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AUTHOR	Caro, Paul W.; And Others
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ABSTRACT

Two studies were conducted to evaluate a fixed-wing instrument procedures training device and to develop a training program for use with it. In the first, a group of trainees who received synthetic instrument flight training with the new device were compared with a control group who did not. Men trained with the device performed more satisfactorily than the control group. The second study concerned development and evaluation of an instrument flight training program designed for use with the new device. Results showed a 40 percent reduction in flight hours required to attain twin-engine transition and instrument flight objectives. It appears that concepts used in developing the program using the device apply to other flight training courses and other programs utilizing training devices. The research was performed by HumRRO Division 6, Aviation, Fort Rucker, Alabama, under Work Unit SYNTRAIN II. (Author/MS)

Technical Report 73-20

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HumRRO

Research on Synthetic Training: Device Evaluation and Training Program Development

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

HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street • Alexandria, Virginia 22314

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September 1973

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DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
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October 2, 1973

DARD-ARS-B

SUBJECT: "Research on Synthetic Training: Device Evaluation and Training Program Development" Work Unit SYNTRAIN II

1. This report presents the results of two studies conducted to evaluate a new fixed wing instrument procedures training device and to develop a training program for use with the device.

2. In the first study, the performance of students who received synthetic instrument flight training in the device was compared with that of students who did not receive synthetic training. The device-trained students were found to be superior during their early training, but this advantage tended to decrease as training continued--perhaps because the study used the existing training program, only slightly modified, rather than a new program developed especially for the device. In addition, certain deficiencies noted in the device itself were probably contributing factors. The second study concentrated on developing and evaluating a training program tailored to the requirements of the new device. Results indicated a 40% reduction in the number of flight hours needed to attain the twin-engine transition and instrument flight objectives of the course, and a considerable decrease in training costs.

3. This report will be of interest to those concerned with the development and evaluation of training devices and their associated training programs.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

R. O. VITERNA
Colonel, GS
Chief, Behavioral
Sciences Office

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The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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FOREWORD

This report describes an experimental evaluation of an off-the-shelf fixed wing instrument procedures trainer and the methodology and concepts employed in the development of a new training program for use with the device. The Human Resources Research Organization performed this research from 1969 to 1971, under Work Unit SYNTRAIN, Modernization of Synthetic Training in Army Aviation.

An interim report of this activity was delivered to the Aviation School in September 1969; the present report supersedes the interim report and presents additional findings. Related publications in the SYNTRAIN series are: *Device-Task Fidelity and Transfer of Training: Aircraft Cockpit Procedures Training*, HumRRO Technical Report 70-10; *An Innovative Instrument Flight Training Program*, HumRRO Professional Paper 16-71; and *Determining Training Device Requirements in Fixed Wing Aviator Training*, HumRRO Technical Report 72-11.

Work Unit SYNTRAIN is a part of the device research program of HumRRO Division No. 6 (Aviation) at Fort Rucker, Alabama. Dr. Wallace W. Prophet is Director of the Division, and Dr. Paul W. Caro is in charge of training-device research for the Division.

Military support for the study was provided by the U.S. Army Aviation Human Research Unit, Fort Rucker, Alabama. LTC Robert O. Carter is the Unit Chief.

Identification of proprietary products in this report is for purposes of research documentation. It does not, in itself, constitute an official endorsement by either HumRRO or the Department of the Army.

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Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

At the time of this research, most of the fixed wing synthetic flight training devices being used by the Army were obsolete and not optimally suited to existing training requirements. In addition, significant advances in aviation training technologies have been made that have not yet been applied to Army aviation fixed wing device training programs. A HumRRO research program (Work Unit SYNTRAIN) was established to (a) identify requirements for fixed wing synthetic flight training devices, (b) develop training programs incorporating modern training technology for use with devices procured to meet those requirements, and (c) evaluate such programs and devices.

A device was procured by the Army to meet a particular fixed wing training requirement identified during an earlier SYNTRAIN study. An experimental evaluation of that device was needed, and was undertaken in SYNTRAIN Sub-Unit II.

RESEARCH PROBLEM

Study One of the present research was an experimental determination of transfer of training between a new, off-the-shelf, twin-engine, synthetic instrument flight training device and the T-42 aircraft in which twin-engine transition and instrument training were conducted in the Officer/Warrant Officer Fixed Wing Aviator Course (O/WOFWAC) at the U.S. Army Aviation School. Trainees who received synthetic instrument flight training in the new twin-engine device were compared with other trainees who did not receive synthetic training. The difference in inflight performance between groups, if any, would be indicative of the training contribution of the new device and the synthetic training program current at that time.

Study Two of the research concerned the development and evaluation of a new instrument flight training program designed especially for use with the new device.

In order to provide data that the Army required in conjunction with decisions concerning procurement of additional devices, it was necessary to evaluate the device before developing an appropriate training program for use with it. The decision could not wait for the training program to be developed and tested. Thus, an opportunity was provided to determine empirically the value of a training device under two circumstances: with a training program suitable for use with an existing device (a common practice when new devices are introduced), and with a training program designed specifically for use with the new device.

APPROACH

Study One

Prior to the instrument training phase, 20 trainees were randomly selected from the rosters of each of the two FY 69 O/WOFWAC classes and assigned to one of two groups. One of these groups received no synthetic device training and served as the control group for this study. The experimental group received approximately 20 hours of synthetic instruction in the new device. The device training that was given to the experimental group consisted of a modification of an existing program developed for training devices then in use by the Army in the fixed wing training program under study.

Measures of the relative performance of the two groups on the end-of-stage check rides routinely administered to all O/WOFWAC students constituted the major criterion for determining transfer of training between the new synthetic device and the aircraft. Other criteria employed were attrition from flight training, daily grades during flight training, time to check ride, check ride grade, and specifically designed check pilot checklists and instructor pilot questionnaires.

Study Two

Largely a development activity, Study Two consisted of the administration of experimental training packages to small groups of trainees, revision of these packages, and the development of a training program based upon experience with them. Deliberate effort was made during program development activities to employ modern training concepts. The program thus developed was tested experimentally to determine the extent to which training with it (in the new device) could be substituted for training in the T-42 aircraft.

RESULTS

Study One

Trainees who received training in the new device, when compared with the control group trainees, tended to perform in a more satisfactory manner. During early periods of training, their attrition rate was lower and they were more likely to be above-average students, according to their flight instructors' ratings. During the Stage 1 check rides, their performance of procedural tasks tended to be superior when evaluated subjectively by check pilots as well as when scored objectively from photographic records of the check ride.

Study Two

The initial administration of the training program developed in Study Two of this research resulted in a 40% reduction in the number of flight hours required to attain the twin-engine transition and instrument flight objectives of the course under study. Use of the new program in a similar course produced comparable results.

CONCLUSIONS

The following conclusions were reached as a result of this research:

(1) The new device can contribute to the effectiveness of twin-engine transition and instrument training.

(2) When the device is used with a training program employing modern training concepts, significant savings to the Army in inflight training time can be obtained.

(3) From the transfer-of-training standpoint, the training program used with a device is perhaps more important than the device itself.

(4) The training concepts employed in the new training program developed during this research have application to other flight training courses for both fixed and rotary wing aircraft.

CONTENTS

Research on Synthetic Training: Device Evaluation and Training Program Development

INTRODUCTION

Instrument flight training devices, perhaps the most common type of synthetic flight training equipment, 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 fixed wing instrument training courses. Their contribution to flight training efficiency is generally recognized.

The value of any flight training equipment must, however, be determined within the context of a training requirement. The mere 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 a particular training application and the appropriateness of the manner in which it is used (1, 2). When training requirements change, as they often do when missions change or when new aircraft enter the inventory, the synthetic training devices in use and their associated training programs must be reevaluated to assure their continued effectiveness.

During FY 67, significant changes were made in flight training programs at the U.S. Army Aviation School. One of these was the adoption of the T-42 (Baron) as the principal instrument training aircraft (Figure 1). The use of a new instrument training aircraft, particularly since it was a twin- instead of a single-engine aircraft, made it necessary to revise objectives of all instrument training programs to include, among other things, objectives related to twin-engine transition training.

T-42 (Baron) Aircraft

Figure 1

At that time, the Army's most modern fixed wing instrument training device was Device 2B12A, which is shown in Figure 2. The training requirement, which resulted in the eventual development of the 2B12A, was stated originally in 1957, and the proposed device was intended for use during the 1960-1965 time frame. Device 2B12A has no twin-engine simulation capability and no cockpit motion. Its aerodynamics and engine simulation are limited, and its cockpit and sound characteristics do not correspond, even approximately, to those of the new instrument training aircraft. In spite of these limitations, Device 2B12A was the best available for synthetic instrument training at the Aviation School.

Instrument Panel of 2B12A Trainer

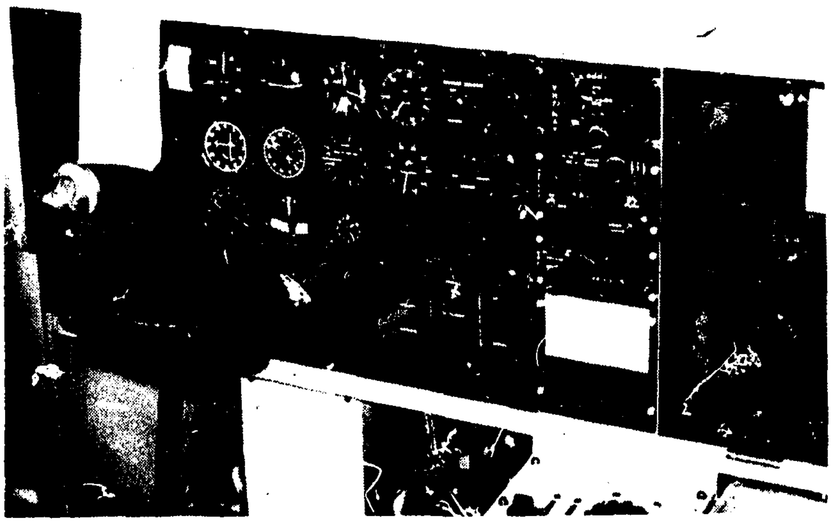

Figure 2

Also during FY 67, the Army added the U-21 aircraft to its inventory, and a U-21 pilot transition training program was instituted at the Aviation School shortly thereafter. No existing Army training devices were suitable for use for U-21 pilot training, and a device was not procured with the aircraft. Consequently, it was necessary, at least temporarily, to conduct all U-21 transition training in the aircraft itself.

The Aviation School, in August 1967, expressed concern over the efficiency of its fixed wing training capability with respect to the introduction of these new aircraft. Aviation School personnel expressed the belief that training devices offer great potential for reducing training costs and upgrading the quality of flight instruction. HumRRO was asked to review the existing fixed wing training programs, and to identify areas where training might be improved through more efficient use of synthetic training equipment.

The requested study was undertaken during the second quarter of FY 68, and its conclusions have been reported in a HumRRO report, *Determining Training Device Requirements in Fixed Wing Aviator Training* (3). The present report describes additional work requested by the Aviation School as a result of conclusions of the earlier study concerning the need for new synthetic training equipment for use in conjunction with instrument training in the T-42 aircraft.

