically demonstrated, the value of similar training in rotary wing aviator training courses has never been established. Personnel responsible for the conduct of synthetic instrument training for rotary wing aviators have assumed its probable contribution is high because of the apparent similarity between fixed wing and rotary wing instrument flight activities. These activities are (a) control of the aircraft using only information internal to the aircraft cockpit, and (b) adherence to established navigation and communication procedures. Since (b) is highly similar for both fixed wing and rotary wing flight, and since (a) differs primarily in the particular psychomotor skills (which differ significantly in the two modes of flight) used to control the aircraft, the assumption that synthetic instrument training would make a similar contribution to these two flight modes might appear justified.

The value of synthetic instrument flight training must, however, be determined within the context of the device in use and the way in which it is used. The designation of a device as an "instrument trainer" does not ensure its value in an instrument training program. Its value must rest on the suitability of its design for the particular training requirement and the appropriateness of the manner in which it is used. The importance of the way in which devices are used, even when they may be optimally designed, has been discussed by Prophet (2).

To assume that information obtained in one situation is applicable to another situation is risky, and the degree of risk depends on the dissimilarity of the two situations involved. To assume that the empirically determined value of a synthetic training program in one fixed wing instrument training course is a

[1]Instrument flight involves controlling the aircraft without reference to extra-cockpit visual cues, that is, the cues for aircraft control and navigation come from sources in the cockpit, the instruments.

reasonable approximation of its value in another fixed wing instrument training course probably involves tolerable risk; to generalize that same value to a dissimilar course, such as a rotary wing course (even when rotary wing modifications may have been made), probably involves risk of much greater magnitude. At the present time, assumptions of the value of rotary wing synthetic instrument training programs are generally based on experience with fixed wing programs.

At the time of the research reported here, the availability of rotary wing instrument training devices was limited. Several rotary wing synthetic flight trainers had been built for the Navy. These devices, 2-B-10 and 2-B-10A, were of the operational flight trainer type and were not being used in instrument flight training programs per se. Another device built for the Navy, Device 2-B-18, is a rotary wing basic instrument trainer and currently is being used for that purpose. A determination was made by the Army, however, that the configuration of this particular device rendered it unsuitable for meeting the Army's rotary wing synthetic instrument trainer requirement. The contribution of Device 2-B-18 to the Navy's training program had not been determined at the time this Technical Report was prepared.

The Army has under development a system of rotary wing instrument flight trainers designed to meet its rotary wing instrument trainer requirement.[1] Pending development of the Synthetic Flight Training System, the U.S. Army Aviation School has been using available fixed wing instrument trainers (Device 1-CA-1) modified to a rotary wing configuration. Some of the 1-CA-1s were rebuilt commercially to include rotary wing dynamics. The changes were extensive, and these commercially rebuilt devices have been redesignated Devices 2-B-3 and 2-B-3A. They are used, for the most part, in graduate aviator training programs. The majority of the devices used for rotary wing training, however, are modified 1-CA-1s rather than 2-B-3s or 2-B-3As. They were modified locally by the U.S. Army Aviation School, and, at the time of this research, they were used exclusively in undergraduate instrument training programs—the Tactical Instrument Phase of the Officer and Warrant Officer Rotary Wing Aviator Courses. The research described in this report involves only the locally modified 1-CA-1s. Figure 1 illustrates the instrument panel of one of these devices.

Instrument Panel of a Device 1-CA-1 Modified by the U.S. Aviation School to a Quasi-Rotary-Wing Configuration

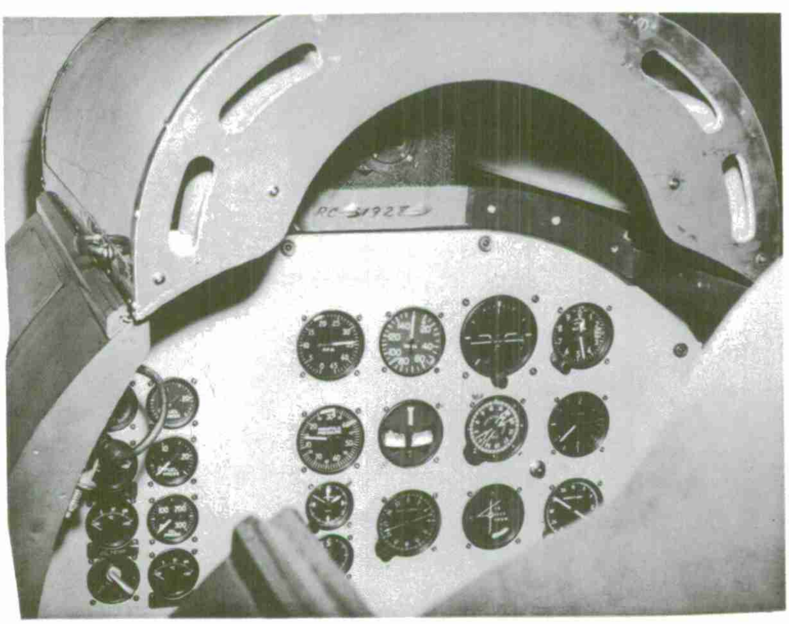

Figure 1

[1]Department of the Army Approved Qualitative Materiel Requirement (QMR) for a Synthetic Flight Training System (SFTS) (Rotary Wing/VTOL), 10 July 1967.

Device 1-CA-1 was originally built in the 1940s as a basic fixed wing instrument trainer and was used by the Navy as early as 1946. A number of studies have since been reported on various aspects of the device's effectiveness in fixed wing training programs (3, 4, 5, and 6). In general, the results of these studies have indicated that device training leads to improved aviator proficiency, reductions in the amount of flight time required to complete the training program, or both. Prior to the present research, however, no studies have been reported of the effectiveness of this device when modified for use as a synthetic trainer in rotary wing instrument training programs.

Research Objective

In recognition of the desirability of an experimental determination of the training value of present rotary wing synthetic training programs that employ these modified fixed wing instrument trainers, the research described in this report was undertaken. The objective was to determine the training value of present synthetic instrument flight training in the Tactical Instrument Phase of the Officer/Warrant Officer Rotary Wing Aviator Course. The objective was met by experimentally varying the amount of synthetic instrument training in that course and determining the effects of these variations on aviator performance during a simulated tactical instrument mission.

This research was concerned exclusively with the instrument training given to undergraduate Army rotary wing aviator trainees in the locally modified 1-CA-1 devices. Other training programs and training devices were not involved in any manner. The design of the research did not permit evaluation of Devices 2-B-3, 2-B-3A, or any rotary wing instrument trainer other than the locally modified 1-CA-1s.

Overview of Rotary Wing Aviator Training

The Officer/Warrant Officer Rotary Wing Aviator Courses (O/WORWAC) at the U.S. Army Aviation School currently graduate approximately 400 aviators each month. Since the majority of these graduates are Warrant Officers, only Warrant Officer Candidates (WOCs) took part in the present research. The training given to these candidates in the Warrant Officer Rotary Wing Aviator Course (WORWAC) differs from that given to officers in the Officer Rotary Wing Aviator Course (ORWAC) only in that the WORWAC is preceded by a four-week Warrant Officer Indoctrination Training (WOIT) program.

The O/WORWAC consists of a three-phase rotary wing flight training program. Phase I lasts 16 weeks and is conducted at the U.S. Army Primary Helicopter School, Fort Wolters, Texas. During Phase I, trainees receive 110 hours of dual flight instruction and solo practice in the OH-23D or the TH-55A helicopters. All of this training is conducted in accordance with Visual Flight Rules (7), and the trainee is required to maintain visual contact with the extra-aircraft environment at all times.

Upon successful completion of Phase I, the trainee is transferred to the Aviation School at Fort Rucker, Alabama, where he receives the second and third phases of O/WORWAC training. Each of these phases lasts eight weeks and includes 50 hours of dual flight instruction and solo practice. Phase II is known as the Tactical Instrument Phase, and the trainee learns to fly the helicopter in accordance with the tactical instrument flight rules specified in Army Regulation 95-63 (8).

Learning to pilot a helicopter solely by reference to instruments is a difficult perceptual-motor task. The instrument pilot must relate the cues provided by the aircraft instrument readings (stimuli) to the appropriate control inputs (responses). In addition, the rules and procedures governing instrument flight must be mastered.

The Tactical Instrument Phase of the O/WORWAC was inaugurated at Fort Rucker in late 1965 to provide training in the instrument flight skills deemed necessary to enable graduates of the phase to perform under tactical conditions such as might be expected to occur in Vietnam. In addition to 50 programed hours of dual instruction in the training aircraft, the single rotor TH-13T helicopter, the course consists of 20 hours of synthetic trainer time, and 118 hours of classroom instruction on related flight subjects. The flight, synthetic, and academic training are given concurrently over an eight-week period. To complete the phase successfully, the student must pass an end-of-phase checkride during which he demonstrates, to the satisfaction of a checkpilot, his mastery of the instrument flight skills and procedures taught during tactical instrument training.

Immediately following the Tactical Instrument Phase, trainees begin the final phase of O/WORWAC, Phase III. The aircraft involved in this phase is the UH-1. It is the Army's primary tactical helicopter, and the purpose of Phase III is to train the future officer or Warrant Officer pilot in the tactical use of this aircraft. Upon graduation from Phase III, trainees are awarded their wings (and warrants, in the case of WOCs in the WORWAC), and their most likely next assignment will require them to engage in tactical operations as copilot in the UH-1 helicopter.

METHOD

Subjects

The trainees participating in this study were WOCs enrolled in three consecutive FY 1966 WORWAC classes. Kaplan (9) has described the procedures used in the selection of WOCs for enrollment in WORWAC.

Prior to the beginning of the Tactical Instrument Phase, 60 WOCs were randomly selected[1] from the roster of each of the three classes and assigned to one of three groups. The only restrictions placed on the selection procedures were that (a) each group consist of an equal number of WOCs from each of the three WORWAC classes, that is, each experimental and control group of 60 WOCs consisted of 20 from Class 66-15, 20 from Class 66-17, and 20 from Class 66-19; and (b) WOCs thus selected not have been recycled during their primary flight training at Fort Wolters.

Because it was necessary to select the WOCs before all of their personnel records arrived at Fort Rucker, each group consisted of WOCs with varying amounts of prior experience likely to affect the results of this research. Some, for example, had been synthetic trainer operators or U.S. Air Force pilots before entering the WORWAC, and it was known that such prior experience typically included extensive practice in devices similar to those used in the present research.

When the appropriate records became available, all WOCs assigned to any group who had (a) prior experience as a synthetic flight trainer operator, (b) a military or FAA aeronautical rating (excluding Student Pilot), or (c) 50 or more hours of flight experience prior to entering Phase I of the WORWAC, were eliminated from the study.[2] Forty-eight WOCs remained in the Zero-Hour Group,

[1]A table of random numbers was used.

[2]These losses are assumed to have been random and to have had no systematic effect on the outcome of the research.

46 in the Ten-Hour Group, and 51 in the Twenty-Hour Group, for a total of 145 WOCs who participated in the research. Table 1 indicates the number of WOCs, by experimental and control group and by WORWAC class, who remained.

Table 1

Number of WOCs in Each Group and Class

Group	Class 66-15	Class 66-17	Class 66-19	Total
Zero-Hour	16	17	15	48
Ten-Hour	15	14	17	46
Twenty-Hour	19	16	16	51
Total	50	47	48	145

Experimental Design

The research described here was modeled after a 3 x 3 factorial design. The experimental variable was amount of training on the synthetic device. The second factor in the research design, WORWAC class, was used as a statistical control rather than as an experimental variable. Where frequency data were used, Chi Square analyses rather than analyses of variance were employed. For other analyses, where appropriate, the analysis of variance was employed.

Amount of Synthetic Device Training

Two groups, designated the Zero-Hour Group and the Ten-Hour Group, underwent one of two experimental programs of instruction. Members of the Zero-Hour Group received no synthetic instrument training; members of the Ten-Hour Group received 10 hours of synthetic training. A control group, the Twenty-Hour Group, underwent the 20-hour synthetic training program routinely administered to all WORWAC students.[1] No changes were made in the inflight or academic portions of the course, and all training was conducted by USAAVNS staff members and contractors normally engaged in such training. Students trained under the 10-hour syllabus covered the same subjects as did the 20-hour group, but in half the normal time.

The synthetic training was administered to members of the Ten-Hour Group and the Twenty-Hour Group concurrently with their inflight training. During the first four weeks of the Tactical Instrument Phase all WOCs received 25 hours of inflight dual instruction, and the Ten-Hour and Twenty-Hour Groups received four and eight hours of synthetic device training, respectively. Both the inflight training and synthetic training were administered by contractor personnel. During the second four weeks of the phase, all trainees received the remaining 25 hours of inflight training allotted to the Tactical Instrument Phase. During this period, the Ten-Hour and Twenty-Hour Groups received six and 12 hours of synthetic device training, respectively. Both the inflight training and the synthetic training during this four-week period were administered by military and Civil Service personnel.

The amount and type of training received by each group during each four-week period are shown in Table 2. The syllabus developed for the 10-hour synthetic training program is given in Appendix A.

WORWAC Class

Previous experience with WORWAC classes had suggested that significant differences in training techniques and standards existed among groups of flight instructors. A means of reducing the influence of these differences upon

[1]Syllabus for O/WORWAC Synthetic Flight Trainer, USAAVNS, 3 May 1966.

Table 2

Amount of Synthetic and Flight Training, by Group

(Hours)

Period	Zero-Hour Group		Ten-Hour Group		Twenty-Hour Group	
	Synthetic Training	Flight Training	Synthetic Training	Flight Training	Synthetic Training	Flight Training
Weeks 1-4	0	25	4	25	8	25
Weeks 5-8	0	25	6	25	12	25
Total	0	50	10	50	20	50

the research results was desired. For this reason, three separate classes (and consequently three separate groups of flight instructors) were used in this study. Where statistically significant differences among classes were found in the present study, and in the absence of significant interaction effects, such differences were attributed to the previously noted difference among groups of flight instructors. Thus, the introduction of the Class variable in this research was a means of reducing the statistical variance which might otherwise contribute to a less precise measure of the effects of the Training Condition variable.

Performance Evaluation

The purpose of the Tactical Instrument Phase of O/WORWAC is to train officers and WOCs to "pilot an Army helicopter under instrument conditions only in an actual or simulated tactical environment using the normal facilities available in the combat zone."[1] Evaluation of the effectiveness of the training received, therefore, must be made in the context of performance in an actual or simulated tactical environment. The end-of-phase checkride routinely administered to all trainees in these courses is an evaluation of their performance in a simulated tactical environment. Measures of the relative performance of the groups of WOCs on the end-of-phase checkride constituted the criteria used in the research reported here to determine the value of the synthetic flight training received by each group.

The evaluation of trainee performance on checkrides in the O/WORWAC at the Aviation School is made by a checkpilot who, typically, is an instructor pilot in the trainee's class. At the end of the checkride, an overall grade is assigned in accordance with procedures specified in current U.S. Army Aviation School Regulations.[2] The grade is subjective in nature and has been found to be significantly affected both by the individual standards and grading practices of the checkpilot and by whether the checkpilot is a member of the trainee's own training flight (11). Additional techniques of performance evaluation and data collection were studied because of the subjective nature of the available checkride grades and the research requirement to evaluate the effects of device training on specific behaviors (in addition to the overall evaluation provided by these checkpilot-assigned grades).

The method of data collection and performance evaluation described by Greer, Smith, and Hatfield (12) and Duffy and Colgan (13) provides for objective recording of trainee performance during checkrides such as those administered

[1]Paragraph 5a(3), AR 95-63 (8).

[2]USAAVNS Regulation 350-16, dated 1 June 1963, was in effect at the time of the research reported here (10).

in the course under study. The performance descriptions thus recorded provide an objective basis for performance evaluation that could be used in the present research. The method referred to is in use at the U.S. Army Primary Helicopter School. The Aviation School, however, has determined that the method is not appropriate at Fort Rucker (11). Therefore, it was necessary to develop data collection techniques that would provide data similar to that obtained during checkrides at the Primary Helicopter School. The techniques of data collection and performance evaluation developed for the present research were adaptations of the Primary Helicopter School's system and were designed to fit the administrative conditions of flight training at Fort Rucker.[1]

The Criterion Checkride

The end-of-phase checkride routinely administered to trainees completing the Tactical Instrument Phase of O/WORWAC requires that the trainee demonstrate to the examining checkpilot his ability to perform certain maneuvers in accordance with prescribed standards. These maneuvers and standards are specified in AR 95-63 (8). In addition, checkpilots typically require trainees to demonstrate an ability to recover from unusual flight attitudes, perform autorotations terminated in a power recovery, and perform a standard ADF approach. The order in which the various maneuvers occur and the particular circumstances under which they are performed are partly left to the discretion of the checkpilot.

Because of such variations in the existing checkride procedures, it was believed that criterion data obtained under those procedures could be subject to variability that would be attributed to factors other than the experimental training conditions under study. Thus, it appeared desirable to impose upon the checkpilot the requirement that at least a portion of each tactical instrument checkride be performed in a standard sequence and, as much as possible, under standard conditions. The importance of such considerations in the collection of flight performance data has been discussed by Greer, Smith, and Hatfield (12).

Approximately half of the tactical instrument checkride was standardized. The standardized portion took the form of a hypothetical, though realistic, tactical instrument mission that required the examinee to depart a heliport; climb on a heading to a fixed altitude; intercept a radial from a particular radio beacon; track inbound to the beacon; enter a tactical holding pattern; execute an approach to the beacon and, at minimum altitude, a missed approach; climb to a given altitude on a given heading; intercept a radial from the beacon; and track outbound on it. The mission given the trainee and the various clearances employed during the course of the mission are presented in Appendix B.

In addition to the standardized portion of the checkride, each trainee was required to execute one ground-controlled approach and perform other maneuvers judged appropriate by the checkpilot.

Data Collection Techniques and Procedures

Data collection during the standardized portion of the criterion checkride was accomplished through the use of time-lapse photographic techniques developed specifically for this purpose. These techniques consisted of photographing, on a fixed time-sampling basis, all instrument displays accessible to both the student and the instructor pilot during the conduct of the hypothetical tactical instrument mission.

[1]The photographic data collection and performance evaluation techniques developed for this research were designed to meet a research requirement and are not believed suitable for operational use.

16mm Camera and Intervalometer Mounted on Firewall of TH-13T Helicopter

Figure 2

All films were taken with 16mm Bolex Model H-16 reflex cameras, fitted with Switar 1:1.6 wide angle lenses. An intervalometer was attached to each camera and adjusted to expose one frame of film every 1.35 seconds. The camera and timer were mounted on the firewall of the TH-13T helicopter approximately 3.5 feet from, and approximately perpendicular to, the center of the instrument panel. Kodak Plus-X reversal movie film in 100-foot rolls was used.[1] The camera system was activated by the checkpilot at a predetermined point shortly after takeoff from the heliport (see Appendix B). Figure 2 shows a camera and timer mounted in the helicopter.

Data describing trainee checkride performance were obtained by "scoring" the film. Research staff members were trained to read each instrument on the instrument pedestal and to record deviations from prescribed or "proper" instrument indications throughout the checkride. These staff members were performing the data-recording function assigned to checkpilots at the Primary Helicopter School, but their data were obtained from photographs of the instruments rather than from the instruments.

Data from the films were evaluated on the basis of how well the student maintained control of the aircraft within the established tolerance levels for instrument flight and the extent to which he followed the procedures governing such flight as described in Army Regulation 95-63 (8). Deviations from the standards prescribed in AR 95-63 were obtained on ten parameters of flight proficiency. Nine of these parameters—Airspeed, Altitude, Pitch, Vertical Speed, Engine RPM, Degree of Bank, Ground Track (ADF), Heading, and Trim[2]—reflected the student's ability to control the aircraft. The tenth parameter, Procedural Error (PE), reflected the student's ability to "do the right thing at the right time" and in the proper sequence as established during training. An example of a procedural error would be a left-hand turn during a holding pattern when a right-hand turn was the "proper" behavior. A further description of the scoring procedures is provided in Appendix B.

In addition to the data collected by photographing the instrument panel during the standardized portion of the checkride, each checkpilot completed a

[1]Identification of products in this technical report is for research documentation purposes only, and their use or citation does not constitute an official endorsement or approval by either the Human Resources Research Office or the Department of the Army.

[2]Trim, as used in this report, refers to the trainee's ability to maintain coordinated flight; that is, to keep the ball of the turn and bank indicator centered at all times.

checklist immediately upon return to the heliport. The checklist is shown in Appendix C. It provided information concerning flight conditions at the beginning and end of the checkride, information about necessary deviations from the standardized portion of the checkride (which might be useful during film scoring), and ratings of student performance on the portion of the checkride that was not photographed.

Data describing training performance on the non-photographed portion of the checkride were extracted from the checklists completed by the checkpilots after each checkride.

In addition to the data obtained during the checkride, other performance measures were obtained from the regular training flight records of the WOCs in this study. These measures consisted of end-of-phase checkride grades assigned by the checkpilots, amount of dual instruction required to pass the checkride, instructor-assigned daily grades during the Tactical Instrument Phase of training, and whether flight performance was satisfactory (or was unsatisfactory and resulted in elimination from the WORWAC or recycle to a later class in order to receive additional training).

RESULTS

Checkride Performance

Performance on Photographed Maneuvers

The specially prepared hypothetical tactical instrument mission constituted the first half of the end-of-phase checkride for the experimental and control groups. All data obtained by the previously described photographic techniques were recorded during this portion of the checkride.

The photographic records of the simulated tactical instrument mission provided 96 measures of inflight performance. Of these, 84 reflected the trainee's ability to control the aircraft within acceptable tolerances, and 12 reflected his ability to follow the standard procedures involved in the proper execution of the 12 maneuvers that constituted the photographed portion of the simulated mission. Table 3 identifies the 12 maneuvers involved, and Table 4 identifies the flight parameters scored on each maneuver.

Table 3

Maneuvers Constituting the Photographed Portion of the Tactical Instrument Checkride

Maneuver Number	Maneuver Identification
1	Inbound Tracking
2	Station Passage
3	Level Turn
4	Station Passage
5	Level Turn
6	Station Passage
7	Descending Turn
8	Station Passage
9	Descending Turn
10	Station Passage
11	Straight Climb
12	Outbound Tracking

Thunderstorms and low ceilings hampered the collection of photographic data on Class 66-15. Checkpilots were unable to reach and maintain the altitudes specified for the standardized mission described in Appendix B. Consequently, much of the film obtained for this class was unusable, and only data from Classes 66-17 and 66-19 were used for photographic analyses. Of the 95 initial entrants to Classes 66-17 and 66-19, six were eliminated or recycled prior to the checkride, which left a total of 89 checkrides available for filming. WOCs were scheduled for checkrides upon recommendation of their instructors. Consequently, there were occasions when more checkrides were scheduled than could be handled administratively by the research staff. Such

Table 4

Distribution of 96 Measures of 10 Parameters Among the 12 Photographed Instrument Maneuvers

Parameter	Number of Maneuvers In Which Scored	Maneuver Number
Airspeed	12	1-12
Degree of Bank	12	1-12
Engine RPM	12	1-12
Heading	1	11
Trim	12	1-12
Pitch	12	1-12
Altitude	9	1-6, 8, 10, 12
Ground Track (ADF)	2	1 and 12
Vertical Speed	12	1-12
Procedure	12	1-12
Total	96	

scheduling problems, weather, and aircraft and camera malfunctions resulted in the loss of 18 of the 89 checkrides. Eleven of the 71 films taken had to be discarded because of improper exposure settings, leaving a total of 60 scorable films.[1] Scorable films were obtained for 21 WOCs in the Zero-Hour Group, 19 WOCs in the Ten-Hour Group, and 20 WOCs in the Twenty-Hour Group.

For each of the 12 maneuvers, contingency tables were constructed to show the number of students in each group who exceeded the established tolerances on each parameter or committed a procedural error. Chi Square analyses were performed on these data. The error rates of each group of WOCs on the 96 measures and the Chi Squares obtained for each comparison are shown in Appendix D. Only three of these 96 Chi Square analyses yielded differences between groups significant at the .05 level. The three significant differences were RPM control during Maneuver 3, procedures during Maneuver 8, and altitude control during Maneuver 12. Table 5 presents the error rate in percent for each group and the Chi Square values obtained for these three statistically significant measures.[2]

Zero-Hour Group versus Twenty-Hour Group comparisons (i.e., no device training versus 20 hours of device training) were also made of the data summarized in Appendix D.[3] Significant differences also were found in these comparisons for the three parameters cited in Table 5. The Chi Square values were 5.72, 4.05, and 5.04 for the RPM, Procedures, and Altitude items, respectively. In these comparisons, one additional significant difference was found: The error rate of the Zero-Hour Group was significantly lower than that of the Twenty-Hour Group for airspeed control during the maneuver

Table 5

Error Rates by Group and Obtained Chi Squares for Parameters Where Significant Differences Were Found[a]

Parameter	Mission Segment	Group Error Rate (Percent)			Chi Square
		Zero-Hour	Ten-Hour	Twenty-Hour	
RPM	Level Turn One (3)	45	40	12	7.65*
Procedures	Low Station Altitude (8)	5	6	30	6.52*
Altitude	Outbound Track (12)	24	25	61	6.78*

[a] *indicates $p < .05$.