The conclusions of the earlier study concerning instrument training were based upon a detailed review of the requirement for instrument training, the features of the newly introduced training aircraft, and the characteristics of existing military as well as commercially available training devices. During that review, the assumed inadequacies of Device 2B12A were confirmed, and information was developed about a soon-to-be-available commercial device that appeared to have potential for use in twin-engine transition and instrument flight training. Subsequently, the Army contracted with the manufacturer to acquire two of these devices[1] for evaluation, and requested HumRRO to provide technical assistance in a determination of their training value to the Army and to develop training programs for use with them. (Interior and exterior views of the new device are shown in Figures 3 and 4.)

This report describes HumRRO's activities in response to the Aviation School's request for assistance in an evaluation of the new device, and for development of training programs for use with it. The Aviation School requested that development of training programs not delay an initial evaluation of the device, however, since the evaluative data were needed in connection with a decision concerning procurement of additional copies of the device. Consequently, two studies were undertaken. In the first, a transfer-of-training experiment was conducted to provide data for use by the Aviation School in its decisions concerning procurement of additional devices.

The second study consisted of a series of activities leading to development of a training program for use with the device. It should be noted that Studies One and Two are relatively independent. Completion of Study One was not a prerequisite to Study Two, although the familiarity with the equipment gained during Study One was of considerable value during the subsequent work.

At the time of this research, the Officer/Warrant Officer Fixed Wing Aviator Course (O/WOFWAC) at the Aviation School was graduating approximately 700 aviators each year.[2] This course was the Army's largest fixed wing training course, and it was the intent of the Aviation School to use the new device in that course. Consequently, that course became the setting for Study One and for most of Study Two.

The O/WOFWAC consisted of a four-phase flight training program. Phases I and II totaled approximately 100 hours of dual instruction and solo practice of basic and advanced contact flight training. This training was conducted at Fort Stewart, Georgia, in the T-41 aircraft.

Upon successful completion of Phases I and II, the trainee was transferred to the Aviation School at Fort Rucker, Alabama, where he received the third and fourth phases of O/WOFWAC training. Phase III, Twin-Engine Qualification and Instrument Training, lasted for eight weeks, and consisted of 60 hours of flight training in the T-42A aircraft and approximately 100 hours of academic (i.e., classroom) instruction, including 21-24 hours of synthetic instrument training in Device 2B12A.[3] The purpose of Phase III was to train enrollees for the award of an Army Instrument Card (Standard) in accordance with Federal Aviation Administration standards and applicable Army regulations, and to qualify the students in the twin-engine airplane.

[1] The new device referred to in this research is the General Aviation Trainer Model 2 (GAT-2) manufactured by Simulation Products Division, Singer Corporation. It is identified for research documentation purposes only, and its use or citation does not constitute an official endorsement or approval by either the Human Resources Research Organization or the Department of the Army. (Since this report was prepared, the new device has been type-classified by the Army and designated Device 2B30.)

[2] Further student inputs to the O/WOFWAC were suspended in October 1970.

[3] *In preparation for the instrument phase*, trainees received 12 hours of synthetic training in Device 1-CA-1 during Phase I and Phase II of the O/WOFWAC. This training was restricted to attitude instrument flying; no navigation procedures were included in the course.

Interior—The New Device

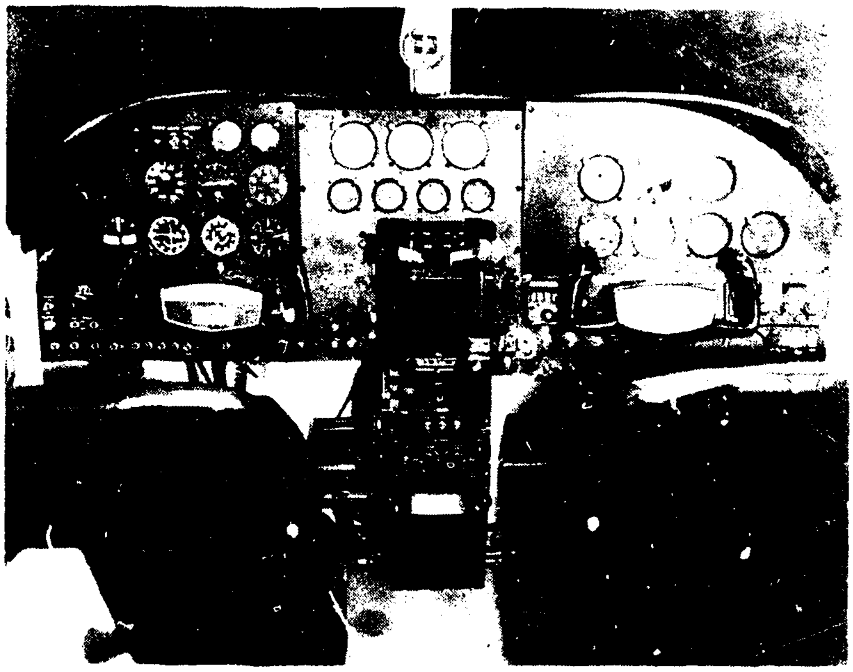

Figure 3

Exterior—The New Device

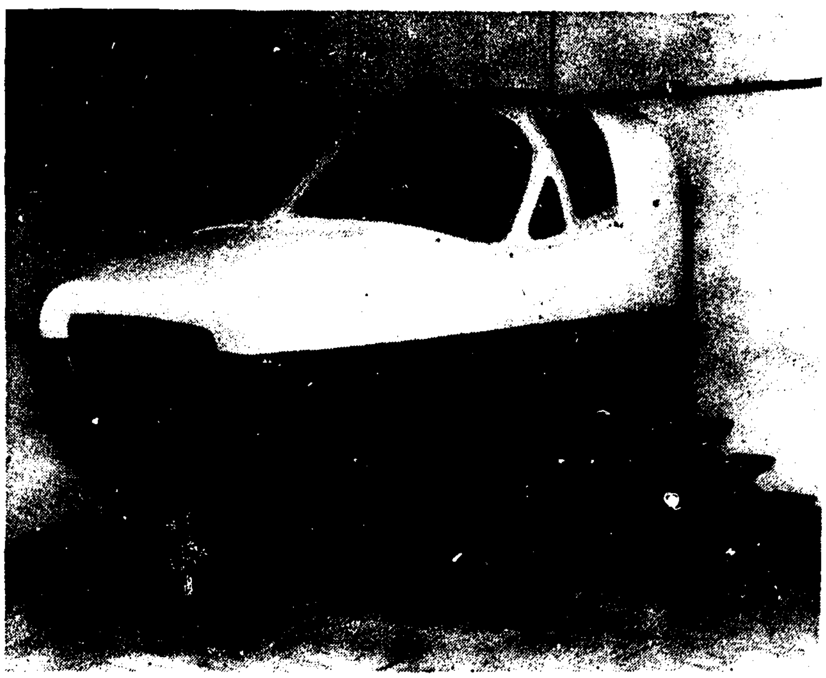

Figure 4

Phase III flight, academic, and synthetic training was conducted concurrently over the eight-week period by a civilian contractor. The 60 flight hours were divided into 10 hours of twin-engine transition training and 50 hours of dual instruction in instrument flying techniques. Two check rides were given in the Phase: the first, Stage 1, normally occurred during the fifth week of training (25-30 flight-hour level), and the second, Stage 2, occurred during the eighth week (55-60 flight-hour level) of training. Both check rides were conducted by check pilots assigned to a flight examiner group whose primary function was to evaluate the training provided by the civilian contractor.

Phase IV, Contact and Tactical Employment, was an eight-week phase in which students were trained in the use of Army fixed wing aircraft under tactical conditions and in the tactical employment of Army aviation. Phase IV flight training was conducted in the 0-1 "Bird Dog" airplane. Graduates of this phase were awarded aviator wings and were typically assigned either to operational units or to graduate level aviator courses at the Aviation School. Additional descriptive information concerning each phase of O/WOFWAC training has been reported by Caro *et al.* (3).

Study One

EVALUATION OF A TRAINING DEVICE USING AN EXISTING TRAINING PROGRAM

RESEARCH OBJECTIVE

This section of the report describes a transfer of training experiment conducted to determine the suitability of the GAT-2 for Army training. Information concerning the GAT-2 was developed during the earlier survey of the Aviation School's synthetic training device requirements (3). Information concerning the device suggested, on analytical grounds, that appropriate use of the GAT-2 would meet some of the Aviation School's requirement for a device for fixed wing instrument training. However, an empirical evaluation was needed to verify the new equipment's suitability for use in an operational flight-training program. Because of a need to make a decision as soon as possible concerning procurement of additional devices, time did not permit the development of a training program that would permit optimum use of the device. Consequently, it was necessary to adapt a training program being used with the 2B12A device for use during the evaluation of the GAT-2.

The objective of the suitability evaluation was to provide, as rapidly as possible, data for use by the Aviation School in its decisions concerning procurement of additional devices. The data were generated through the conduct of a transfer-of-training experiment that compared the flight performance of students trained in the new device using an existing training program with that of students who received no synthetic training.

METHOD

SUBJECTS

The trainees participating in this study were officers, warrant officers, or warrant officer candidates enrolled in two FY 69 O/WOFWAC classes (Classes 69-15/16 and 69-19/20). Prior to the beginning of Phase III, 20 trainees were randomly selected from the roster of each class and assigned to one of two groups, for a total of 40 trainees. The only restrictions placed on the selection procedure were that (a) trainees not have more than 50 hours flight experience prior to entering Phase I of the O/WOFWAC, and (b) trainees not have been recycled during their Phase I and Phase II flight training at Fort Stewart.

The remaining members of each class, excluding foreign nationals, were categorized on the basis of their prior aeronautical experience levels. Students with 50 hours or less were administratively tagged as low time students, while those with more than 50 hours were tagged as high time students. These latter students were not manipulated in any way, and the research interest in them was not revealed to Aviation School personnel during the course of the study.

The number of students in each group and their respective mean prior flight experience levels are shown in Table 1. The low prior time group had a mean of approximately six hours; the high prior time group had a mean of approximately 240 hours. Differences in mean prior experience between the Experimental, Control, and Low Time Groups in Table 1 do not appear to be significant.

Table 1

Number of Students in Each Group and Mean Prior Experience Levels

Group	N	Mean Prior Experience (Hours)	Range (Hours)
Experimental	24	6.8	0-44
Control	16	10.6	0-50
Low Time	20	6.5	0-50
High Time	37	240.6	51-900

EXPERIMENTAL DESIGN

A simple, one-way analysis of variance model was used in the design of this research, with group assignment as the experimental variable. Where frequency data were used, Chi Square data analysis techniques were employed.

Groups Involved

The Experimental Group, consisting of 12 trainees from each of the two O/WOFWAC classes, received synthetic training in the new device. The Control Group, the size of which was restricted to levels that the civilian flight contractor could handle in the event such students might require additional training, consisted of eight trainees from each class who received no synthetic training.

No changes were made in the flight or academic portions of training for these two groups. The Low Time and High Time Groups both received the normal O/WOFWAC program of instruction, including training in Device 2B12A, and were distinguished only by the differences in prior experience levels as indicated in Table 1.