[1] It is assumed that the pattern of losses was unrelated to critical aspects of the study.

[2] A probability of $< .05$ was established as the minimum value that would be considered statistically significant, throughout the analyses.

[3] Comparisons were not made of the Zero-Hour Group versus the Ten-Hour Group or the Ten-Hour Group versus the Twenty-Hour Group since the transfer effect was anticipated to be greatest between the least trained and the most trained group.

Descending Turn One ($\chi^2 = 4.61$). The error rates for the Zero-Hour Group and the Twenty-Hour Group on this parameter were 5% and 30%, respectively.

The error rate, by group, on each parameter was also obtained for the following combinations of maneuvers:[1] (a) Inbound and Outbound Track (Maneuvers 1 and 12); (b) Station Passages (Maneuvers 2, 4, 6, 8, and 10); (c) Level Turns (Maneuvers 3 and 5); (d) Descending Turns (Maneuvers 7 and 9); and (e) Climbs and Descents (Maneuvers 7, 9, and 11). The error rate by group and the Chi Squares obtained for each of these maneuver combination comparisons are given in Appendix E. None of these analyses yielded a significant Chi Square.

Zero-Hour Group versus Twenty-Hour Group comparisons were also made of these data. Two significant group differences were found in these analyses: RPM during Level Turns ($\chi^2 = 4.91$) and airspeed during Climbs and Descents ($\chi^2 = 5.16$). The Twenty-Hour Group had a lower error rate for RPM on Level Turns (35%) than did the Zero-Hour Group (70%). The Zero-Hour Group, on the other hand, had a lower error rate for airspeed during Climbs and Descents (10%) than did the Twenty-Hour Group (40%).

The error rate by group on each of the 10 flight parameters was also obtained for all maneuvers combined. The Bank parameter was found to be significant in these analyses ($\chi^2 = 11.06$, $p < .01$). The error rates for Zero-, Ten-, and Twenty-Hour Groups in this analysis were 71%, 90%, and 40%, respectively. When only the Zero-Hour and the Twenty-Hour Groups were compared for all maneuvers combined, Bank error rate was found to yield the only significant difference between groups ($\chi^2 = 6.61$). The error rates and Chi Square values involved in the comparisons of groups on all maneuvers combined are also contained in Appendix E.

In order to obtain a single estimate of each WOC's performance during the filmed portions of the checkride, an overall error rate was computed from the total number of errors made, divided by the total number of items performed out of 96. Class by Training Condition analysis of variance of these scores failed to yield any significant F ratios. Table 6 presents the mean error scores by group and by class.

Table 6

Mean Overall Mission Error Rates, by Group and Class

(Percent)

Group	Class 66-17			Class 66-19			Total		
	Mean	*N*	SD	Mean	*N*	SD	Mean	*N*	SD
Zero-Hour	21	12	5	21	9	10	21	21	7
Ten-Hour	18	9	8	25	10	9	22	19	9
Twenty-Hour	21	9	9	24	11	7	23	20	8
Total	20	30	7	23	30	8	22	60	8

Performance on Non-Photographed Maneuvers

From the checklists completed by the checkpilots at the end of each flight, subjective ratings were obtained of trainee performance during three or more components of four non-photographed flight tasks. The questionnaire is shown in Appendix C. The non-photographed tasks were (a) Recovery from Unusual Attitudes, (b) Autorotations, (c) Standard ADF Approach, and (d) Ground-Controlled Approach (GCA).

[1] Where combinations of maneuvers were compared, error rates were computed by scoring each trainee on an error (i.e., one or more) versus no-error basis. Thus, error rate refers to the percentage of trainees within a group making an error.

The inclusion of these tasks in the checkride was at the option of the checkpilot; consequently, not all subjects performed all four tasks. Further, the simultaneous scheduling of more checkrides than could be handled resulted in the failure to obtain checkpilot evaluations of trainee performance on all of the 145 experimental and control WOCs who participated in this study. Checkpilot ratings were obtained on 85 Recoveries, 90 Autorotations, 101 Standard ADF Approaches, and 103 GCAs. The values of N reported in Appendix C reflect these differences.

The performance ratings of these task components were made in accordance with procedures outlined for the assignment of daily flight grades in the Uniform Flight Grading System (10). Under these procedures a rating scale of four values is used: U (unsatisfactory, i.e., failing), C (low to fair proficiency), B (good proficiency), and A (excellent proficiency). In order to facilitate statistical analysis of ratings assigned by checkpilots, the letter ratings were converted to a four-point scale, which assigned one point for U, two points for C, three points for B, and four points for A. In this manner, a maneuver score was obtained for the mean of the component task ratings of each maneuver. An overall grade for the non-photographed portion of the checkride was also obtained by computing the mean of all task components across maneuvers.

Appendix C contains the means of the checkpilot ratings of each group and class on each of the four non-photographed checkride maneuvers. A Class by Training Condition analysis of variance was performed on the data summarized in Appendix C for each maneuver.[1] None of the obtained F ratios was significant in these analyses.

Table 7

Mean Checkpilot Ratings of Non-Photographed Portion of AI Checkride, by Group and Class

Group	Class	Mean	*N*	SD
Zero-Hour	66-15	2.97	11	.34
	66-17	3.00	15	.43
	66-19	2.93	11	.29
	Total	2.97	37	.36
Ten-Hour	66-15	3.00	10	.43
	66-17	3.03	9	.44
	66-19	2.84	12	.22
	Total	2.95	31	.36
Twenty-Hour	66-15	2.92	11	.54
	66-17	3.13	10	.37
	66-19	2.83	11	.34
	Total	2.95	32	.43

Table 7 contains the means of the overall grade for the non-photographed portion of the checkride. The mean grade for the Zero-Hour Group, all classes combined, was 2.97; for the Ten-Hour Group, 2.95; and for the Twenty-Hour Group, 2.95. Class by Training Condition analysis of variance of the data summarized in Table 7 also failed to yield significant F ratios.

Two of the task components listed in the checklist concerned communication procedures. The evaluation of the trainee's communication procedures was considered desirable in the present study, because one of the purposes of an instrument training device such as the 1-CA-1 is to provide practice in communication procedures per se. Although communication procedures may not receive the same emphasis in the Army's Tactical Instrument program as in its Standard Instrument program, training in communication procedures is given to O/WORWAC trainees in the training device. It has been assumed that this training resulted in a positive contribution to performance during flight.

[1]Where appropriate, the method of unweighted means was employed in the analyses of variance to account for unequal *N*s, as described by Winer (14).

Checkpilot ratings of the trainee's communication skills during the performance of a Standard ADF Approach or Ground Control Approach were also obtained from the checkride checklist. The ratings were made on the basis of the U, C, B, A scale, and numerical values were assigned to these letter grades in the manner previously described. Table 8 contains the means for the ratings of communication skills for each group during the GCA and Standard ADF tasks.

Class by Training Condition analysis of variance was performed on the data summarized in Table 8. None of the obtained F ratios was significant in this analysis.

Table 8

Mean Checkpilot Ratings of Communication Skills During GCA and ADF Approaches, by Group and Class

Group	Class	Mean	N	SD
Zero-Hour	66-15	2.95	11	.52
	66-17	2.93	14	.58
	66-19	2.96	12	.84
	Total	2.95	37	.64
Ten-Hour	66-15	2.90	10	.74
	66-17	3.06	8	.62
	66-19	2.77	11	.34
	Total	2.90	29	.57
Twenty-Hour	66-15	2.77	11	.61
	66-17	3.10	10	.57
	66-19	2.91	11	.38
	Total	2.92	32	.52

Checkride Grades

An overall grade was assigned by the examining checkpilot at the conclusion of each end-of-phase checkride during this study. These grades were assigned in accordance with procedures outlined for the assignment of checkride grades in the Uniform Flight Grading System (10), and the grading procedures were unrelated to the conduct of this research. Thus, they provided an independent, although subjective, evaluation of student performance for determining the effectiveness of the device training programs under study.

Checkride grades differ from daily flight grades in that passing checkride grades are numerical and range from 70 to 100, whereas passing daily flight grades are alphabetical and can have only the three values, A, B, or C. Unsatisfactory checkride and daily flight grades both are indicated by the letter U. For purposes of this summary, all U checkride grades were assigned a numerical value of 65.[1] Where more than one checkride was administered to a given WOC, as was the case when the first checkride was unsatisfactory, only the grade on the first checkride was used.

The checkpilot-assigned, end-of-phase checkride grade for each WOC was obtained from his flight record, and a Training Condition by Class (3 x 3) analysis of variance was performed on these grades. No significant F ratios were found in this analysis. The mean checkride grades for each group and class are shown in Table 9.

Table 9

Mean Checkride Grades, by Group and Class

Group	Class	Mean	N	SD
Zero-Hour	66-15	80.36	14	6.58
	66-17	78.59	17	8.44
	66-19	78.92	13	8.21
	Total	79.25	44	7.68
Ten-Hour	66-15	81.31	13	8.23
	66-17	83.27	11	6.15
	66-19	76.41	17	8.85
	Total	79.80	41	8.37
Twenty-Hour	66-15	80.16	19	7.54
	66-17	80.73	15	5.90
	66-19	76.69	16	8.64
	Total	79.22	50	7.54

[1]The number of U checkride grades involved in this analysis was three in Zero-Hour Group, five in Ten-Hour Group, and five in Twenty-Hour Group.

Other Performance Measures

The criterion of the effectiveness of tactical instrument training is trainee performance "in an actual or simulated environment."[1] Performance during the hypothetical tactical instrument checkride provided an opportunity to determine whether the criterion had been met. In addition to performance on the checkride per se, however, there are other measures of trainee performance that may be useful in the evaluation of experimental training programs such as those involved in the present research. Three of these measures are discussed below.

Table 10

Attrition During Tactical Instrument Training, by Group

Group	Number Entering Training	Number Eliminated		
		Total	Flight Deficiency	Other Reasons
Zero-Hour	48	4	4	0
Ten-Hour	46	5	3	2
Twenty-Hour	51	1	1	0

Attrition

Eliminations[2] that occurred during the Tactical Instrument Phase of the WORWAC are summarized in Table 10. The "Total" column indicates all WOCs who entered the Tactical Instrument Phase but failed to complete that phase with their class. The "Flight Deficiency" column includes only those WOCs who were eliminated for reasons connected with flight performance.

Four students were eliminated from the Zero-Hour Group for reasons of flight deficiency, while only one such elimination occurred in the Twenty-Hour Group. The largest difference in "Total" attrition occurs between the Ten-Hour Group, where five were eliminated, and the Twenty-Hour Group, where only one student was eliminated.

To test the significance of differences in attrition among the three groups, Fisher Exact Probability Tests were performed on the data in Table 10. This analysis indicated that none of the differences among groups in attrition for "Total," "Flight Deficiency," or "Other Reasons" was statistically significant.

Time to Checkride

Fifty hours of flight time are programed for the Tactical Instrument Phase of the O/WORWAC, and the end-of-phase checkride flight normally occurs during the last two hours of the phase. Minor deviations do occur; the better students tend to be put up for a checkride at the scheduled time or somewhat earlier, whereas the poorer students often require more flight time (sometimes more than the programed 50 hours) before their instructors feel they are ready for a checkride.

The amount of flight time recorded for each WOC prior to the end-of-phase checkride was extracted from his flight records. The mean time to checkride for each group, by WORWAC class, is indicated in Table 11. The highest mean time to checkride was 48.27 hours for the Zero-Hour Group, while the lowest was 47.59 hours for the Twenty-Hour Group. Training Condition by Class (3 x 3) analysis of variance of the data summarized in Table 11 yielded no significant $\underline{F}$ ratios.

[1] Paragraph 5a(3), AR 95-63 (8).

[2] All WOCs who were eliminated from their original WORWAC class are included in these figures. Some of these candidates were not eliminated from training, but were recycled to a later class in order to receive additional training. The seven WOCs eliminated from the Zero- and Ten-Hour Groups for flight deficiency subsequently completed the training phase.

Table 11

Mean Time to Checkride, by Group and Class

Group	Class	Mean	N	SD
Zero-Hour	66-15	47.77	14	1.42
	66-17	48.19	17	2.33
	66-19	48.92	13	3.75
	Total	48.27	44	2.61
Ten-Hour	66-15	47.67	13	1.19
	66-17	47.68	11	1.06
	66-19	48.22	17	2.69
	Total	47.90	41	1.92
Twenty-Hour	66-15	48.11	19	2.25
	66-17	46.77	15	1.14
	66-19	47.73	16	1.99
	Total	47.59	50	1.94

Table 12

Mean Daily Grades, by Group and Class

Group	Class	Mean	N	SD
Zero-Hour	66-15	2.92	14	.13
	66-17	2.86	17	.24
	66-19	2.82	13	.25
	Total	2.87	44	.22
Ten-Hour	66-15	2.90	13	.16
	66-17	2.86	11	.24
	66-19	2.73	17	.26
	Total	2.82	41	.24
Twenty-Hour	66-15	2.87	19	.23
	66-17	2.91	15	.14
	66-19	2.71	16	.24
	Total	2.83	50	.23

Daily Grades During Training

The mean instructor-assigned daily grades received by members of each experimental and control group by class during the Tactical Instrument Phase of their training are shown in Table 12. These data were derived in the manner described above for the evaluation of the non-photographed checkride tasks. The total number of graded flights during the Tactical Instrument Phase was used to derive a mean daily grade for each WOC. Daily grades received by WOCs eliminated from training are not included.

The mean daily grade for all subjects in the Zero-Hour Group was 2.87; for the Ten-Hour Group, 2.82; and for the Twenty-Hour Group, 2.83. Training Condition by Class analysis of variance of these data failed to yield a significant F ratio for Training Condition or for the interaction term. The F ratio for Class was significant ($F=5.43$, $p < .01$). The significant F ratio for Class reflects the previously noted variation in flight training across classes. It is unrelated to the experimental device training under consideration.

DISCUSSION

The objective of the research was to determine the extent to which skills acquired during synthetic device training in the Tactical Instrument Phase of the O/WORWAC enhanced subsequent trainee performance in a simulated tactical environment. The procedure employed was to compare the performance on a criterion check flight of trainees who had received synthetic device training, in addition to inflight training, with the performance of a similar group who had received inflight training only. In such research, the contribution of the synthetic device training program may be measured by determining the extent to which the performance of the device-trained group exceeds the performance of the non-device-trained group on the criterion test.

In the present research, little evidence could be found to indicate that aircraft control or procedural skills acquired in the device did transfer to the tactical instrument situation. There were 96 objectively recorded measures of aircraft control and procedural tasks obtained during a standardized criterion checkride. Statistically significant differences among the experimental and control groups occurred on only three of these measures. When only the groups receiving 20 and zero hours of device training were compared, one additional statistically significant difference was found.

The fact that the experimental and control groups differed significantly on four (out of 96) measures of their criterion checkride performance can reasonably be attributed to chance. To attribute the difference to any other cause would not be justified. The fact that the direction of the differences between the two groups was divided is further evidence of the probable chance nature of these differences. The Zero-Hour Group, the group receiving no device training, was superior on three of the parameters, while the Twenty-Hour Group was superior on the fourth.

When the same error rates by group data on each parameter were combined for similar maneuvers, 47 measures of performance were available for analysis.[1] In these analyses, two group differences were significant at the .05 level, one favoring the Zero-Hour Group, the other favoring the Twenty-Hour Group. This outcome also reasonably may be attributed to chance factors.

The emphasis in this research has been placed on the data recorded through photographic techniques. This emphasis is the result of the difficulties discussed elsewhere (11, 12) of obtaining statistically reliable measures of trainee performance where reliance is placed on subjective checkpilot evaluations. The present research did, however, take advantage of the availability of instructor evaluations of the performance of trainees. Further, additional ratings were obtained from the checkpilots—using evaluation procedures they used routinely and in which they were presumably skilled—that provided evaluations of trainee performance independent of the photographically recorded performance. The results of analyses of these checkpilot-provided evaluations tended to confirm the analyses of the objectively recorded data: No statistically significant differences among groups were obtained in any of the analyses of checkpilot-provided evaluations. Similar analyses of data obtained from instructor pilots during the training of the WOCs involved in this research also failed to reveal differences among groups during the course of training.

A question might reasonably be raised as to whether the present research used the appropriate criteria in evaluating the effectiveness of device training. The criteria used were of two kinds only: skill in control of the aircraft under simulated tactical instrument conditions; and adherence to required navigation, communication, and aircraft maneuvering procedures. No attempt was made to measure such factors as the attitudes of trainees toward instrument flying, which, conceivably, could have been influenced by device training or the level of effort required of instructor pilots as a function of WOC training received in the 1-CA-1. However, any such benefits that might have been realized were not reflected in grades during training, time-to-criterion performance, criterion performance itself, or attrition from flight training.

The only reasonable conclusion from this research was that no reliable evidence was found to support the assumption that synthetic device training administered in the modified 1-CA-1 trainer during the O/WORWAC improves subsequent aviator performance in a tactical instrument situation. Although it is conceivable that performance not evaluated in the present research would support the assumed importance of the synthetic training program, it is unlikely that its practical significance would exceed that of the criterion specified in

[1]The data were combined as described to determine whether the lack of significant differences among groups could be attributed to unreliability of the individual measures. Such was not found to be the case.

paragraph 5a(3), AR 95-63 for the objective of tactical instrument flight training—to "pilot an Army helicopter under instrument conditions only in an actual or simulated tactical environment using the normal facilities available in the combat zone" (8).

It should be emphasized that the research described was a determination of the transfer of training value of a synthetic training program rather than of a synthetic training device. Prophet (2) has pointed out that a training device is a tool and, as such, it is going to produce no results better than the quality of the training program of which it is a part. Without further exploration, the lack of evidence of transfer in the present study must be attributed to the program rather than to any part of it. It is possible, for example, that if the present 1-CA-1 device were used differently—that is, in a different program—some evidence of beneficial transfer might be found.

Research is currently under way to study ways to increase the effectiveness of the synthetic training given in the Tactical Instrument Training program. This research includes a stimulus-response comparison of the requirements of inflight criterion performance with the characteristics of the synthetic device used in tactical instrument training. Preliminary results suggest that the synthetic task, as presently structured, bears little psychological resemblance to the criterion task. Further, the physical limitations of the locally modified 1-CA-1 training device—the device used in the programs under study—are such that little or no gain in transfer of skills to the criterion situation can be expected to result from modifications to the present synthetic training program.

LITERATURE CITED
AND
APPENDICES

LITERATURE CITED

1. Society of Automotive Engineers. Conference Proceedings, Third International Simulation and Training Conference, New York, April 1967.

2. Prophet, Wallace W. *The Importance of Training Requirements Information in the Design and Use of Aviation Training Devices*, HumRRO Professional Paper 8-66, October 1966.

3. Danneskiold, Rex D., and Johnson, LCDR Woodbury. *An Evaluation of an Experimental Flight Grading Method for Use in the Naval Air Basic Training Command*, Joint Research Report, The Psychological Corporation and the U.S. Naval School of Aviation Medicine, Bureau of Medicine and Surgery Research Project Number NM 001 658.24, Report Number .03, Washington, August 1954.

4. Danneskiold, Rex D. *Objective Scoring Procedure for Operational Flight Trainer Performance*, Technical Report SPECDEVCEN 999-2-4, The Psychological Corporation and the U.S. Navy Special Devices Center Project 20-A-13, 1955.

5. Flexman, Ralph E., Matheny, W.G., and Brown, E.L. "Evaluation of the School Link and Special Methods of Instruction in a Ten-Hour Private Pilot Flight Training Program," *Aeronautical Bull.*, No. 8, The Institute of Aviation, University of Illinois, Urbana, 1950.

6. Pomarolli, Richard S. *The Effectiveness of the Naval Air Basic Instrument Trainer*, Special Report 65-7, U.S. Naval Aerospace Medical Institute, U.S. Naval Aviation Medical Center, Pensacola, Fla., November 1965.

7. Federal Aviation Administration. *Visual Flight Rules*, FAA Regulations, Section 91.105, General Operating and Flight Rules.

8. Department of the Army. *Army Aviation Instrument Training Program*, Army Regulation No. 95-63, February 1966.

9. Kaplan, Harry. *Prediction of Success in Army Aviation Training*, Technical Research Report 1142, U.S. Army Personnel Research Office, Office of the Chief of Research and Development, Department of the Army, Washington, June 1965.

10. U.S. Army Aviation School. *Education and Training*, USAAVNS Regulation 350-16, June 1967.

11. Caro, Paul W., Jr. *Flight Evaluation Procedures and Quality Control of Training*, HumRRO Technical Report 68-3, March 1968.

12. Greer, George D., Jr., Smith, Wayne D., and Hatfield, CPT Jimmy L. *Improving Flight Proficiency Evaluation in Army Helicopter Pilot Training*, HumRRO Technical Report 77, May 1962.

13. Duffy, John O., and Colgan, Carroll M. *A System of Flight Training Quality Control and Its Application to Helicopter Training*, HumRRO Consulting Report, June 1963.

14. Winer, B.J. *Statistical Principles in Experimental Design*, McGraw-Hill Book Company, New York, 1962, pp. 222-224.

Appendix A

TEN-HOUR EXPERIMENTAL SYLLABUS
SYNTHETIC R/W FLIGHT TRAINING FOR THE **WORWAC**

Period	Subject	Period Time	Cumulativ Time
1	1. Orientation & Familiarization	02:00	02:00
	2. Explanation of Instruments		
	3. ADF (Standard)		
	a. Orientation		
	b. Tracking		
	c. Station Identification & Passage		
	d. Voice Procedures		
2	2. ADF (Standard)	02:00	04:00
	a. Time & Distance		
	b. Interception		
	c. Holding		
	d. Reporting		
3	1. Orientation & Familiarization	02:00	06:00
	2. ADF (Tactical)		
	a. Orientation		
	b. Interception		
	c. Tracking		
	d. Holding		
4	ADF (Tactical)	02:00	08:00
	a. Holding		
	b. Approaches		
	c. Missed Approach		
5	Review ADF (Standard & Tactical)	02:00	10:00

Appendix B

PHOTOGRAPHIC RECORD OF FLIGHT PERFORMANCE

The Simulated Tactical Instrument Mission

Checkpilot Standardization

Twenty-four checkpilots were given special training for the conduct of the simulated tactical instrument mission. The special training consisted of a ground school briefing covering all aspects of the flight profile for the mission and the use of the camera equipment. Following the ground school, each checkpilot was given at least one standardization flight over the mission course. The ground school and the standardization flight were conducted by a member of the research staff, an ex-Army pilot with several thousand hours of military Instructor Pilot time.

Student Briefing and Flight Procedures

Prior to the start of each checkride, each WOC participating in this study was given an individual briefing covering the photographed portion of the checkride. All briefings were conducted by the checkpilots, who also served as the Flight Operations Center (FOC) controller for the checkride. The preflight briefing, the sequence of student activities, and the inflight clearances given to the students by the FOC are summarized below.

The following situation briefing was given:

> A friendly combat patrol has engaged the enemy at COORS 654485. Fighting has been heavy and the patrol has suffered some casualties. Two casualties are serious and need to be evacuated to the rear. In addition, the patrol needs rifle ammunition and grenades.
>
> The patrol leader has selected a landing area at COORS 653484, has set up his portable homing beacon at that location, and has requested resupply and evacuation of his wounded by helicopter.
>
> Your mission is to fly ammunition in to the patrol, pick up the two wounded and transport them to the Surgical Hospital at COORS 656472. GCA is available and operating at the latter coordinates for approach purposes.
>
> Weather conditions here and at the hospital area are ceiling 500 feet, overcast, visibility one-half mile. The patrol leader has estimated the weather at his location as ceiling 200 feet, overcast, visibility one-half mile. Light rain and fog are the obstructions to visibility. The local forecaster states that these conditions will remain the same until 1600 hours.
>
> The beacon at COORS 654485 has been assigned the identifier XCI, and will operate on 275 MCs. Call sign for contact is "River Control."
>
> The GCA at COORS 656472 is operating on 304.6 MCs. Call sign is "Headland GCA."