Two classes were used in this research because of the relatively small number of Experimental and Control Subjects who could be administratively handled in a single O/WOFWAC class. Prior research has often shown significant class differences because of the use of different groups of instructional personnel; however, in this case, the same group of instructors was used throughout and there were no other systematic changes in group treatment between classes.

Synthetic Training in the New Device

Conventional synthetic training in the O/WOFWAC occurs during the second through the fifth weeks and is concurrent with inflight instruction. The synthetic training administered to the Experimental Group in the new device differed from that conventionally administered to O/WOFWAC trainees in three major aspects. First, the training began one week prior to flight line instruction.[4] Second, primary emphasis during this early period was on normal and emergency procedural tasks common to light twin-engine aircraft and capable of simulation in the GAT-2. This procedural training was intended to assist the trainee during the transition portion (i.e., the first 10 hours) of T-42 flight training. The third difference was that, in addition to pilot training in the device, each student received an equal amount of time performing copilot tasks and/or observing a student acting as pilot. (A determination of the effects of providing copilot training was not directly addressed in this study; it is assumed to have been of some value, particularly during the initial learning of both twin-engine and instrument procedures.)

Except for differences dictated by the unique operating characteristics of the new device, the remainder of the Experimental Group's synthetic training was identical in content to that conventionally given to O/WOFWAC trainees in Device 2B12A (and to the Low Time and High Time subjects identified in Table 1). The syllabi used with both devices are shown in Appendix A. All synthetic and flight instruction was provided by the civilian contractor. The content and sequence of the flight training was independent of Experimental or Control Group assignment.

PERFORMANCE EVALUATION

To assess the training value of the new device, flight performance of trainees in the four groups was compared. Primary interest centered on flight performance of the Experimental and Control Groups. The High Time and Low Time 2B12A trained groups were included in some analyses (where data were available) to provide additional information; however, no direct attempt was made in this research to compare the relative training effectiveness of the new device and the 2B12A.[5]

Flight performance data were extracted from four sources: photographic recordings of aircraft performance during the two instrument-phase check rides; recordings of communications between each trainee, check pilot, and ground controller during the two check rides; check pilot checklists and instructor-pilot questionnaires developed by the research staff; and trainee flight records.

Photographic Records

Photographic records of the two check rides were obtained through the use of a 16mm motion picture camera, mounted on the right rear seat rails of the T-42 aircraft

[4] The Experimental Group started synthetic training during the administrative week of training, a period normally reserved for inprocessing and related administrative activities. Inprocessing of the Experimental Group was accomplished on a special schedule utilizing the half day not required for synthetic training.

[5] A comparison of the relative training value of the new device and the 2B12A was beyond the scope of this research. Equipment limitations precluded obtaining photographic data on the 2B12A trained groups. Nevertheless, performance measures that were readily available from trainee flight records and instructor pilot questionnaires of the 2B12A-trained groups were included in the appropriate analyses to provide information about trainees undergoing the routine program of instruction.

(Figure 5). Standardized check rides were administered so that all trainee performance would be recorded and filmed on the same series of tasks performed in the same sequence. A description of the maneuvers included in each check ride is shown in Appendix B.

Camera and Intervalometer Mounted in T-42 Aircraft

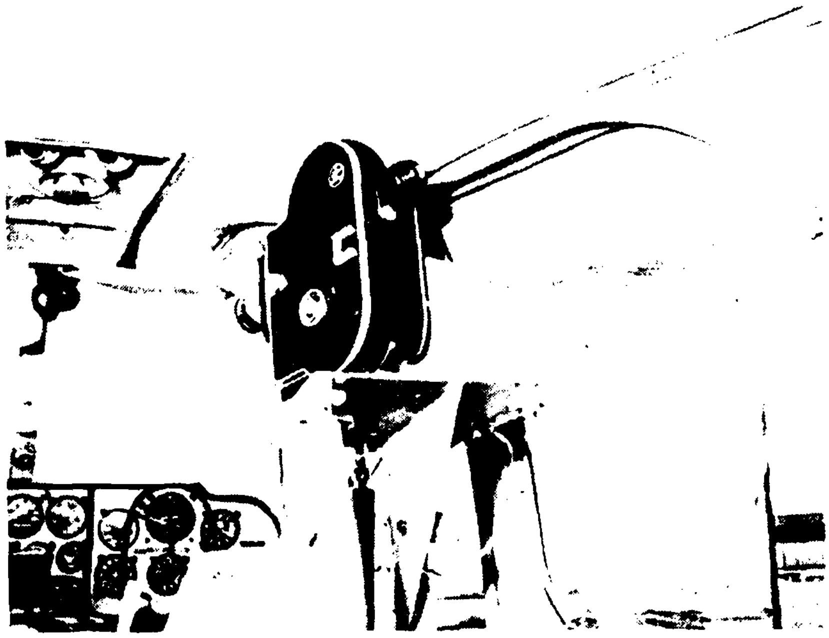

Figure 5

Time-lapse photographic techniques were employed, and the films were scored after completion of the check ride by a team of nonrated enlisted men working under the supervision of a qualified instructor pilot. Photographic and scoring procedures used were developed during earlier HumRRO research (4, 5).

Communication Recordings

Portable cassette-type tape recorders were used to record transmissions between the aircraft and Air Traffic Control (ATC) ground controllers and communications between the check pilot and the trainee on the aircraft intercom system. These recordings provided information concerning the trainees' communication skills, as well as information related to deviations of each check ride from the standardized flight profile caused by air traffic, weather, or other uncontrollable events, the latter information being of value during performance scoring activities.

Checklists and Questionnaires

A checklist was completed at the conclusion of each check ride. The checklist required the check pilot to rate the trainee's performance on a number of maneuvers and procedures that did not lend themselves to evaluation by photographic means. The checklists are shown in Appendix C.

A questionnaire was developed for use with instructor pilot personnel employed by the flight training contractor. The questionnaire, designed for administration at the end of the first week of flight training, asked the instructor pilots to rate their trainees' progress on a number of procedural and aircraft control tasks that had been introduced in the new device prior to the trainees' arrival on the flight line. The ratings consisted of instructor pilot determinations of whether the trainee's performance in the aircraft during his first week of training was generally above average, average, or below average.

Trainee Flight Records

In addition to the specially developed data sources just described, information concerning trainee attrition rates, daily flight grades, check-ride grades, and time to check ride was extracted from the flight records of all trainees of interest routinely maintained by the Aviation School.

RESULTS

DATA FROM PHOTOGRAPHED CHECK RIDE MANEUVERS[6]

The photographed portion of the fifth week check ride (Stage 1) consisted of a Very High Frequency Omnidirectional Range (VOR) navigation problem conducted under simulated instrument flight conditions.[7] With the check pilot acting as Air Traffic Control (ATC), each trainee was issued a standardized clearance. To comply with this clearance, each student had to: orient himself in relation to a VOR facility; select and fly an appropriate interception course to a specific radial; intercept and track inbound on that radial; hold at the VOR until cleared for an approach; execute the published approach when cleared; and, at minimum altitude, execute a missed approach.

The photographic record of trainee performance of this task was scored in the manner reported elsewhere (5). For scoring purposes, 16 performance measures were derived. Ten of these measures reflected the trainee's ability to control the aircraft within acceptable tolerances, and six performance measures reflected the trainee's ability to follow the standard procedures involved in complying with the ATC clearance. The 16 measures and the criteria or tolerances associated with them are identified in Table 2.

Error/no error frequency counts were made for each group, and Chi Square analyses were performed on each of the 16 performance measures identified in Table 2. The

[6] Photographic records of the check rides were obtained only on Experimental and Control Group trainees.

[7] The camera system also operated during other portions of the check ride; however, the IFR navigation problem was of primary concern during this check ride.

Table 2

Performance Measures Derived From Stage 1 Check Ride VOR Navigation Problem

Performance Measure		Type of Item	Criterion or Tolerance
Number	Description		
(1)	VOR Orientation	Procedural	Proper/Improper
(2)	Course Selection	Procedural	Proper/Improper
(3)	Track Interception	Procedural	Proper/Improper
	Inbound Track:		
(4)	Altitude	A/C Control	± 100 feet
(5)	Airspeed	A/C Control	± 10 knots
(6)	Ground Track	A/C Control	± 5 degrees
(7)	Procedures	Procedural	Proper/Improper
	Holding Pattern:		
(8)	Altitude	A/C Control	± 100 feet
(9)	Airspeed	A/C Control	± 10 knots
(10)	Heading	A/C Control	± 10 degrees
(11)	Time Outbound	Procedural	Proper/Improper
(12)	Procedures	Procedural	Proper/Improper
	Approach:		
(13)	Procedure Turn Altitude	A/C Control	+ 100 feet
(14)	Inbound Final Track	A/C Control	± 10 degrees
(15)	Low Station Altitude	A/C Control	+ 100 feet
(16)	Altitude at Missed Approach	A/C Control	+ 100 feet

frequency of errors for each group and the obtained Chi Square for each of the 16 measures are shown in Table 3.

Differences between groups ($p < .05$) were found for 4 of the 16 measures. In each case, the Experimental Group made fewer errors than did the Control Group. The variations in numbers reported in Table 3 reflect differences in the number of students completing various portions of the check ride, as well as differences in the scorability of filmed segments. Other data losses occurred due to attrition prior to the check ride, camera system malfunctions, and aircraft breakdowns. The data in Table 3 are based on examination of 16 Experimental Group films and 13 Control Group films. Except for attrition, which is discussed later in this report, the data losses appear to have occurred at random and are not considered to have had any systematic effect on the results reported here.

The eighth week or end-of-phase (Stage 2) check ride was in the form of a simulated instrument flight that required the student to file an IFR flight plan; make an instrument take-off; follow a radar vector to course interception; intercept and track outbound on a specific radial; intercept and track inbound on a specific Victor airway; hold at his clearance limit (an intersection along the airway); upon receiving further clearance, proceed along the airway to his destination facility, hold at the facility until cleared for

Table 3

Error Frequency by Group and Obtained Chi Squares for 16 Flight Performance Measures

Performance Measure		Group Error Frequency						
		Experimental			Control			
		Errors		No Errors	Errors		No Errors	
Number	Description	N	%	N	N	%	N	Chi Square[a]
(1)	VOR Orientation	3	20	12	3	23	10	0.039
(2)	Course Selection	3	20	12	8	62	5	5.038*
(3)	Track Interception	3	20	12	8	62	5	5.038*
	Inbound Track:							
(4)	Altitude	4	27	11	2	18	9	0.257
(5)	Airspeed	1	7	14	0	0	11	0.762
(6)	Ground Track	3	20	12	6	60	4	4.167*
(7)	Procedures	4	27	11	4	35	7	0.280
	Holding Pattern:							
(8)	Altitude	6	38	10	4	33	8	0.052
(9)	Airspeed	0	0	16	1	8	11	1.383
(10)	Heading	0	0	16	1	8	11	1.383
(11)	Time Outbound	2	12	14	2	17	10	0.097
(12)	Procedures	2	12	14	7	58	5	6.604*
	Approach:							
(13)	Procedure Turn Altitude	0	0	15	0	0	10	N/A
(14)	Inbound Final Track	6	40	9	3	30	7	0.260
(15)	Low Station Altitude	1	7	14	2	20	8	1.010
(16)	Altitude at Missed Approach	4	27	11	2	20	8	0.146

[a]The symbol * indicates statistical significance ($p < .05$; $df = 1$).

an approach; execute the published VOR approach when cleared; at minimum altitude execute a missed approach; request clearance to his alternate destination; follow a radar vector to the LOM (Locator Outer Marker) serving his alternate destination; and, when cleared, execute an instrument landing system (ILS) approach.