After the student completes his flight planning he goes to the aircraft, hovers to the takeoff pad, makes his instrument check and requests a clearance. The checkpilot, acting as FOC, gives the following clearance:[1]

[1]The material printed in capital letters was read to the trainee by the checkpilot at the appropriate time during the checkride. The other material constituted administrative instructions to the checkpilot.

FOC CLEARS ARMY COPTER___[1] TO RIVER BEACON VIA 070° MAGNETIC COURSE. MAINTAIN 2500 FEET. INTERSECT THE 070° MC ON A HEADING OF 360°. REPORT TO RIVER CONTROL WHEN ESTABLISHED ON 070° MC TO RIVER BEACON.

Student copies, reads back clearance, and requests takeoff clearance from the tower.

Student takes off when cleared by tower and climbs out on a 360° heading. When the student intercepts the 070° MC, the checkpilot turns camera on. After the student establishes himself on the 070° MC and reports inbound to River Beacon, the checkpilot issues the following clearance:

ARMY COPTER___, THIS IS RIVER CONTROL. CEILING ESTIMATED 200 FEET, VISIBILITY ONE-HALF MILE, WIND ENE 8. APPROACH AXIS 070°, HOLD, EXPECT APPROACH CLEARANCE AT___. FIELD ELEVATION 500 FEET, NO OBSTACLES.

Just prior to student's completing one holding pattern, the checkpilot clears him for an approach:

ARMY COPTER___IS CLEARED FOR AN APPROACH, START DESCENT AT THE BEACON.

The student should report missed approach at minimums over the Beacon and request clearance to his alternate, Headland. The checkpilot then issues the following clearance:

ARMY COPTER___IS CLEARED TO HEADLAND VIA THE 170° BEARING FROM RIVER. MAINTAIN 1500 FEET. TURN RIGHT TO 205° HEADING, MAINTAIN 205° UNTIL INTERCEPTING 170° BEARING.

The checkpilot allows the student to track outbound on 170° bearing for five minutes, then turns the camera off. This concludes the photographed portion of the checkride.

Film Scoring Procedures

The simulated tactical instrument mission was divided into 12 separate but consecutive film segments for scoring purposes. Each segment represented a single flight maneuver (e.g., a Level Turn) or a known point in space (e.g., a Station Passage). The 12 segments are identified in Table B-1.

Figure B-1 is a diagram of the Figure 8 Pattern taught in the Tactical Instrument Training Program. Upon arrival at the radio beacon the student began holding, using the Figure 8 Pattern, and completed one full circuit around it before receiving final approach clearance. The descent to minimum

Table B-1

Segment Lengths, Frames Scored, and Sampling Rate for Each Segment/Maneuver

Segment	Maneuver	Length in Frames of Film	Number of Frames Scored	Sampling Rate (Percent)
1	Inbound Tracking	225	23	10
2	Station Passage	1	1	100
3	Level Turn	70	14	20
4	Station Passage	1	1	100
5	Level Turn	70	14	20
6	Station Passage	1	1	100
7	Descending Turn	70	14	20
8	Station Passage	1	1	100
9	Descending Turn	70	14	20
10	Station Passage	1	1	100
11	Straight Climb	50	10	20
12	Outbound Tracking	225	23	10

[1]The checkpilot inserted aircraft numbers and time into the clearances as appropriate.

The Figure 8 Holding Pattern

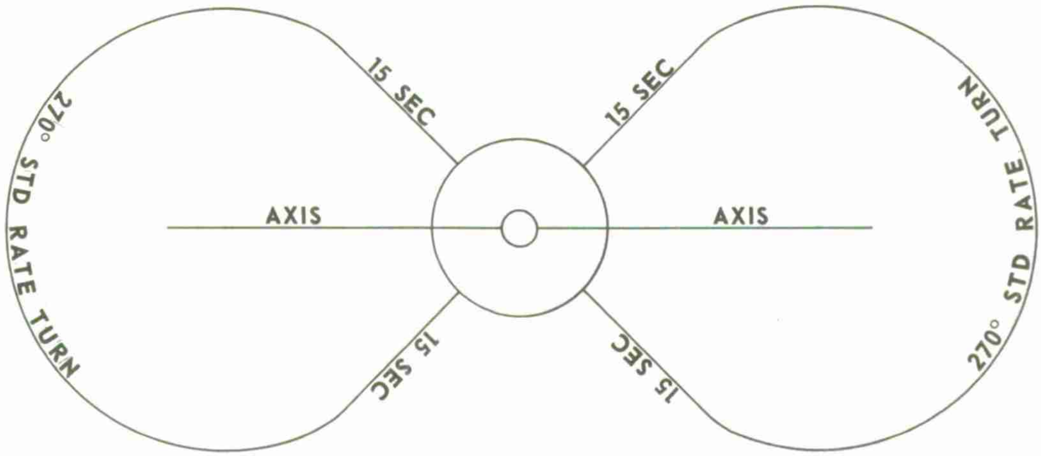

Figure B-1

altitude was also done in the Figure 8 Pattern. The performance of WOCs during execution of portions of this pattern was scored during both holding and approach. These portions are identified in Table B-1 as Segments 2 through 10. The straight and level portions of the pattern were not scored because performance measures of straight and level flight were available from the inbound (Segment 1) and outbound (Segment 12) tracking portions of the mission. Segment 11 was the climb to altitude following execution of the missed approach. Each Station Passage was treated as a segment, since it served to verify the position of the aircraft in relation to the pattern being flown.

The camera system exposed one frame of film every 1.35 seconds (or approximately 45 frames per minute) and the time required to complete each maneuver under standard conditions was translated into frames of film. For example, five minutes of tracking would yield approximately 225 frames of film. Preliminary investigation revealed, however, that it was unnecessary and impractical to score each of the 225 frames when a sample of them would yield essentially the same results. Therefore, sampling rates were arbitrarily chosen for each film segment and are shown in Table B-1. The higher sampling rates for Turns and Straight Climb reflect the fact that the instrument readings are changing relatively more rapidly during these maneuvers and the maneuvers themselves are of shorter duration.

The films were scored by a specially trained three-man team of observers—a projectionist and two scorers—whose roles were interchangeable to minimize eyestrain and monotony. The projectionist's task was to load the projector, identify each segment on the film, and select the appropriate frames to be scored.

To assist in the identification of each film segment, the following guidelines were employed: Inbound Track consisted of the 225 frames of film immediately preceding the first Station Passage. Station Passage was defined as that frame in which the ADF pointer was closest to 90° off the nose on its downward swing (an event that occurred whenever the aircraft passed directly over the beacon). Turns began at "roll-in" and ended at "roll-out"; Straight Climb began when manifold pressure was increased to a climb setting and ended when 1500 feet of altitude had been reached; Outbound Track consisted of the 225 frames following interception of the 170° radial from River Beacon.

A frame counter, mounted on the projector, was used to identify specific frames to be scored. Frames were selected by using different lists of computer-generated random numbers prepared for each segment of each film. For example, as shown in Table B-1, 23 randomly selected, but consecutively ordered, frame numbers from 1 to 225 were used in scoring the Inbound Track segment. The frame counter was reset to zero at the start of each segment, and numbers from the appropriate list were used to identify the scorable frames.

The scorers were seated side by side approximately six feet from the viewing screen and independently recorded their observations on specially prepared data sheets. Differences between scorers and questions of procedure were resolved by a member of the research staff who was an FAA-rated rotary wing instructor, an ex-Army pilot with several thousand hours of military Instructor Pilot time.

The observations recorded on the score sheet were of two types, one reflecting procedural errors and the other reflecting the WOC's ability to control the aircraft within the tolerance levels established by AR 95-63. Procedural errors were such things as improper turns, descents below established minimum altitudes, interception and/or tracking of the wrong radial, and other deviations from the standardized mission profile. Aircraft control errors were recorded when the student was observed to be outside the tolerance levels established for each panel instrument scored. The frequency of a given error, within segments, was not recorded. The standards and tolerance levels established for each film segment are shown in Table B-2.

As indicated in Table B-2, the tolerances set for a given parameter were generally constant throughout the flight and reflected current USAAVNS training

Table B-2

Aircraft Control Standards and Tolerance Levels Established for Each Flight Segment

Parameter	Flight Segment[a]	Standard	Tolerance Level
Airspeed	1-10, 12	60 knots	± 10 knots
	11	50 knots	± 10 knots
Pitch	1-12	horizon bar on artificial horizon	1 bar width above or below
Bank	1, 2, 4, 6, 8, 10-12	0	± 5°
	3, 5, 7, 9	10°	± 5°
Altitude	1-6	2500′	± 100′
	8	1500′	± 100′
	10	700′[b]	± 100′
	12	1500′	± 100′
RPM	1-12	3200	± 100
ADF	1	070°	± 10°
	12	170°	± 10°
Heading	11	205°	± 10°
Vertical Speed	1-6, 12	0	± 200
	7-11	500′	± 200′
Trim	1-12	ball centered	½ ball out

[a]See Table B-1 for Segment identification.

[b]Descent below 700′ on Segment #10 constituted an automatic procedural error for "busting minimums."

objectives. For instance, the airspeed tolerance was always plus or minus 10 knots; however, the standards to which these tolerances applied varied with the requirements of the particular maneuver being flown. In the case of airspeed, the standard was 60 knots for all portions of the flight except Straight Climb. The airspeed during Straight Climb was 50 knots.

Consideration was always given to the overall task the student was performing. For example, Student X, while tracking inbound to the radio beacon at an assigned altitude of 2500 feet, might allow his altitude to drop below 2400 feet. Realizing this, he would probably add sufficient power to regain the lost altitude, and this action would register a climb on the vertical speed indicator. In such cases, the event of "less than 2400 feet" of altitude would be recorded as an altitude error but the event of "more than 200 fpm vertical speed" would not constitute an error until the corrective action had been completed. If, however, the student continued his climb beyond 2500 feet while exceeding the vertical speed tolerance, a vertical speed error would be recorded.

Appendix C

CHECKLIST RECORD OF FLIGHT PERFORMANCE

CHECKPILOT'S CHECK FLIGHT CHECKLIST ECHO III

Student: WOC ______________________ Date: ______________

Checkpilot: ______________________ A/C No.: ______________

WORWAC Class No.: ______________________ Section: ______________

Approximate Time of Take-off: ______________ Landing: ______________

Weather at Hanchey Field:

At beginning of check flight:

Wind direction: __________; velocity: __________ knots

Turbulence: none __________; light __________; moderate __________

At end of check flight:

Wind direction: __________; velocity: __________ knots

Turbulence: none __________; light __________; moderate __________

Student's Tension:

None apparent __________; moderately tense __________; very tense __________

Checkpilot comments on photographed portion of the flight:

____

____

____

____

____

____

Checkpilot rating of tasks not photographed (circle grade to indicate A, B, C, or U performance; omit any item not included in the checkride):

Recovery from unusual attitudes:

power correction	A	B	C	U
attitude correction	A	B	C	U
altitude control	A	B	C	U

Autorotation:

attitude control	A	B	C	U
airspeed control	A	B	C	U
pedal usage	A	B	C	U
RPM control	A	B	C	U

Standard ADF approach:

tracking inbound	A	B	C	U
holding pattern entry	A	B	C	U
holding	A	B	C	U
procedure turn	A	B	C	U
approach to field	A	B	C	U
missed approach	A	B	C	U
communication procedures	A	B	C	U

Ground Control approach:

communication procedures	A	B	C	U
glide slope control	A	B	C	U
center line control	A	B	C	U
airspeed control	A	B	C	U

Checkpilot comments:

Table C-1

Mean Checkpilot Ratings of Recovery From Unusual Attitude, by Group and Class

Group	Class	Mean	*N*	SD
Zero-Hour	66-15	3.12	11	.58
	66-17	3.05	14	.49
	66-19	2.93	9	.36
	Total	3.04	34	.48
Ten-Hour	66-15	3.10	10	.22
	66-17	3.05	7	.13
	66-19	2.85	9	.34
	Total	3.00	26	.27
Twenty-Hour	66-15	2.88	11	.73
	66-17	3.21	8	.40
	66-19	3.11	6	.27
	Total	3.04	25	.56

Table C-2

Mean Checkpilot Ratings of Autorotation, by Group and Class

Group	Class	Mean	*N*	SD
Zero-Hour	66-15	3.07	11	.52
	66-17	3.16	14	.65
	66-19	3.02	10	.38
	Total	3.09	35	.53
Ten-Hour	66-15	3.07	9	.49
	66-17	3.06	9	.53
	66-19	2.91	11	.42
	Total	3.01	29	.47
Twenty-Hour	66-15	2.98	10	.43
	66-17	3.18	10	.49
	66-19	2.75	6	.32
	Total	2.98	26	.45

Table C-3

Mean Checkpilot Ratings of Standard ADF Approach, by Group and Class

Group	Class	Mean	*N*	SD
Zero-Hour	66-15	2.82	11	.47
	66-17	2.89	15	.50
	66-19	2.77	12	.54
	Total	2.83	38	.49
Ten-Hour	66-15	2.78	10	.55
	66-17	2.95	8	.45
	66-19	2.76	12	.39
	Total	2.81	30	.46
Twenty-Hour	66-15	2.97	11	.67
	66-17	3.01	10	.36
	66-19	2.76	12	.44
	Total	2.91	33	.50

Table C-4

Mean Checkpilot Ratings of Ground Control Approach (GCA), by Group and Class

Group	Class	Mean	*N*	SD
Zero-Hour	66-15	3.02	10	.43
	66-17	3.03	15	.71
	66-19	3.08	12	.34
	Total	3.05	37	.53
Ten-Hour	66-15	3.35	10	.67
	66-17	3.14	9	.65
	66-19	2.83	13	.41
	Total	3.08	32	.60
Twenty-Hour	66-15	2.93	11	.64
	66-17	3.15	10	.49
	66-19	2.77	13	.46
	Total	2.93	34	.54

Appendix D

GROUP ERROR RATES AND OBTAINED CHI SQUARES FOR EACH PARAMETER, BY FLIGHT SEGMENT[a]

Parameter	Group Error Rate (Percent)			Chi Square
	Zero-Hour	Ten-Hour	Twenty-Hour	
		Segment 1 – Inbound Tracking		
A/S	10	11	10	.03
Bnk	5	11	0	2.34
RPM	38	39	32	.26
Hdg	NA	NA	NA	NA
Trim	5	0	0	1.79
Pitch	71	56	63	1.06
Alt	38	44	37	.26
ADF	19	22	37	1.83
V/S	29	33	32	.11
PE	0	5	0	2.14
		Segment 2 – Station Passage 1		
A/S	5	10	0	2.28
Bnk	0	0	0	—
RPM	5	16	10	1.35
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	14	21	25	.75
Alt	10	10	10	.00
ADF	NA	NA	NA	NA
V/S	5	16	15	1.50
PE	24	5	15	2.69
		Segment 3 – Level Turn 1		
A/S	30	6	10	4.85
Bnk	30	28	21	.43
RPM	45	50	10	7.65*
Hdg	NA	NA	NA	NA
Trim	5	0	0	1.88
Pitch	80	83	95	1.90
Alt	55	44	37	1.31
ADF	NA	NA	NA	NA
V/S	40	17	26	2.60
PE	15	0	5	3.40
		Segment 4 – Station Passage 2		
A/S	0	0	10	4.15
Bnk	0	0	0	—
RPM	15	11	10	.21
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	20	17	37	2.38

(Continued)

Appendix D (*Continued*)

Parameter	Group Error Rate (Percent)			Chi Square
	Zero-Hour	Ten-Hour	Twenty-Hour	
Segment 4 – Station Passage 2 (Continued)				
Alt	20	17	32	1.31
ADF	NA	NA	NA	NA
V/S	10	0	5	1.90
PE	15	6	21	1.86
Segment 5 – Level Turn 2				
A/S	5	18	16	1.63
Bnk	20	35	10	3.31
RPM	45	35	37	.43
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	70	59	79	1.72
Alt	25	29	42	1.39
ADF	NA	NA	NA	NA
V/S	30	18	26	.77
PE	20	12	16	.46
Segment 6 – Station Passage 3				
A/S	5	6	5	.04
Bnk	0	0	0	—
RPM	15	38	10	4.68
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	25	6	20	2.23
Alt	15	25	30	1.30
ADF	NA	NA	NA	NA
V/S	20	6	10	1.71
PE	15	38	20	2.70
Segment 7 – Descending Turn 1				
A/S	5	25	30	4.65
Bnk	29	38	15	2.41
RPM	52	38	50	.89
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	71	81	75	.48
Alt	NA	NA	NA	NA
ADF	NA	NA	NA	NA
V/S	52	50	65	1.00
PE	24	0	20	4.28
Segment 8 – Station Passage 4 – Low Station Altitude				
A/S	0	0	5	1.88
Bnk	16	11	5	1.21
RPM	26	33	25	.37
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	21	39	20	2.15
Alt	53	33	60	2.84
ADF	NA	NA	NA	NA
V/S	5	11	10	.45
PE	5	6	30	6.51*

(*Continued*)

Appendix D (*Continued*)

Parameter	Group Error Rate (Percent)			Chi Square
	Zero-Hour	Ten-Hour	Twenty-Hour	
	Segment 9 – Descending Turn 2			
A/S	10	10	16	.42
Bnk	10	21	16	1.03
RPM	57	58	63	.17
Hdg	NA	NA	NA	NA
Trim	0	5	0	2.14
Pitch	71	84	79	.96
Alt	NA	NA	NA	NA
ADF	NA	NA	NA	NA
V/S	48	68	63	1.96
PE	10	10	10	.00
	Segment 10 Station Passage 5 – Missed Approach			
A/S	5	5	10	.54
Bnk	5	10	5	.67
RPM	24	21	20	.09
Hdg	NA	NA	NA	NA
Trim	0	5	0	2.19
Pitch	48	26	35	1.99
Alt	5	21	20	2.66
ADF	NA	NA	NA	NA
V/S	0	0	10	4.14
PE	5	16	15	1.50
	Segment 11 – Straight Climb			
A/S	0	20	16	3.93
Bnk	0	0	0	—
RPM	26	40	26	.96
Hdg	10	7	10	.19
Trim	0	7	0	2.58
Pitch	90	80	79	.88
Alt	NA	NA	NA	NA
ADF	NA	NA	NA	NA
V/S	42	53	58	1.00
PE	0	7	5	1.21
	Segment 12 – Outbound Tracking			
A/S	0	19	17	3.44
Bnk	6	0	6	.95
RPM	53	69	56	.97
Hdg	NA	NA	NA	NA
Trim	0	0	0	—
Pitch	82	69	83	1.30
Alt	24	25	61	6.78*
ADF	18	25	22	.27
V/S	35	38	67	4.31
PE	12	25	11	1.53

[a]*indicates Chi Square for which $p < .05$.

Appendix E

GROUP ERROR RATES AND OBTAINED CHI SQUARES FOR EACH PARAMETER, BY TASK[a]

Parameter	Group Error Rate (Percent)			Chi Square
	Zero-Hour	Ten-Hour	Twenty-Hour	
Tracking to and From a Radio Beacon (Segments 1 and 12)				
A/S	10	21	30	2.70
Bnk	10	16	5	1.27
RPM	57	79	65	2.17
Trim	5	0	0	1.89
Pitch	86	95	95	1.50
Alt	43	53	65	2.02
ADF	29	37	50	3.98
V/S	43	53	70	3.06
PE	14	37	10	5.05
Station Passage (Segments 2, 4, 6, 8, and 10)				
A/S	14	16	20	.26
Bnk	19	21	10	.99
RPM	48	68	55	1.79
Trim	0	5	0	2.19
Pitch	67	63	80	1.59
Alt	67	58	85	3.58
V/S	24	32	45	2.11
PE	48	47	55	.30
Level Turns (Segments 3 and 5)				
A/S	35	22	20	1.35
Bnk	40	50	30	1.58
RPM	70	61	35	5.32
Trim	5	0	0	1.93
Pitch	100	83	95	1.82
Alt	65	50	50	1.19
V/S	55	28	45	2.91
PE	30	11	15	2.51
Descending Turns (Segments 7 and 9)				
A/S	10	26	30	2.88
Bnk	38	47	30	1.24
RPM	76	63	75	1.00
Trim	0	5	0	2.19
Pitch	90	95	95	.42
V/S	67	68	80	1.04
PE	29	10	25	2.11

(Continued)

Appendix E *(Continued)*

Parameter	Group Error Rate (Percent)			Chi Square
	Zero-Hour	Ten-Hour	Twenty-Hour	
	Climbs and Descents (Segments 7, 9, and 11)			
A/S	10	37	40	5.68
Bnk	38	53	30	2.13
RPM	76	63	80	1.55
Trim	0	5	0	2.19
Pitch	95	100	100	1.89
V/S	76	84	80	.40
PE	29	16	25	.96
	All Flight Segments Combined			
A/S	42.8	63.2	60.0	1.96
Bnk	71.4	89.5	40.0	11.06*
RPM	90.5	89.5	95.0	.45
Pitch	100.0	100.0	100.0	NA
Alt	90.5	73.7	90.0	2.79
ADF	28.6	31.6	50.0	2.33
Hdg	26.3	6.7	10.5	.19
V/S	90.5	94.7	85.0	1.03
Trim	9.5	5.3	0	1.96
PE	61.9	57.9	70.0	.64

[a]*indicates $p < .05$.

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13. ABSTRACT

The objective was to determine the training value of synthetic instrument flight training given in the Tactical Instrument Phase of the Army's Officer/Warrant Officer Rotary Wing Aviator Course. Synthetic training in that course is administered in a modified fixed wing instrument training device. One group of trainees received the standard 20-hour synthetic instrument flight training program, a second group received 10 hours, and a third group received no synthetic training. The synthetic training given in the modified fixed wing training device did not increase trainee helicopter instrument flight proficiency in terms of aircraft control and procedural skills. In addition, there were no significant differences among the three groups in attrition, instructor-assigned daily grades, amount of flight instructional time required to complete the phase, and final checkride grades.