Filming of this check ride was hampered by inclement weather to the extent that the simulated instrument flight just described could not be executed in its entirety and only the ILS approach was considered sufficiently standardized for evaluation using the photographic scoring techniques.[8] In addition, attrition in the Control Group prior to this check ride markedly reduced the sample size. Nevertheless, data from 18 ILS

[8]The majority of these check rides were flown under actual instrument conditions, and flight routes could not be standardized to the extent necessary for research purposes. Approximately one-half the flights were terminated with an ILS approach.

approaches (12 Experimental and 6 Control) were obtained. Scoring for the ILS approach began at glide slope interception and was terminated at either published altitude minimums or when the check pilot removed the trainee's hood, whichever occurred first. Normally, this portion of the ILS approach required about 3 to 3 1/2 minutes. The total time each trainee was outside the "doughnut" on the ILS indicator during this period was extracted from the photographic records. (Being outside the doughnut indicated a course deviation of at least one-half degree.)

The mean frequency and mean percent of time off course for each group are shown in Table 4. Although the frequency off-course means for the two groups are similar, the time off-course means indicate that the Control Group was off course during a larger portion of the approach than the Experimental Group. This difference, however, is not significant.

Table 4

Mean Frequency Off Course and Mean Percent Time Off Course on ILS

Group	N	Mean Frequency Off Course	Mean Percent Time Off Course[a]
Experimental	12	3.67	29
Control	6	3.83	38

[a]Time off course reflects deviation from both course and glide slope.

DATA FROM COMMUNICATION RECORDINGS[9]

The primary intent of the use of tape recorders during the Stage 1 and Stage 2 check rides was to provide data of value to research personnel scoring the check ride films. However, an attempt was made to use the course corrections given by the final controller during the Ground Controlled Approach (GCA), (PAR) on the Stage 1 check ride, as an indication of trainee proficiency with this type of approach. The number of times the final controller reported the trainee off course and/or off glide slope was extracted from each tape. It was found, however, that variations among ground controllers were wide enough to make the reported deviations suspect as trainee performance data. The recordings proved useful as debriefing aids for the check pilots, and a number of check pilots recommended that recorders be used routinely on all check rides because of their value in debriefing.

CHECKLIST DATA[10]

From the checklists completed by the check pilots at the end of each Stage 1 check ride, subjective ratings were obtained of trainee performance during four flight tasks that were not included in that portion of the check ride that was scored from photographs. These four maneuvers could not be standardized to the extent necessary for after-the-event evaluation by means of photographic record. They either allowed essentially nonstandard performance (e.g., Recovery from Unusual Attitudes), or they involved stimuli outside the aircraft that could not be photographed (e.g., VFR Landing).

[9] Communications data were available only on Experimental and Control Group trainees.
[10] Checklist data were obtained on Experimental and Control Groups only.

These tasks were a VFR Take-off, Recovery from Unusual Attitudes, Single Engine Procedures, and a VFR Traffic Pattern and Landing. The ratings consisted of check pilot determination of whether trainee performance on each maneuver was "proper" or "improper." The relative performance of the Experimental and Control Groups on each rated task was evaluated using the Chi Square technique. Table 5 shows the number of trainees in each group rated proper or improper in the performance of each task. A significant difference between groups was found for the single-engine procedures task ($p < .05$).

Table 5

Check Pilots' Ratings of Stage 1 Maneuvers

Task	Group	Rated Proper N	Rated Proper %	Rated Improper N	Chi Square[a]
VFR Take Off	Experimental	20	87	3	1.121
	Control	11	73	4	
Recovery from Unusual Attitudes	Experimental	16	70	7	.510
	Control	12	80	3	
Single Engine Procedures	Experimental	15	65	8	4.710*
	Control	4	29	10	
Traffic Pattern and Landing (VFR)	Experimental	9	39	14	.021
	Control	5	42	7	

[a]The symbol * indicates statistical significance ($p < .05$; $df = 1$).

The checklist for the Stage 2 check ride provided subjective ratings on seven flight tasks. These included an Instrument Take-Off, Track Interception, Holding Pattern, Missed Approach, Communications, Partial Panel, and Single-Engine Procedures. Chi Square analyses of these ratings failed to yield significant differences at the .05 level between groups on any of these tasks.

INSTRUCTOR PILOT QUESTIONNAIRES

The instructor pilots employed by the flight training contractor were surveyed at the end of the first week of flight training. The survey included the instructor pilots of all four groups of trainees and asked them to rate their trainees' progress on a number of procedural and aircraft control tasks. These tasks had been introduced to the experimental trainees in the new device during the period prior to their first aircraft flight. Regardless of group assignment, all trainees received training on these tasks in the aircraft during the first week of flight training. The ratings consisted of instructor pilot determination of whether trainee performance in the aircraft during the first week of training was generally above average, average, or below average.

It should be noted that synthetic training in the instrument phase of O/WOFWAC normally does not begin until the second week of the course. Consequently, the Control Group had not missed any synthetic training normally administered to O/WOFWAC trainees at the time this instructor pilot questionnaire was administered. The Control Group, then, was similar in treatment at that point to other members of their O/WOFWAC class who met the same selection criteria (i.e., minimum prior aeronautical experience) and, in fact, had been selected randomly from among such trainees.

In order to increase the sensitivity of a statistical test of the effectiveness of the training received by the Experimental Group, the Control Group of 16 was combined with 19 additional low prior experience trainees in their classes (on whom questionnaire data also had been collected), and the differences in instructor pilot ratings of the Experimental Group and the thus augmented Control Group were investigated. These data are indicated in Table 6.

Table 6

Instructor Pilot Ratings of First Week's Performance

Group	Instructor Pilot Ratings: Above Average N	Instructor Pilot Ratings: Above Average %	Instructor Pilot Ratings: Average or Below N	Percent Above Average	Chi Square
Experimental	24	10	14	42	5.630
Augmented Control	35	5	30	14	
High Time	35	11	24	31	

The different frequencies of ratings between the Experimental and the augmented Control Group were tested for statistical significance using the Chi Square technique. The greater frequency of above-average ratings obtained by the Experimental Group was found to be significant ($p < .05$, $X^2 = 5.630$, $df = 1$) when compared with the augmented Control Group.

As might be expected, flight instructors quickly discovered, without being told, when a student had had significant amounts of prior aeronautical experience. Such students typically excel, especially early in training. It is therefore interesting to note in Table 6 that the first week instructor ratings of the Experimental Group are somewhat better than those received by the High Prior Time Group, the group most likely to excel at this stage of training. Although this difference is not significant, it is noteworthy that the Experimental Group was performing at a level approximately equal to that of students with relatively large amounts of prior aeronautical experience.

DATA FROM TRAINEE FLIGHT RECORDS

Attrition

Table 7 indicates the attrition (eliminations and recycles due to flight skill deficiencies) in terms of the number of students who failed to complete the phase with their class for reasons of flight deficiency. (Two trainees in the High Prior Time Group were attrited for reasons other than flight deficiency.) Five of the Control subjects were unable to complete Stage 1 training with their class, while only one of the Experimental subjects attrited at this stage. A Fisher Exact Probability Test of this difference was significant ($p < .05$). Similar analysis of the Stage 2 data failed to yield a significant difference. Attrition figures for the low prior time and high prior time groups are also included in Table 7. It should be noted that significant differences in Stage 1 attrition were also found between the Control Group and the Low Time Group and between the Control Group and the High Time Group. These findings are not unexpected and will be addressed in the discussion section.

Table 7

Flight Deficiency Attrition

Group	Number Entering Training	Attrition		
		Stage One	Stage Two	Total
Experimental	24	1	1	2
Control	16	5	0	5
Low Time	20	1	0	1
High Time	37	2	1	3

Time to Check Ride

The flight times required for students to pass the Stage 1 and Stage 2 check rides were extracted from individual flight records and are summarized in Table 8 where it can be seen that there was very little difference between groups. Such differences as did exist were found not to be significant using analysis of variance techniques.

Table 8

Flight Hours to Pass Check Ride for Each Group, by Stage of Training

Group	C-1 Stage			C-2 Stage		
	Mean	N	SD	Mean	N	SD
Experimental	30.1	23	1.70	58.8	22	2.58
Control	30.3	11	2.12	58.6	11	3.71
Low Time	29.9	19	1.31	58.8	19	2.85
High Time	29.3	33	1.12	57.0	32	2.47

Instructor-Assigned Daily Grades During Training

Instructor-assigned daily flight grades were extracted from the flight records of each student. These grades are subjective in nature and are assigned in accordance with the Uniform Flight Grading System.[11] To facilitate statistical analysis, daily grades of U, C, B, and A were assigned the numerical values of 1, 2, 3, and 4, respectively. The total number of graded flights for each trainee during each stage of training was used to derive a mean daily grade for each trainee.

The mean daily grade data for each group in each stage of instrument flight training are summarized in Table 9. For the Stage 1 data, no significant differences between groups were found using analysis of variance techniques. A similar analysis of the Stage 2 grade data did produce a significant difference ($F_{3,80} = 2.87$). A t test following the analysis of variance revealed that this difference is between the Low Prior Time and High Prior Time Groups, a result that is consistent with the hypothesis that prior aeronautical experience would have a facilitative effect on trainee performance.

[11] U.S. Army Aviation School (USAAVNS) Regulation 350-16, June 1967.

Table 9

Instructor-Assigned Daily Grades for Each Group and Stage of Training

Group	Stage 1			Stage 2		
	Mean	N	SD	Mean	N	SD
Experimental	2.66	23	.32	2.71	22	.26
Control	2.52	15	.37	2.74	11	.32
Low Time	2.59	20	.37	2.58	19	.33
High Time	2.77	35	.26	2.82	32	.25

Check-Ride Grades

An overall check-ride grade was assigned by the examining pilot at the conclusion of each check ride in both stages of training during this research. These grades were assigned in accordance with procedures outlined in the Uniform Flight Grading System[12] and thus provided an independent, although subjective, evaluation of student performance. For the purposes of this research, unsatisfactory check rides, which normally do not receive numerical grades, were assigned a grade of 65. Table 10 summarizes the check-ride grades received by each group on each check ride. Analysis of variance of the data summarized in Table 10 failed to show significant differences between groups on either the Stage 1 or Stage 2 check rides.

Table 10

Check Ride Grades for Each Group

Group	Stage 1 Check Ride			Stage 2 Check Ride		
	Mean	N	SD	Mean	N	SD
Experimental	79.0	23	7.59	77.0	23	8.43
Control	74.5	15	9.58	79.2	11	8.78
Low Prior Time (2B12A)	80.0	20	6.55	77.8	19	7.76
High Prior Time (2B12A)	82.8	35	11.58	82.2	32	7.06

DISCUSSION

The primary objective of this initial part of the research was to determine the suitability of the new device as a possible replacement for existing obsolete equipment. The central question posed by the objective was, "Does training in the new device transfer to the aircraft in such a way that device-trained students outperform (in the aircraft) non-device-trained students?" The results obtained indicate a qualified affirmative response to that question.