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1	CO ARMY TRANS RES COMD FT EUSTIS ATTN TECH LIB
1	CG US ARMY AD COMD ENT AFB ATTN ADGCB
6	CG 1ST ARMY FT GEORGE G MEADE
1	CG 3RD US ARMY FT MCPHERSON GA
1	CG FOURTH ARMY FT SAM HOUSTON ATTN G3
7	CG FIFTH ARMY FT SHERIDAN ATTN ALFGC TNG
1	CG SIXTH ARMY PRES OF SAN FRAN ATTN AMAAV
1	CG EUSA ATTN AG-AC APO 96301 SAN FRAN
1	CLIN PSYCHOL SERV DEPT OF NEUROPSYCHIAT WALTER REED GEN HOSP
1	DIR HEL APG MD
1	CG USA CDC EXPERIMENTATION COMD FT ORD
2	ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1	TECH LIB ARMY NATICK LABS NATICK MASS
1	CO USA CDC INST OF LAND CBT FT BELVOIR
1	REDSTONE SCIENTIFIC INFO CTR US ARMYMSL COMD ATTN CHF DOC SEC ALA
1	CO USAPA MBLTY DET TOBYHANNA ARMY DEPOT
1	CG ARMY ELEC PG FT HUACHUCA ATTN TECH LIB
12	CO 1ST AIR DEF GUIDED MSL BRGD TNG FT BLISS
2	CG US ARMY CDC EXPERIMENTATION COMD FT ORD
1	SIXTH U S ARMY LIB DEPOT BLDG M 13 14 PRES OF SAN
1	PLANS OFFICER PSYCH HDQTRS USACDCECFORT ORD
5	CG FT ORD ATTN G3 TNG DIV
1	DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR
2	DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1	CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1	DPTY FOR BIOASTRONAUT PG AIR PG CTR EGLIN AFB
1	CO USA MOBILITY EQUIP RED CTR ATTN TECH DOC CTR FT. BELVOIR
1	CO FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
1	CG 5TH RGN USARADCOM ATTN G3 TNG GUNTER AFB ALA
3	6TH RGN USARADCOM FT BAKER
1	4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
1	PERS SUBSYS DIV CREW SUBSYS DRCT AERONAUT SYS DIV WRIGHT-PATTERSON AFB
1	DIR ARMY BD FOR AVN ACCIDENT RES FT RUCKER
2	CO PICATINNY ARSNL DOVER N J ATTN SUMPA VCI
1	DEF SUPPLY AGY CAMERON STATION ATTN LIB
1	CO ARMY CBT DEVEL COMD FT BENJ HARRISON ATTN ADJ GEN AGY
1	REF M MS IS MASA ALA
1	CBT OPNS RES GP CDC FT BELVOIR ATTN SR OPRS ANLS HUMAN FACTORS
1	CO ARMY CDC INF AGY FT BENNING
1	CO ARMY CDC ARMOR AGY FT KNOX
8	ARMY CDC SPEC WARFARE AGY FT BRAGG
1	EVAL DIV OAD ARMY SIG CTR + SCH FT MONMOUTH
1	CO US ARMY CDC AVN AGCY FT RUCKER
1	CHF CURRICULUM BR RESIDENT INSTR DEPT ARMY LOGISTICS MANGT CTR FT LEE
3	CO ARMY CBT DEVEL COMD CBT SUPPORT GP
2	CIVLN PERS OFCR US ARMY SPT CTR ST LOUIS ATTN EMPLOYEE DEVEL OFCR
3	LIB ARMY WAR COLL CARLISLE BKS
1	COMDT COMD + GEN STAFF CO FT LEAVENWORTH ATTN ARCHIVES
1	DIR OF MILIT PSYCHOL + LDRSHP US MILIT ACAD WEST POINT
1	US MILIT ACAD WEST POINT ATTN LIB
1	COMDT ARMY AVN SCH FT RUCKER ATTN SCH LIB
2	COMDT ARMY SECUR AGY TNG CTR + SCH FT DEVENS ATTN LIB
1	COMDT ARMED FORCES INDSTR COLL FT LESLEY J MCNAIR
2	COMDT NATL WAR COLL FT LESLEY J MCNAIR ATTN CLASSF RECORDS BR LIB
1	MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON ATTN STIMSON LIB
3	DIR OF INSTR ARMOR SCH FT KNOX
1	COMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1	COMDT ARMY CHAPLAIN SCH FT HAMILTON
1	COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1	ARMY FINANCE SCH FT BENJ HARRISON
4	COMDT ARMY ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ADV
1	EDUC ADV USAIS ATTN AJIIS-H FT BENNING
1	DIR OF INSTR USAIS ATTN AJIIS-D-EPRD FT BENNING
1	HQ US ARMY ADJ GEN SCH FT BENJ HARRISON ATT COMDT
1	LIB ARMY QM SCH FT LEE
1	COMDT ARMY QM SCH FT LEE ATTN EDUC ADV
1	COMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1	CO USA SEC AGY TNG CTR & SCH ATTN IATEV RSCH ADV FT DEVENS
1	COMDT ARMY MILIT POLICE SCH FT GORDON ATTN DIR OF INSTR
2	COMDT US ARMY SOUTHEASTERN SIG SCH ATTN: EDUC ADVISOR FT GORDON
1	COMDT USA AD SCH FT BLISS
1	CG ARMY ORD CTR + SCH ABERDEEN PG ATTN AISD-SL
5	ASST COMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LIB
10	CG ARMY ARTY + MSL CTR FT SILL ATTN AVN OFFR
1	COMDT ARMY DEF INTEL SCH ATTN SI+AS DEPT
1	COMDT ARMED FORCES STAFF COLL NORFOLK
1	COMDT ARMY SIG SCH FT MONMOUTH ATTN EDUC COORD
1	COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1	DPTY COMDT USA AVN SCH ELEMENT GA
1	DPTY ASST COMDT USA AVN SCH ELEMENT GA
1	USA AVN SCH ELEMENT OFC OF DIR OF INSTR ATTN EDUC ADV GA
1	EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6	COMDT ARMY ENGNR SCH FT BELVOIR ATTN AIBBES-SY
2	COMDT US ARMY SCH EUROPE ATTN REF LIB APO 09172 NY
1	CHF POLICY + TNG LIT DIV ARMY ARMOR SCH FT KNOX
1	COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
1	COMDT ARMY PRIMY HEL SCH FT WOLTERS
1	DIR US MIL ACAD WEST POINT
1	DIR OF MILIT INSTR US MILIT ACAD WEST POINT
1	SPEC WARFARE SCH LIB FT BRAGG
4	USA SPEC WARFARE SCH ATT: COUNTERINSURGENCY DEPT FT BRAGG
1	ARMY SIG CTR + SCH FT MONMOUTH ATTN TNG LIT DIV OAO
2	SECY US ARMY MSL & MUNITIONS CTR & SCH REDSTONE ARSNL
2	COMDT WOMENS ARMY CORPS SCH + CTR FT MCCLELLAN
2	HQ ABERDEEN PG ATTN TECH LIB
1	COMDT US ARMY INTEL SCH FT HOLABIRD
1	COMDT ARMY QM SCH OFC DIR OF NONRESID ACTVY FT LEE ATTN TNG MEDIA
2	DIR BRGD + BN OPNS DEPT USAIS FT BENNING
1	DIR COMM ELEC USAIS FT BENNING
1	DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
2	DIR COMPANY TACTICS DEPT USAIS FT BENNING
1	CG US ARMY SIGNAL CTR & SCH ATTN SIGDTL-3 (COBET II)
1	SECY OF ARMY, PENTAGON
1	DCS-PERS DA ATTN CHF C+S DIV
1	DIR OF PERS STUDIES + RES DOCSPER DA ATTN BG WALLACE L CLEMENT
1	CO FOREIGN SCI + TECH CTR MUN BLDG
2	ACS FOR FORCE DEVEL DA ATTN CHF TNG DIV
1	CG USA MAT COMD ATTN AMCRD-TE
1	CHF OF ENGNRS DA ATTN ENGTE-T
1	HQ ARMY MAT COMD R+D DRCTE ATTN AMCRD-RC
2	CG ARMY MED R+D COMD ATTN BEHAV SCI RES BR
1	US ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN: CRD-AR
1	DPD PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) OPOMD
1	ARMY PROVOST MARSHAL GEN
1	DIR CIVIL AFFAIRS DRCTE ODCSOPS
1	OFC RESERVE COMPON DA
2	CHF ARMY SECUR AGY ARLINGTON HALL STA ATTN AC OF S G1
50	ADMIN DDC ATTN: TCA (HEALY) CAMERON STA ALEX., VA. 22314
1	CO US ARMY MED RES LAB FT KNOX
1	CG ARMY ELECT COMD FT MONMOUTH ATTN AMSEL CB
1	CHF OF R+D DA ATTN CHF TECH + INDSTR LIAISON OFC
2	CG ARMY MED R+D COMD ATTN MEDDH-SR
1	U S ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN CRD-AIC
1	COMDT ARMY CBT SURVEIL SCH FT HUACHUCA ATTN ATSUR S3
2	TNG + DEVEL DIV ODCS-PERS
1	CO US ARMY MAT COMD WASH D.C. ATTN: AMCPT-CM RDBT OETIENNE
1	PRES ARMY ARMOR BD FT KNOX
1	PRES ARMY MAINT BD FT KNOX
2	PRES ARMY AVN TEST BD FT RUCKER
2	PRES ARMY ARTY BD FT SILL
1	DPTY PRES ARMY MAT COMD BD ABERDEEN PG
1	CO ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1	US ARMY ARCTIC TEST CTR R & D OFFICE SEATTLE
1	CG 2D ARMORED DIV FT HOOD ATTN DIV AVN OFCR
6	CG 4TH ARMORED DIV APO 09326 NY
4	CO 2D ARMORED CAV REGT APO 09696 NY
1	CO 3D ARMORED CAV REGT APO 09034 NY
1	CO 14TH ARMORED CAV REGT APO 09026 NY
2	CG ARMY ARMOR & ARTY FIRING CTR FT STEWART ATTN AC OF S TNG OFCR
1	1ST ARMORED DIV HQ & HQ CO FT HOOD ATTN AC OF S G2
10	1ST INF DIV 1ST MED TANK BN 63D ARMOR FT RILEY
4	3D INF DIV 1ST BN 64TH ARMOR APO 09036 NY
2	1ST TANK BN 73D ARMOR 7TH INF DIV APO 96207 SAN FRAN
8	8TH INF DIV 2D BN 68TH ARMOR APO 09034 NY
1	CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV (SPEARHEAD) APO 09039 NY
1	CO 5TH BN 33D ARMOR FT KNOX
1	CO 3D MED TANK BN 37TH ARMOR APO 09066 NY
2	CO 2D BN 34TH ARMOR APO 96266 SAN FRAN
2	CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF SG3
1	55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
4	CO 150TH AVN BN NJ AIR NG ELIZABETH
1	CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1	TEXAS NG 49TH ARMORED DIV DALLAS
1	CG ARMY ARMOR CTR FT KNOX ATTN G3 AIBKGT
2	CG 1ST INF DIV ATTN G3 APO 96345 SAN FRAN
1	CG 3RD INF DIV ATTN G3 NY
3	CG 4TH INF DIV ATTN G3 APO 96262 SAN FRAN
1	CG 7TH INF DIV ATTN G2 APO 96207 SAN FRAN
1	CG 8TH INF DIV ATTN G2 APO 09111 NY
1	CG 5TH INF DIV (MECH) FT CARSON
5	CG 24TH INF DIV ATTN G3 FT RILEY
3	CG 82D ABN INF DIV FT BRAGG ATTN G3
1	CO 197TH INF BRGD FT BENNING ATTN S3
1	CO 1ST BN (REINF) 3D INF (THE OLD GUARD) FT MYER
1	CO HQ 2D BN 6TH INF REGT APO 09742 NY
7	CO 3D BN 6TH INF REGT APO 09742 NY
1	CO 171ST INF BRGD APO 98731 SEATTLE
3	CG 25TH INF DIV APO 96225 SAN FRAN
1	CO 3D BN 39TH INF APO 09029 NY
1	CO 1ST BN 39TH INF APO 09034 NY
1	CO 2ND BN 15TH INF NY ATTN S 3
4	CO 1ST BN (MECH) 52D INF 1ST ARMORED DIV (OLD IRONSIDES) FT HOOD
4	4TH BN (MECH) 54TH INF FT KNOX
1	CO ARMY PARTIC GP NAV TNG DEVICE CTR PT WASHINGTON ATTN CODE 01A
2	CONSOL RES GP 7TH PSYOP GP APO 96248 SAN FRAN
2	DA OFC OF ASST CHF OF STAFF FOR COMM-ELCT ATTN CETS-6 WASH
1	CHF MED RES PROJ ARMY HOSP US MILIT ACAD WEST POINT
1	CG MILIT DIST OF WASHINGTON
1	DIR ARMY LIB PENTAGON
1	STRATEGIC PLANNING GP CORPS OF ENGNR ARMY MAP SERV
1	CHF OF MILIT HIST DA ATTN GEN REF BR
1	CO 24TH ARTY GP (AD) COVENTRY
1	CG 31ST ARTY BRGD AIR DEF OAKDALE PENNA
1	49TH ARTY GP AIR DEF FT LAWTON
2	HQ 4/59TH ARTY REGT NORFOLK
1	28TH ARTY GP AIR DEF SELFRIDGE AFB
1	52D ARTY BRGD AD FT HANCOCK
1	HQ 45TH ARTY BRGD AIR DEF ARLINGTON HTS ILL
1	35TH ARTY BRGD AIR DEF FT GEO G MEADE
1	CG 101ST ABN DIV FT CAMPBELL
1	CG 1ST CAV DIV APO 96490 SAN FRAN
1	US ARMY GEN EQUIP ATTN TECH LIB FT LEE
1	US ARMY TROPIC TEST CTR PO DRAWER 942 ATTN BEHAV SCIENTIST FT CLAYTON
2	CINC US PACIFIC FLT FPO 96614 SAN FRAN
1	CINC US ATLANTIC FLT CODE 312A NORFOLK ATTN LTC DOTY
1	CINC PACIFIC OPNS ANLS SECT FPO 96610 SAN FRAN
1	COR TNG COMMAND US PACIFIC FLT SAN DIEGO
1	CHF BUR OF MED + SURG DN ATTN CODE 513
1	HEAD CLIN PSYCHOL SECT PROFESNL DIV BUR OF MED + SURG DN
5	TECH LIB PERS 11B BUR OF NAV PERS ARL ANNEX
3	DIR PERS RES DIV BUR OF NAV PERS
1	TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1	HUMAN FACTORS BR PSYCHOL RES DIV ONR
1	ENGNR PSYCHOL BR ONR CODE 455 ATTN ASST HEAD WASH DC
3	CO + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1	CO FLT ANTI-AIR WARFARE TNG SAN DIEGO