Device-trained students, especially early in instrument training, tended to outperform students who did not receive device training. During early periods of training the

[12] USAAVNS Regulation, *op. cit.*

device-trained students had a lower attrition rate, and they were more likely to be above-average students according to their instructors' ratings. On the Stage 1 check ride during the fifth week of training, their performance on procedural tasks tended to be superior when evaluated subjectively by the check pilots as well as when scored objectively from photographic records. These findings are consonant with other aviation training research where early benefits tend to become attenuated in later stages of training (6, 7, 8).

In this research, a number of factors are believed to have had some bearing on the results. First, the training program used with the new device, except for the initial training periods, was a modification of the existing synthetic POI and did not take full advantage of the new device's unique characteristics. Indeed, the results suggest that the device training received prior to actual aircraft instruction was of relatively more value than device training that was concurrent with flight training. Also, since the early device training was designed to take advantage of the new device's twin-engine configuration and later device instruction was not, the attenuation of early benefits may have been due to training program content rather than the device itself.

On the other hand, there is insufficient objective evidence about trainee performance in the later stages of training to warrant firm conclusions about the device's contribution to this stage of training. Check-ride grades, for instance, are subjective in nature and have been shown in most cases to be of questionable reliability (9). Even though in the present case the check pilots were from an independent evaluation section, considerable variability in the application of the evaluation standards employed by the check pilots was known to exist. Time to check ride, while not a subjective measure, is nevertheless influenced by administrative constraints and schedule requirements that have little to do with trainee proficiency. (Although the training system does not preclude proficiency-based advancement (PBA) in training, U.S. Title 10 requirements in effect at the time this research was conducted and flight contractor commitments severely limited application of the PBA technique in practice.)

It should be noted that the 31% attrition rate for the Control Group at the Stage 1 check-ride level presumably comparatively improved the range of talent for the Control Group over that of the Experimental Group by eliminating more of the Control Group students who were less capable. In contrast, the device training received by the Experimental Group may have allowed some trainees to complete the program who otherwise would not. Attrition in the advanced stages of flight training is very expensive. Synthetic training, to the extent that it reduces attrition, must be considered as making a substantial contribution to the cost effectiveness of the overall training system.

It must also be recognized that the significant differences in attrition rates between the Control Group and the two 2B12A groups suggest that training in existing equipment is also making a contribution. The training program then being used with the 2B12A had been in use by USAAVNS for some time and could be considered as USAAVNS' optimized program for that piece of equipment. As noted previously, the optimum training program for the GAT-2 was yet to be developed. Nevertheless, students trained in the new device with a training program developed for the 2B12A fared as well as those trained in the 2B12A with the USAAVNS optimized training program.

There has been no evidence presented in this research that synthetic training in the new device is more effective than similar training in existing equipment. Indeed, a direct comparison of the relative contribution of the two devices was not part of the objective of this project. Nevertheless, on the basis of its greater overall task similarity to that required in the training aircraft, one would predict greater transfer from the new device (2).[13] Further, the twin-engine configuration of the GAT-2 allows the trainee to practice several procedures that cannot be simulated in the 2B12A. That such procedural training was effective can be seen in the results from the flight instructor questionnaires administered at the end of the first week of flight training and also in the check pilot ratings of single-engine procedures on the Stage 1 check ride. Nevertheless, a number of device characteristics were noted that were not considered to have contributed to the transfer of training to the T-42 aircraft reported in this section, and some of these characteristics may have caused interference with skill development that led to negative transfer of training.

The most likely causes of such effects were found to be (a) lack of instrument/control response uniformity between devices (e.g., major discrepancies were noted between indicated airspeed values under supposedly identical simulated flight conditions); (b) the elevator trim in the device did not operate in a manner compatible with elevator trim in an aircraft; and (c) the "slop" in the pitch control in the device results in vertical speed rates that are excessively (and unrealistically) difficult to stabilize.

At the conclusion of the research described, an interim report based upon analyses of the data contained in this section was delivered to the Aviation School. On the basis of the information developed in this research, including the deficiencies just noted, the Aviation School prepared and submitted a Draft Proposed Training Device Requirement (DPTDR)[14] which, if approved, would provide equipment even more suitable for use in the Army's fixed wing instrument training program.

[13] The task commonality analysis (TCA) procedures described in Caro (2) were under development at the time the device discussed here was under development. The relevant TCA procedures for identification of aircraft equipment features were applied to the training aircraft, and the results were provided the device manufacturer for his guidance in assuring cost-effective correspondence between the two items of equipment. It is believed that the use of TCA procedures in this manner contributed to the positive results of this study.

[14] Draft Proposed Training Device Requirement (DPTDR) for a Multi-Engine Fixed Wing Instrument Trainer, 7 April 1970. This action eventually led to the procurement by the Army of Device 2B27A.

Study Two

DEVELOPMENT AND VALIDATION TESTING OF AN OPTIMUM TRAINING PROGRAM FOR THE NEW DEVICE[15]

RESEARCH OBJECTIVE

The work described in this section was undertaken immediately following that described in Study One. The same research equipment was used, that is, the T-42 aircraft and the new device previously described. The need for the research described in this section was based upon the assumption, confirmed subjectively by the impressions of the research staff during Study One, that a training program that is optimum for one training device cannot be optimum for a different device.

Ideally, it would have been more appropriate to develop an optimum training program for the new device before the first part of this research was conducted. Because of the Aviation School's desire to generate, as quickly as possible, empirical data on which to base a decision concerning the procurement of additional devices, the two-part research effort described in this report was undertaken. The decision to procure additional devices provided a basis for justification of the research reported here.

The objective of the second part of this research effort was to develop and validate a training program that would be optimum for use with the new training device.

METHOD

The procedures involved in the development of the new training program were developmental rather than experimental, and involved application of the professional judgment of the HumRRO research staff. Some of the concepts and training rationale included in the program were taken directly from other pilot training programs (including some at the Army Aviation School), while others evolved from concepts found in the training technology and human learning literature. During the evolutionary process, typical trainees were used to evaluate several methods of instruction and of shaping trainee behavior through augmented feedback techniques. Some of these methods and techniques were either dropped from further consideration or were extensively modified before the total program was made available to the Army.

Cost effectiveness was the single guiding principle used in devising the new training program and each of its elements. For training, cost effectiveness translates to achieving given training requirements with the minimal feasible cost in dollars. Toward this end, a number of considerations of modern training technology were applied in combination. Most notable of these considerations were the following:

(1) Organization of the training program around a functional context, that is, around sets of meaningful, purposeful, mission modules, and teaching training content in the context of the mission-oriented purpose it supports.

[15] Portions of the information in this section have been reported elsewhere (10).

(2) Individualization of training, that is, adapting the pace and redundancy in training to the rate of learning of each student and advancing a student to the next set of instructional content only after he has demonstrated mastery of an earlier set.

(3) Sequencing of instruction, that is, arranging the order of instructional content so that there is assurance students have been taught (and have mastered) prerequisite knowledges and skills before training in a new set is undertaken.

(4) Minimizing of equipment cost, that is, to the extent that is efficient, substituting training in devices or other less expensive equipment for the much more expensive training conducted in aircraft.

(5) Avoidance of over-training, that is, assuring that training time is restricted to that needed to bring a trainee to the required level of proficiency and no more.

(6) Efficient utilization of personnel resources, that is, each instructor should be optimally qualified for his task, should be provided with the tools he may require for efficient use of his time and talents, and should have clearly stated and measurable instructional objectives to attain.

(7) Use of incentive awards.

The detailed development of the training program was guided by these principles. In addition, the staff engaged in the program development possessed knowledge of numerous aviator and other training studies, pilot training practices of other organizations, and the Army's training requirements, and detailed familiarity with resources available.

An attempt to describe the detailed evolution of each individual feature of the training program that resulted from this developmental process would not be fruitful. A basis for each of these features, either in the training-related literature or in the practices of other training organizations, will be recognized by the reader. Instead, this part of the report describes the principal features of the program, its initial use by the Army, and its training efficiency when compared to the program it was developed to replace.

PROGRAM OBJECTIVES AND LIMITATIONS

The pilot performance objectives of its twin-engine transition and instrument flight training have been stated clearly by the U.S. Army Aviation School in various documents related to the course. These objectives, which require course graduates to operate the twin-engine T-42 aircraft in accordance with FAA and Army visual and instrument flight regulations, were adopted, without change, as the objectives for the new training program. Graduates from the new program were to be indistinguishable, as far as flight performance is concerned, from graduates of the existing program.

The intent of the new program, therefore, was to produce pilot graduates who met these performance objectives at less overall cost than was being incurred in the existing program. Costs can be reduced in flight training programs principally through reductions in aircraft operating time. Thus, a reduction in the number of aircraft flight hours required to attain the stated performance objectives is the principal means through which reduced costs are to be realized.

Consideration was given during development of the new program to the relative costs of all its features to assure that savings resulting from reduced flight-hour costs were not offset by costs incurred as a result of the introduction of other training practices. To reduce the risk of introducing undesired costs elsewhere, the new course made use of only those resources already available at the Aviation School (excluding the new device itself) and required the same calendar time for its conduct as did the existing program.

PROGRAM SCHEDULE

The new program is divided into two segments. During the first segment, all flight training that can be adapted is conducted in the new device. The aircraft is not used. In addition, all required academic training is accomplished during the same period. The device and academic training are accomplished on a proficiency basis. Approximately three weeks of five working days each are devoted to device and academic training. Training in the device, including associated briefing and administrative time, occupies approximately four hours each workday, and academic training occupies about an additional three hours per day. During the last few periods of academic training, a paper procedures trainer (3, 10) for the T-42 aircraft is used to aid trainees in their transition from the new device to the training aircraft. No other training activities are scheduled during these first three weeks.

All scheduled training during the remaining five weeks is conducted in the aircraft, although the new device may be used for training at the option of the flight instructor. The aircraft training concentrates upon two activities: (a) the conduct of training that is required, but that cannot be conducted in the simulated instrument flight rules (IFR) environment of the new device, such as landings; and (b) the refinement of skills previously trained in the device.

When, in the opinion of the flight instructors, the trainee is prepared for the check ride, which the Aviation School requires of trainees in the existing program, those rides are administered by a check pilot. When the trainee successfully passes the end-of-training check ride, no further twin-engine transition and instrument flight training is administered to him. In the event this occurs prior to the scheduled completion of the course, he is excused from further nonessential military duties until the next phase of his training is scheduled to begin.

The new program is designed for administration on an individual basis with advancement based solely upon student proficiency, that is, the criteria of training are based upon attained trainee performance. There is no requirement in the new program that any minimum amount of flight training, as measured by hours spent in the device or hours logged in an aircraft, be administered to each trainee. To facilitate personnel and equipment scheduling, the hours estimated to be required for each type of training, indicated in Table 11, are provided. These numbers do not represent *hour* requirements, however. Course completion is based solely upon attained proficiency rather than hours of exposure to a training environment. For comparison purposes, the hours scheduled in the existing program also are presented in Table 11.

Table 11

Approximate Training Hours Required

Program	Time (Hours)		
	Aircraft	Device	Classroom
New Program	35	25	45
Existing Program	60	21	90

PRINCIPAL PROGRAM FEATURES

The new training program has been made available to the Aviation School. The present description of it is significantly less detailed than the documentation provided the Aviation School, since a fully detailed exposition of the program would be of little interest to personnel not involved in comparable training. The intent of this description is to convey to the reader the general nature of the new program rather than the details necessary for its administration.

Thus, attention is concentrated upon those principal features that distinguish it from the existing twin-engine transition and instrument training program of the Aviation School and comparable programs of other training organizations. These features are described in greater detail in Appendix D.

The new program incorporated four administrative innovations. First, the instructor pilot was given full responsibility for training each student assigned to him; the instructor pilot thus became a training manager. Second, a diagnostic progress check ride was introduced, to help assure that a student would receive the end-of-course check ride as early as possible instead of after a fixed number of flight hours. Third, an incentive program was instituted that rewarded student and instructor alike with free time when training requirements were met in less than the prescribed course duration. Fourth, several procedures were introduced in addition to the progress check ride that provided more feedback to the instructor about the progress of his students.

Innovations in the training content of the new program included provision for device training in every procedure and maneuver that could be performed in both the device and the aircraft. Thus, the emphasis in aircraft training was upon activities that could be practiced only in the aircraft. Another important feature was the capability of the device to provide crew training, which also permitted the use of peer instructional techniques.

All training was carried out in a functional context rather than in isolated unrealistic segments. A substantial economy resulted from the use of a low-cost T-42 paper trainer (developed by HumRRO) to practice T-42 checklist procedures. Finally, a major change was the improved continuity of training achieved by giving one instructor complete responsibility for all of the training (synthetic, inflight, and academic) received by each student assigned to him.

Other distinguishing aspects of the new program included (a) individualizing instruction through proficiency advancement techniques, (b) using objective measurement to determine criterion performance and to pace training, and (c) requiring trainees to be able to describe orally all relevant aspects of a given maneuver before they attempt to perform that maneuver.

INITIAL TRAINING PROGRAM USE

INSTRUCTOR TRAINING

The new training program has a number of features that are unfamiliar to most instructor pilots. For example, it requires that they be familiar with the new device, the use of special recording forms, and functional context training. Therefore, before the new program could be made available, it was necessary to train flight instructors to use it.

Two Army officers who were qualified to conduct flight instruction in the existing twin-engine transition and instrument training program were designated by the Aviation

School to be trained by HumRRO to conduct the new training program.[16] Upon completion of their training, they were to train other Aviation School personnel in the conduct and administration of the program. The two pilots had completed an Aviation School Methods of Instruction (MOI) course, the principal purpose of which was to assure their standardized performance in the T-42. In addition, both instructor pilots had taught twin-engine transition and instrument training courses. Similar qualifications (i.e., instructor pilot qualification and aircraft performance standardization) would be required of all instructors prior to their training specifically in the conduct of the new training program.

The instructor training for the new program consisted of two phases. The first phase, which lasted two weeks, was devoted to standardizing instructor performance in the new device, acquainting them with the programed textbooks that the new students would be using, and instructing them in the conduct of the new program. The latter consisted of instruction in behavioral change techniques and human learning theory, as well as how to use Maneuver Performance Records (MPRs) and other course features. Specific attention was directed to the modification of existing concepts of the role of the flight instructor in relation to the student and the importance of performance criteria rather than experience for training.

The second phase of instructor training lasted eight weeks, a time period that corresponded to the scheduled length of the Army's existing twin-engine transition and instrument training program. During this phase, each flight instructor was assigned two trainees and administered the new program to them under the supervision of the HumRRO research staff. Training in the device and study of assigned academic material occupied the first three weeks of the phase, and training in the aircraft occupied much of the remaining time. All student training by these instructors proceeded in accordance with the previous description of the new program.

TRAINING PROGRAM EFFECTIVENESS

The new program's initial administration by two instructors trained by HumRRO conformed very closely to the anticipated hour requirements indicated in Table 11. The actual aircraft, device, and classroom hours required for each trainee to achieve the performance requirements of twin-engine transition and instrument training are indicated in Table 12. The aircraft hour requirement is broken down to indicate the distribution of that time by type of training, that is, IFR (actual instrument and hooded flight), visual flight rules (VFR) day, and VFR night.

The students tended to require less device time to reach the performance criteria established for that training than had been anticipated. This may be attributed in part to a possible "Hawthorne effect,"[17] since the instructors as well as the trainees expressed keen interest in the newness of the device and its far greater apparent training capability than was the case with other training equipment. The extent of such a Hawthorne effect, if in fact it did occur, cannot be determined on the basis of the initial administration of

[16] Since only two of the new devices had been procured by the Army at the time of the training reported here, the use of more than two instructors during the initial program administration would have been inconvenient. The training of the two flight instructors was undertaken because of the intent to convey the necessary skills to Army personnel who then would undertake the training of an adequate number of other personnel. This approach is consistent with HumRRO's contract with the Army to engage in training-related research and development activities rather than to undertake directly the administration of training programs.

[17] A reaction to a change rather than to the effects of the change.

Table 12

Distribution of Training Time
(Hours)

Trainee	Device Time[a]	Aircraft Time				Classroom Time
		IFR/Hood	VFR (Day)	VFR (Night)	Total	
1	19:00	27:45	5:10	1:00	33:55	39:00
2	19:30	27:55	5:10	1:00	34:05	39:00
3	21:00	27:35	5:55	1:00	34:30	39:00
4	21:00	27:15	6:40	1:15	35:10	39:00

[a]Time during which the trainee occupied the pilot seat only. This figure does not include the time in which he received training related to copilot functions or observed the training being administered to another student.

the program. It is believed unlikely, however, that such an effect could invalidate the training concepts underlying the new program.

One trainee required slightly more than the 35 flight hours anticipated in Table 11. That particular trainee was grounded for medical reasons the day before he had been scheduled by his flight instructor to be administered an end-of-course performance check ride. Upon return to flight status, he was given an additional two-hour period of flight instruction before being rescheduled to take a check ride.

It cannot be expected that all students will complete the new course within the 35-hour estimate. It is, after all, a course that is administered on an individual, proficiency-based advancement, and not all trainees are equally adept at acquiring the necessary skills. It can reasonably be expected that the 35-hour estimate will be exceeded with the new training program about as frequently as the 60-hour limit of the existing program has been exceeded in the past.

Two check rides (as well as the diagnostic progress rides described earlier) were administered to each of the trainees by a check pilot from the Standards Section of the Aviation School's Department of Advanced Fixed Wing Training. It was these independently administered check rides that determined whether the trainees had attained the course objectives. The check rides were identical in content and standards to check rides administered to trainees in the existing course, and in keeping with established Aviation School requirements, grades were assigned in accordance with the Uniform Flight Grading System described in Study One of this report. The phase flight grades of the students involved ranged from 82 to 86 without the addition of incentive points for early attainment of the course performance requirements. The average phase flight grade for students in the existing course is 83.7. The average was 82.2 for the class from which the four students were obtained.

PROGRAM COST

The relative effectiveness of any new training program that achieves performance objectives identical to an existing program can only be measured by some index of efficiency. The index most appropriate to the present situation is cost. The program that costs less to administer, all factors considered, would have to be judged the more cost effective of the two programs under consideration. It was beyond the scope of the present research to determine exactly the cost effectiveness of the new training program, although a model for the collection of aviator training cost data had previously been developed by HumRRO (11).

A study was made of the estimated cost of conducting training in the new device (3). On the basis of those data and data provided by the Aviation School at the time of this study concerning the cost of flying the T-42, it was determined that an hour of instruction in the new device, using the newly developed training program, costs approximately $40 less than an hour of instruction in the aircraft. Thus, a reduction of 25 flight training hours per student, that is, from 60 to 35 hours in the aircraft, would yield a savings in flight training costs of approximately $1,000 per trainee. Additional savings would be realized from reductions in facilities and in training support personnel that would result from the lower flight-hour requirement of the new program.

APPLICATION TO ANOTHER TRAINING PROGRAM

Student inputs to the O/WOFWAC were suspended in October 1970. Since that time, additional fixed wing Army aviators have been obtained through the cross-training of rotary wing Army aviators. The Twin-Engine Transition and Instrument Flight Phase of the cross-training program is similar to the comparable Phase of the O/WOFWAC. The training objectives are identical, and the training aircraft is the same. Therefore, it was inferred that the new training device and many of the training techniques employed in the new program developed for it could be applied to the cross-training program as well. Consequently, the Aviation School requested HumRRO to investigate the possibility of modifying the new training program for use in the cross-training program.

The cross-training program, more formally called the Fixed Wing Qualification Course (FWQC), differed from the O/WOFWAC only with respect to the aeronautical experience level of course entrants. Since entrants to the FWQC were already rated aviators (i.e., helicopter pilots), they typically completed twin-engine transition and instrument training in 45 programed flight hours instead of the 50 hours required for O/WOFWAC trainees. The program texts used in the new program developed during Study Two were developed originally for the FWQC. After review of the new program and the FWQC training requirements, it was concluded that no significant modification to the new program would be needed.

A demonstration of the efficacy of the new program for the FWQC was conducted using the same instructor pilots who participated in the O/WOFWAC program first described. The results of this demonstration, as shown in Table 13, indicated that, using the new training program, flight time in the FWQC could be reduced from 45 to approximately 25 flight hours while maintaining the same quality of performance as average course graduates. The results of this demonstration confirm those reported in Table 12 for initial program use.

Pending the delivery of additional GAT-2 devices, the Aviation School also has been investigating the suitability of the new device-training program combination for use in other fixed-wing training programs. The implications for reducing flight training costs without lowering the quality of course graduates are impressive, particularly in an era of limited resources for training.

It should be noted that many of the training concepts employed in the new O/WOFWAC and FWQC programs described in this report have application to other flight training programs. For example, the training program used in the recently completed operational suitability test of Device 2B24 (12), the Army's new helicopter simulator, drew heavily upon the GAT-2 training program. Training programs that have been developed by HumRRO for U.S. Coast Guard aviators also employ many elements of the GAT-2 training program model.

Table 13

Distribution of Training Time in FWQC
(Hours)

Trainee	Device Time[a]	Aircraft Time				Classroom Time
		IFR/Hood	VFR (Day)	VFR (Night)	Total	
1	19:30	19:15	4:45	1:00	25:00	39:00
2	19:30	19:00	5:00	1:00	25:00	39:00
3	16:30	20:00	4:55	1:00	25:55	39:00
4	16:30	18:45	5:40	1:00	25:25	39:00

[a]Does not include copilot and solo time.

TRAINING DEVICES AND TRAINING PROGRAMS

The introduction of new training devices and equipment into an existing training program is a common occurrence in all large training organizations. In the case described in this report, it happened to have been in an Army pilot training setting. It could have been in many other settings: armor, air defense, submarine, automotive repair, public education, mental health, and so on.

In fact, Study One has been replicated many times. Often, the replication has been less formal—perhaps without a designated control group or elaborate data-gathering procedures, but the general approach and the results have been comparable. The approach consists of substituting a new training device for an obsolete or worn-out one, adjusting the training program to fit the new device, and training a few students just to check everything out before procuring the new device in quantity. Although there have been exceptions, the general procedure in such cases is to gather little or no formal data, because the benefits of the new equipment are obvious. Observed increases in training efficiency in such cases are attributed to the new training device, and the decision to procure more devices, which occurred as a consequence of information gathered during Study One, is an empirically justified decision.