1 CO NUCLEAR WEAPONS TNG CTR PACIEIC U S NAV AIR STA SAN DIEGO
1 CD NAV AIR DEVEL CTR JOHNSVILLE PENNA ATTN NADC LIB
2 FLT ANTI-AIR WARFARE TNG CTR DAM NECK VA BEACH
2 CO FLT TNG CTR NAV BASE NEWPORT
2 CO FLT TNG CTR NOREOLK
1 CO FLFET TNG CTR U S NAV STA SAN DIEGO
1 CLIN PSYCHOL MENTAL HYGIENF UNIT US NAV ACAD ANNAPOLIS
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
2 CO + DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NOREOLK
2 CO FLT SONAR SCH KEY WEST
1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAV RES ATTN SPEC ASST EOR R & D
1 CHF OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
1 CHF OF NAV RES ATTN HFAD GP PSYCHOL BR CODE 452
1 DIR US NAV RES LAB ATTN CODE 5120
5 CO DEF OF NAV RFS BR OFFICE BOX 39 FPO D9510 NY
1 CHF OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CO NAV SCH DE AVN MED NAV AVN MED CTR PENSACOLA
1 CO MED FLD RES LAB CAMP LEJEUNE
1 CDR NAV MSL CTR POINT MUGU CALIE ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
2 OIC NAV PERS RFS ACTVY SAN DIEGO
1 NAV NEUROPSYCHIAT RFS UNIT SAN DIEGO
2 CDR NAV MSL CTR CODE 5342 POINT NUGU CALIF
1 DIR PERS RES LAB NAV PERS PROGRAN SUPPORT ACTIVITY WASH NAV YD
1 NAV TNG PERS CTR NAV STA NAV YD ANNEX CODE B3 ATTN LIB WASH
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ NARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR NARINE CORPS SCH QUANTICO
1 DIR NARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV OPNS OP-01P1
1 CHE OF NAV OPNS OP-D3T
1 CHF OF NAV OPNS OP-0TT2
2 COMDT HQS 8TH NAV DIST ATTN EDUC ADV NEW ORLEANS
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OE NAV OPS OP03EG
2 COMDT PTP COAST GUARD HQ
1 CHF OFCR PERS RES + REVIEW BR COAST GUARD HQ
1 OPNS ANLS DEC HQ STRATEGIC AIR COMD OFEUTT AFB
1 AIR TNG CDMD RANDOLPH AFB ATTN ATETM
1 CHE SCI DIV ORCTE SCI + TECH DCS R+D HQ AIR EORCE AERSTA
1 CHF SPEC WARFARE DIV ORCTE OF PLANS + OPNS DCS-PLANS+OPNS HQ AIR FORCE
1 CHF OF PERS RES BR ORCTE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF ANAL DIV 1AFPDPL (R1 DIR OF PERSONNEL PLANNING HQS USAF
1 AFSC-STLO (RTSAWI CD DEPT OF THE NAVY
1 FAA CHF INFD RETRIEVAL BR WASH D.C.
1 FED AVN AGY MED LIB HQ-64D
1 HQ AFSC SCBB ANDREWS AFB
2 CDR ELEC TYS DIV L G HANSCOM FLD BEDEDRD MASS ATTN ESRHA
1 HQ SAMSO (SMSIR) AF UNIT POST OFC LA AFS CALIF
2 MILIT TNG CTR OPE LACKLAND AFB
2 657DTH AERO NED RES LAB MRPT WRIGHT-PATTERSON AFB
1 AIR NOVEMENT DESIGNATOR AMRH BRDOKS AFB
1 HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
4 HQ AIR TRANS CDMD ATCTO-N RANDOLPH AFB
1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTI
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
1 AIR FORCE SCH OF AEROSPACE MED BRDDKS AFB ATTN AEROMED LIB
1 DIR OF LIB US AIR FORCE ACAD
1 COMDT DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 COMDT ATTN LIB DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 657DTH PERS RES LAB PRA-4 AEROSPACE NED DIV LACKLAND AFB
1 TECH TNG CTR (LNTC/OP-1-L1I LOWRY AFB
2 AF HUMAN RESOURCES LAR MRHTD WRIGHT-PATTERSON AFB
2 CO HUMAN RFSOURCFS LAB BRDOKS AFB
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR NATL SECUR AGY FT GFO G MEADE ATTN TDL
1 DIR NATL SECUR AGY FT GEO G NFADE ATTN DIR OF TNG
5 CIA ATTN OCR/ADD STANDARD DIST
1 SYS EVAL DIV RES DIRECTORATE DDD-OCD PENTAGON
1 DEPT DF STATF BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF MGT & GEN TNG DIV TR 200 EAA WASH DC
1 BUR DE RES & ENGR US POST OFC DEPI ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR DE DFPT DE HEW ATTN T O CLEMENS
1 DFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC
1 SYS DEVEL CORP SANTA MDNICA ATTN LIB
2 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RESEARCH ANALYSIS CORP MCLEAN VA 22101
1 RAND CORP WASHINGTON ATTN LIB
1 DIR RAND CORP SANTA NONICA ATTN LIB
1 U OF ILL GP EEFECTIVE RFS LAB
2 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 U DE PGH LEARNING R+D CTR ATTN DIR
1 HUMAN SCI RES INC NORFOLK
1 WESTERN ELECTRIC CD INC NY
1 HUMAN SCI RES INC MCLFAN VA
2 TECH INFO CTR ENGNR DATA SFRV N AMER AVN INC COLUMBUS C
1 CHRYSLER CORP MSL DIV DFTROIT ATTN TECH INFO CTR
1 RAYTHEON CD ELEC SFRV OPNS BURLTNGTON MASS
2 EDUC & TNG CONSULTANTS ATTN L C SILVERN LA
1 GEN DYNAMICS PDMONA DIV ATTN LIB DIV CALIF
1 AVN SAFETY ENGR & RES DIV OF FLIGHT SAFETY EOUND INC PHOENIX
2 NARQUARDT CORP POMDNA CALIF ATTN DFPT 58D
1 OTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 CHF PERS SUBSYS AIRPLANE DIV NS 74-9D RENTON WASH
1 THIOKOL CHEM CORP HUMETRICS DIV LOS ANGELES ATTN LIBN
2 CTR FOR RES IN SOCIAL SYS FLD DEC FT BRAGG
1 INST FOR DEE ANLS RES + ENGNR SUPPORT DIV WASHINGTON
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 R M STOGDILL OHIO STATE UNIV
1 EDITOR TNG RES ABSTR AMER SOC OF ING DIRS U OF TENN
1 U DE CHICAGO DEPT OF SOC
1 HUMAN EACTORS SECT R+D GEN DYNAMICS ELECTRIC BOAT GROTON
1 CTR FOR RES IN SDCIAL SYS AMER U
6 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GSD2 TNG
2 CANADIAN LIAISON OFCR ARMY ARMOR BD FT KNOX
1 GERMAN LIAISON OFCR ARMY AVN TEST BD FT RUCKER
3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
1 ARMY ATTACHE ROYAL SWEDISH EMBSY WASHINGTON
1 NATL INST FOR ALCOHOL RES OSLO
1 DEE RES NED LAB ONTARID
2 FRENCH LIAISON OFCR ARMY AVN TEST BD FT RUCKER
1 BRITISH LIAISON DFCR ARMY AVN TEST BD ET RUCKER
1 DEC OF AIR ATTACHE AUSTRALIAN FMBSY ATTN: T.A. NAVGN WASH, D.C.
1 YORK U DEPT OF PSYCHOL
2 AUSTRALIAN ENBSY OFC DF MILIT ATTACHE WASHINGTON
2 U OF SHEFFIELD DEPT OF PSYCHOL
1 MENNINGER FOUNDATION TOPEKA
2 AMER INST FOR RES SILVER SPRING
1 ANER INST FOR RES PGH ATTN LIBN
1 DIR PRIMATE LAB UNIV OF WIS MADISON
1 COLUNBIA U SCH OF BUS
3 MATRIX CORP ALEXANDRIA ATTN TECH LIBN
1 AMER TEL+TEL CD NY
1 U OE GEORGIA DEPT DE PSYCHOL
1 DR GEORGE T HAUTY CHNN DEPT DE PSYOLU OF DEL
1 GEN ELECTRIC CO SANTA BARBARA ATTN LIB
1 VITRO LABS SILVER SPRING MD ATTN LIBN
1 HEAD DEPT DE PSYCHOL UNIV OF SC COLUMBIA
1 TENN VALLEY AUTHORITY ATTN CHF LABOR RELATIONS BR DIV DF PERSONNEL KNOXVILLE
1 U OF GEORGIA DEPT DE PSYCHOL
1 U DE UTAH DEPT DE PSYCHOL
1 GE CO WASH D C
1 AMER INST FOR RES PALO ALTO CALIE
1 MICH STATE U COLL DF SOC SCI
1 N MEX STATE U
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 NORTRDNICS DIV OF NORTHROP CORP ANAHEIM CALIF
1 OHIO STATE U SCH OF AVN
1 AIRCRAFT ARMAMFNTS INC COCKEYSVILLE MD
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 TUFTS U HUMAN FNGNR INFO + ANLS PROJ
1 HUMAN EACTORS RES GP WASH U ST LOUIS
1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 BELL TEL LABS INC TECH INFD LIB WHIPPANY LAB NJ ATTN TECH REPORTS LIBN
1 ENGNR LIB FAIRCHILD HILLER REPUBLIC AVN DIV FARMINGDALE N Y
1 WASHINGTON ENGNR SERV CO INC KENSINGTON MD
1 LIFE SCI INC FT WORTH ATTN PRES
1 AMER BEHAV SCI CALIF
2 DIR INSTR RESOURCES STATE COLL ST CLOUD MINN
1 COLL OF WM + NARY SCH DF EDUC
1 SO ILLINOIS U DEPT DE PSYCHOL
2 COMMUNICABLE DISEASE CTR DEVFL + CONSULTATION SERV SECT ATLANTA
2 WASH MILITARY SYS DIV BETHESDA MD
1 NORTHWESTERN U DEPT OF INDSTR ENGNR
1 HONEYWELL ORD STA MAIL STA 8D6 MINN
1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 AEROSPACE SAFETY DIV U DE SOUTHERN CALIE LA
1 MR BRANDON B SMITH RES ASSDC U DE MINN
1 CTR FOR THE ADVANCED STUDY DE EDUC ADMIN ATTN IDNE PIERRON U DF OREG
1 A A HEYL ASSDC DIR CAREL WASH DC
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GFN LIB DOCU DEPT
1 ELORIDA STATE U LIB GIFTS + EXCH
1 HARVARD U PSYCHOL LABS LIB
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U DE NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PFRIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 U OF NINNESOTA LIB
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL DH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U DF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
2 DIR U LIB GEO WASHINGTON U
2 LIB OF CONGRESS CHE OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U EARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 U DF LOUISVILLE LIB BELKNAP CAMPUS
1 G E RYAN JAYCOPTERS LTD N Y
1 SYS ENGR GROUP RSCH & TECH DIV AFSC WRIGHT-PATTERSON AFB
1 S GRYDE TNG COORDINATOR HONEYWELL INC W COVINA CALIF
1 M E EASTER SCH OF AVN OHIO STATE UNIV AIRPORT COLUMBUS
1 R E FLEXMAN DIR OF ADVANCED TNG REQUIREMENTS LINK PRECISION CO N Y
1 W B BDNEY ONR NAV TNG DEVICE CTR FLA
1 H KERBER LIFE SCI RSCH DEPT GOODYEAR AFRDSPACF CD OHIO
1 E HALL MELPAR ARL VA
1 D E NEYER OPERATOR TNG BR TNG RSCH DIV BEHAVIDRAL SCI LAB WRIGHT-PATTERSON AFB
1 CO NAV TNG DEVICE CEN ATTN CODE 55 FLA
1 J CURTIN HUMAN FACTORS DEPT MACDONNELL-DOUGLAS CORP MO
1 J GROSSLIGHT HEAD DEPT OF PSYCH FLA STATE UNIV TALLAHASSEE
1 G B POTTER DIR AVN SAFETY DIV UNIV OF S CALIF LA
1 DFC OF SURGEON GEN ATTN AVN SEC DEPT OF ARMY WASH D C
1 USA TRANS RSCH COMD ATTN F NCCOURT FT EUSTIS VA
1 R A MDNTY CORNELL AERONAUTICAL LAB INC P O BOX 235 BUEEALD
1 LEARNING RESOURCES CEN U OF TENN KNOXVILLE
1 L W CURETON SCH OF EDUC U OF TENN KNOXVILLE

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