Had a similar procedure been followed in this research—that is, had the effort terminated at the conclusion of Study One, and had Study Two not been undertaken—the Army would have realized relatively little of the potential benefits to be derived from use of the new device. It probably would never have been known that approximately a 40% increase in training efficiency could be realized simply by developing a training program designed specifically for the new device instead of using an existing program (even with adjustments required by some of the features of the new equipment), which was designed for older devices.

The need for effort corresponding to Study Two should be apparent in almost all training programs where new or modified training equipment is introduced. The need is greatest, of course, in instances where the older equipment has been in use for an extended period of time. Advances in the technology of training during the past decade, particularly advances related to the design and use of training devices, almost guarantee that device training programs that have not undergone extensive updating in the past few years probably are not as effective as they can be. The introduction of new equipment usually provides an ideal opportunity to take advantage of new information and techniques related to training, and efforts to develop optimum training programs for such new equipment should be made whenever these opportunities arise.

It is surprising, therefore, to observe that many training organizations, military and civilian alike, will tend to ignore the importance of training program design when new equipment is introduced. There are many instances in which literally millions of dollars have been invested in the development of training vehicles, devices, and simulators, but not one dollar has been devoted to the development of appropriate methods and techniques for their use. Instead, the new equipment typically is turned over to training personnel whose orientation and experience is limited to existing programs, procedures, personnel, and policies, and who are instructed to upset the training schedule and the personnel structure as little as possible during the time the new equipment is being introduced and tested—and above all, to stick with the training syllabus already approved by higher headquarters! Under circumstances such as these, there is little chance that Study Two type of program development activities can be undertaken.

As a consequence, training program designers and administrators tend to rely upon the device itself to assure adequate training. Too often, people appear to forget that training equipment doesn't train. It is the manner in which training vehicles, devices, and simulators are used that yields the benefit. A training program must be developed for each situation in which skills are to be developed, and each program must take into account the capabilities of the specific equipment used if its potential contribution to transfer of training is to be realized.

It has also long been known that factors other than equipment/device similarity impact on transfer of training. For instance, Gagne (13) pointed out that transfer of training from devices and simulators to operational equipment is a function of factors such as training objectives and instructional quality as well as the characteristics of the training equipment. Muckler *et al.*, (14) identified instructional techniques and instructor ability as important variables involved in transfer of training. Prophet (1) stated that training devices are only the vehicles for the training programs, and they often are less important than are the training device instructor and the organization and content of the device training program.

Probably no one would maintain that the manner in which training equipment is used is unimportant. In spite of this, attention to the program of appropriate use of training equipment, particularly newly procured training equipment, is seldom sufficient. There are many studies conducted to determine whether a new item of training equipment is useful, but there are few studies conducted to determine the best way to use new equipment. When viewed together, the two studies reported here lend support to the notion that the training program used with a device is more important, from the transfer of training standpoint, than the device itself.

LITERATURE CITED
AND
APPENDICES

LITERATURE CITED

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

2. Caro, Paul W. *Equipment-Device Task Commonality Analysis and Transfer of Training*, HumRRO Technical Report 70-7, June 1970.

3. Caro, Paul W., Jolley, Oran B., Isley, Robert N., and Wright, Robert H. *Determining Training Device Requirements in Fixed Wing Aviator Training*, HumRRO Technical Report 72-11, April 1972.

4. Isley, Robert N., Caro, Paul W., and Jolley, Oran B. *Evaluation of Synthetic Instrument Flight Training in the Officer/Warrant Officer Rotary Wing Aviator Course*, HumRRO Technical Report 68-14, November 1968.

5. Isley, Robert N. and Caro, Paul W. "Use of Time-Lapse Photography in Flight Performance Evaluation," *Journal of Applied Psychology*, vol. 54, no. 1, February 1970, pp. 72-76. Issued as HumRRO Professional Paper 10-70, April 1970.

6. Prophet, Wallace W. and Jolley, Oran B. *Evaluation of the Integrated Contact-Instrument Concept for Army Fixed Wing Flight Instruction*, HumRRO Technical Report 69-26, December 1969.

7. Caro, Paul W., Isley, Robert N., and Jolley, Oran B. *The Captive Helicopter as a Training Device: Experimental Evaluation of a Concept*, HumRRO Technical Report 68-9, June 1968.

8. Sutter, E.L., Townsend, J.C., and Ornstein, G.N. *The Light Plane as a Pre-Primary Selection and Training Device: II Analysis of Training Data*, Air Force Personnel and Training Research Center Technical Report 54-35, August 1954.

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

10. Caro, Paul W. *An Innovative Instrument Flight Training Program*, HumRRO Professional Paper 16-71, July 1971.

11. Jolley, Oran B. and Caro, Paul W. *A Determination of Selected Costs of Flight and Synthetic Flight Training*, HumRRO Technical Report 70-6, April 1970.

12. Smith, Major Luther S. and Sasser, CW3 Willie H. *Expanded Service Test of UH-1H Field Unit Subsystem of Synthetic Flight Training System (SFTS) (Device 2B24)*, USAAVNTBD, Fort Rucker, Alabama, April 1972.

13. Gagne, R.M. (ed.). *Psychological Principles in System Development*. Holt, Rinehart and Winston, New York, 1962.

14. Muckler, F.A., Nygaard, J.E., O'Kelly, L.I., and Williams, A.C., Jr. *Psychological Variables in the Design of Flight Simulators for Training*, Wright Air Development Center, WADC Technical Report 56-369, Wright-Patterson Air Force Base, Ohio, 1959.

15. Weingarten, Kenneth, Hungerland, Jacklyn, Brennan, Mark, and Allred, Brent. *The APSTRAT Instructional Model*, HumRRO Professional Paper 6-71, May 1971.

16. Siskel, Maurice, Jr. and Smith, Wayne D. *A Preliminary Training Study of the H-34 Cockpit Procedures Trainer*, HumRRO Research Memorandum, October 1960.

Appendix A

SYNTHETIC TRAINING SYLLABI

Flight Syllabus Training Day	New Device			Device 2B12A		
	Period	Subject	Period Time[a]	Period	Subject	Period Time
--	1	Cockpit Procedures	1:10			
--	2	Basic IFR Maneuvers	1:10			
--	3	Review and S.E. Procedures	1:10			
--	4	Emergency Procedures	1:10			
--	5	Review	1:10			
1-6 (no synthetic training)						
7	6	Proficiency IFR Maneuvers	1:00	1	Intro. to trainer	1:30
8	7	Review and intro. to Radar (PAR & ASR)	1:00	2	Review - Basic IFR Maneuvers	1:30
9	8	Review & intro. to VOR/RMI	1:00	3	Review - intro. to GCA (PAR & ASR)	1:30
10	9	VOR/RMI	1:00	4	Review & intro. to VOR/RMI	1:30
11	10	Review VOR/RMI	1:00	5	Review	1:30
12	11	Review & intro. to ADF/RMI	1:00	6	Review	1:30
15	12	ADF/RMI	1:00	7	Review	1:30
17	13	Review ADF/RMI	1:00	8	Review	1:30
19	14	Review & intro. to ILS	1:00	9	Review	1:30
20	15	ILS	1:00	10	Intro. to ADF/RMI	1:30
21	16	Review ILS	1:00	11	Review	1:30
22	17	Review	1:00	12	Intro. to ILS	1:30
23	18	Enroute navigation	1:00	13	Review ILS	1:30
24	19	Review	1:00	14	Enroute navigation	1:30[b]
25	20	Review	1:00	15	Review	1:30
26	21	Review	1:00	16	Review	1:30
Total			21:50			24:00

[a]Period time in the new device is pilot time only; in addition, trainees received approximately 15 hours of copilot/observer training.

[b]Completion of 21:00 hours represents the minimum synthetic trainer requirement.

Appendix B

SYNOPSES OF STANDARDIZED CHECK RIDES

Stage 1 Check Ride

1. Take-off, VFR.
2. GCA.
   a. Hood ON. (Established in climb at instructor's discretion.)
   b. Student: contacts Cairns approach control for a GCA with missed approach.
   c. At the command, "Contact final controller, ____________________." Camera and recorder ON.
3. Missed approach. After student is established in climb:
   a. Hood OFF.
   b. Recorder OFF.
   c. Climb to 4500 feet.
   d. Slow cruise.
   e. Cardinal heading.
4. Steep turns, VFR.
   a. Right turn, 45° bank, 360°.
   b. Left turn, 45° bank, 360°.
5. Clearing turns (not graded).
6. Stalls, straight ahead, VFR.
   a. Gear - down.
   b. Flaps - down (28°).
   c. Power OFF.
7. Unusual attitudes, IFR (slow cruise).
   a. Student: puts hood on.
   b. Descending turns to the left, 150 kts, recover to slow cruise.
   c. Climbing turn to right, 80 kts, recover to slow cruise.
   d. Remove hood.
8. Single engine, VFR (slow cruise).
   a. Cut left engine.
   b. Clean-up, full feather.
   c. Restart.
   d. Go to normal cruise.
9. Gear extension (manual).

10. VOR, IFR. DHN.
    a. Puts hood on.
    b. Orientation.
    c. Recorder ON.
    d. Issue clearance: "Army________is cleared to the Dothan VOR via the 210° radial, maintain 3500 feet. Upon arrival hold southeast on the 154 radial, left turns, expect approach clearance at___________."
    e. After second circuit (third time over the fix), clear the student for a Dothan VOR 1 approach to report procedure turn.
    f. Make VOR approach.

11. Missed approach: start.
    a. After climb is established, remove hood.

12. Landing, VFR.
    a. Make normal pattern entry on downwind.
    b. On downwind, cut left engine after gear is down.
    c. Land.

13. Take-off, VFR.
    a. Return to Cairns AAF.
    b. Landing
    c. Camera and recorder OFF.

Stage 2 Check Ride (IFR)

Flight plan filed to Dothan with Cairns AAF listed as an alternate.

1. Clearance receipt and readback.
    a. RECORDER ON.
    b. Clearance: "Army________is cleared to the Echo intersection via Cairns 021 radial to Skipperville, V7 Echo. Maintain 3000. Depart runway________. After take-off left/right turn heading_______to intercept the Cairns 021 radial. Departure frequency_______, squawk_______low just before departure."
    c. Student: reads clearance back.

2. Instrument take-off.
    a. Camera ON.
    b. Line up.
    c. Take-off.
    d. Student: reports time off.
    e. Instructor: "Radar contact_______miles___ _____________ (Direction) of Cairns, report level at 3000."
    f. Student: rogers instruction.

3. Hand off.
    a. Student: reports level at 3000.
    b. Instructor: "Roger, radar service terminated______miles southwest of Skipperville, contact Cairms approach control frequency 118.4 now."
    c. Student: rogers instructions, switches to 118.4 and reports: "Cairns approach control Army__________estimating Skipperville at_________, 3000."
    d. Instructor: "Roger, Army______, hold northwest at Echo on V7, expect further clearance at_______."
    e. Student: rogers instructions.

4. At Echo (hold 2 circuits using CDIs),
   a. Student: enters holding pattern (slow cruise).
   b. Student: reports reaching holding fix.
   c. Instructor: fails right engine.
      NOTE: Give the engine back at instructor discretion.
   d. Instructor: issues following clearance during second holding pattern: "Army ______is cleared to the Dothan VOR, from over Echo, via V7, maintain 3000', hold southeast of Dothan on the 154 radial, left turns, 1-minute pattern, expect approach clearance at______."

5. Departing Echo.
   a. Student: reports departing Echo.
   b. Instructor: take away CDIs.

6. Dothan VOR.
   a. Student: enters holding pattern (goes to slow cruise).
   b. Student: reports reaching Dothan VOR.
   c. Instructor: does not answer, simulates lost communication.
   d. Student: follows lost communication procedures. Departs Dothan VOR, outbound for approach, at expected approach time.
   e. Instructor: re-establishes communications on missed approach.

7. Missed approach.
   a. Student: at the appropriate time, initiates missed approach, reports, and requests clearance to Cairns AAF, his alternate.
   b. Instructor: issues clearance and tells the student to contact Cairns approach control on frequency______, and request an ILS approach with radar vector to the outer marker.
   c. Instructor: as soon as the student is established on course and altitude, instructor fails the RMI. Give the RMI back prior to turn toward intercepting localizer.

8. Outer marker.
   a. Instructor: fails left engine.
   b. Student: executes an ILS approach to circling or straight in landing.
   c. Instructor: after touchdown, CAMERA and RECORDER OFF.

Appendix C

CHECKLIST RECORDS OF FLIGHT PERFORMANCE

Check Pilot's Flight Checklist (Stage 1)

Student:______________________________ Date:______________________________

Check Pilot:__________________________ A/C No.:____________________________

Class No.:____________________________ Type Check Ride:____________________

Approximate Time of Take-off:_________ Landing:____________________________

Weather at Cairns 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_______

Check pilot comments on photographed portion of the flight: (Indicate any deviations from standardized flight profile)

____

____

____

____

____

____

Check pilot rating of student performance. Circle the appropriate response. (Omit any item not included in the check ride.)

<u>Take-off (VFR)</u>

line up	left	proper	right
power application		proper	improper
heading (runway)	left	proper	right
rotation	early	proper	late
gear up	early	proper	late
heading control (climb-out)		proper	improper
power reduction:			
throttles		proper	improper
props		proper	improper
sequence		proper	improper

<u>Recovery From Unusual Attitudes (IFR)</u>

power	proper	improper
pitch	proper	improper
roll	proper	improper
altitude control	proper	improper
sequence	proper	improper

<u>Single Engine Procedures</u>

heading control	proper	improper
altitude control	proper	improper
power control	proper	improper
clean up	proper	improper
restart	proper	improper

<u>Manual Landing Gear Extension</u>	proper	improper

<u>Landing (VFR)</u>

pattern entry:			
entry point		proper	improper
altitude	high	proper	low
airspeed		proper	improper
downwind leg:			
distance out		proper	improper
heading		proper	improper
gear		proper	improper
flaps		proper	improper
cockpit check		proper	improper
alt. control		proper	improper
airspeed		proper	improper
base leg:			
turn	early	proper	late
heading		proper	improper
airspeed	high	proper	low
flaps		proper	improper
descent		proper	improper
final:			
turn	early	proper	late
heading		proper	improper
airspeed		proper	improper
descent		proper	improper
landing:			
touchdown	early	proper	late
attitude		proper	improper
heading	left	proper	right
brake appl.		proper	improper
cockpit cleanup		proper	improper

Comments:____

Check Pilot's Flight Checklist (Stage 2)

Student:______________________ Date:______________________

Check Pilot:______________________ A/C No.:______________________

Class No.:______________________ Type Check Ride:______________________

Approximate Time of Take-off:__________ Landing:______________________

Weather at Cairns Field:

At <u>beginning</u> of check flight:

Wind direction:______; velocity______knots

Turbulence: none______; light______; moderate______

At <u>end</u> of check flight:

Wind direction:______; velocity______knots

Turbulence: none______; light______; moderate______

Student's Tension:

None apparent______; moderately tense______; very tense

Check pilot comments on <u>photographed</u> portion of the flight: (Indicate <u>any</u> deviations from standardized flight profile)

____

____

____

____

____

____

Check pilot rating of student performance. Circle the appropriate response (omit any item not included in the check ride).

Take-off (ITO)

line up		proper	improper
power application		proper	improper
heading (runway)	left	proper	right
rotation	early	proper	late
gear up	early	proper	late
heading (climbout)		proper	improper
power reduction:			
throttles		proper	improper
props		proper	improper
sequence		proper	improper

Track Interception

turned to intended heading	proper	improper
rolled out on course	proper	improper

Holding Pattern

entry	proper	improper
timing	proper	improper
altitude	proper	improper
track	proper	improper

Missed Approach

time	proper	improper
report	proper	improper
procedures	proper	improper

Communication

tuning radios	proper	improper
reporting	proper	improper
lost comm. procedures	proper	improper

Partial Panel

heading control	proper	improper
bank control	proper	improper
airspeed control	proper	improper
altitude control	proper	improper

Single Engine Procedures

heading control	proper	improper
altitude control	proper	improper
power control	proper	improper
clean-up	proper	improper

Comments: ____

____

____

____

____

____

Appendix D

A DESCRIPTION OF THE PRINCIPAL FEATURES OF THE NEW TRAINING PROGRAM

ADMINISTRATIVE FEATURES

Some of the distinguishing features of the new program are administrative in nature. The most significant of these is the concentration of responsibility for all of a student's training in the hands of his *flight instructor*. Traditionally, in undergraduate training programs, the flight instructor has been responsible for only that portion of a student's training that takes place in the aircraft, while a device instructor is responsible for device training, and several classroom instructors share responsibility for other portions of training. Presumably, this divided responsibility is compensated for by a superior management effort or higher instructing skills. In practice, however, flight instructors often complain that device instructors are teaching the wrong thing or that classroom instructors do not present necessary information until some time after it is needed in the air.

In the new program, by contrast, the flight instructor is *the* instructor. He conducts or oversees all training received by his students. The resources he needs—an aircraft, a training device, programed textbooks, and personnel to assist him when required—are made available.

During the initial three weeks of the course, the flight instructor conducts carefully structured training in the device. During this period, he also assigns to his trainees programed texts[1] covering all the information that they will require, and he does this on a schedule that assures that they have covered the material prior to needing it in the trainer. An assistant, who is familiar with the programed texts, is available during this period to help the students should they have difficulty with the material, but the effort of the assistant is supervised directly by the flight instructor. It should be noted that much of the training provided by the flight instructor in the device could not be achieved by a nonrated device operator.

After each trainee has completed all the required programed texts and has developed all the specified skills in the device, the locus of instruction is shifted to the aircraft. This occurs at about the beginning of the fourth week of training. The remaining *scheduled* training takes place in the aircraft. However, should the instructor feel that additional practice in the device would help the trainee overcome a particular problem, remedial device training may be prescribed.

Training in the aircraft is expensive, and the instructor's effort is directed toward minimizing requirements for it. His responsibility, so far as inflight training is concerned, is to prepare his student for the final check ride to be administered by the Aviation School's flight check personnel. It is emphasized to the instructor that building up student flight time is not the goal of the new program; rather, it is the building of flight skills to the specified performance level. Therefore, on occasions when the student appears unresponsive during flight instruction—as students occasionally do—the instructor

[1] Programed textbooks which contained all the information required to be taught in the new program were available from other courses at the Aviation School.

is encouraged to terminate the period. To continue to fly a student under these circumstances only adds expense to an already costly program. Thus, there is no requirement to log any specific amount of aircraft time per student per day.

To encourage the flight instructor to prepare his students in a minimum amount of time, a progress ride identical in content to the end-of-course check ride is administered at an hour level between two-thirds and three-fourths of the total projected flight time that conduct of the course should take, that is, at about the 25-hour level. Students passing this progress ride will have demonstrated end-of-course proficiency and can be graduated from the phase at that point. One purpose of the progress ride is to discourage flight instructors from holding back a student beyond the time when he could pass a check ride just so that he might attain a higher grade. Such a practice adds unnecessary cost to training.

The primary purpose of the progress ride, however, is diagnostic. It is intended to identify those skills upon which the instructor should concentrate in order to prepare his student for the end-of-course check ride as soon as possible. An important part of the progress check ride, then, must be a provision for detailed feedback to the instructor involved. This feedback is accomplished by having the check pilot debrief the instructor in detail on trainee performance. This debriefing occurs right after the progress ride itself.

Attaining high grades has certain useful motivational value in flight training as does building up more flight time. It could be expected that a course designed to lower student grades and reduce the amount of flight time he can log might be poorly received. The new program includes an incentive award system designed to overcome these problems. The award system is performance oriented rather than schedule oriented and has two elements:

First, a student is awarded a check-ride grade by his check pilot as is customary. Added to that check-ride grade is a number of points determined by the hour level at which he completes training—the lower the total flight time required to complete training the greater the number of points awarded. For example, with a "scheduled" course length of 35 hours, a trainee who passes the course check ride in 30 hours with a check-ride grade of 75 would be credited with an additional five points, one point for each hour saved. His adjusted check-ride grade would be 80, a grade that would more accurately reflect his ability to develop skill as a pilot.

Second, free time is used as an incentive. Other HumRRO research has shown that Army trainees attach considerable value to free time and that it can be used to motivate them (15). In the program under review here, a trainee who passes the required check ride in less than the allotted eight weeks is given time off from all nonessential military duties for the remainder of the course. When all trainees assigned to a particular instructor complete the course requirements, then the instructor is also awarded time off as an incentive to expedite this training and reduce expensive flight time.

Thus, there are four principal administrative aspects of the new program that distinguish it from traditional practices: (a) the assignment of full responsibility for training to the flight instructor; (b) a diagnostic progress ride at a set point in training; (c) feedback to the instructor pilot; and (d) an incentive award system.

TRAINING CONTENT FEATURES

The new device is by no means a T-42 simulator. As noted in Study One, it is particularly weak with respect to handling qualities, and it is very difficult to trim. Further, the cockpit controls and the instrument panel are notably different from those of the training aircraft. Nevertheless, the similarity between the T-42 and the new device is much greater than that between the T-42 and any other pilot training device in the

Army inventory. The significance of these similarities is that they permit the device to be treated as an aircraft rather than as an item of training equipment. The simulation provided in the new device is sufficiently complete that it is a plausible representative of an unspecified light twin-engine aircraft, such as the T-42. A pilot able to fly one such aircraft, presumably, could make the transition to another with minimum difficulty.

During the first three weeks of student training, when the device and programed textbooks were being studied, every procedure and maneuver that could be performed in both the device and the aircraft were performed in the device. These included all aircraft prestart, start, run-up, and shutdown procedures, using checklists prepared to correspond, whenever possible, to the T-42 checklists; IFR missions, from instrument take-off through approaches and missed approaches; and, to a limited extent, training to cope with inflight emergencies. In the case of the latter, for example, a fuel starvation engine failure may be simulated, and the single-engine procedures similar to those required in the aircraft can be practiced.

All this training is performed in the context of crew training. Because of dual instruments and controls, a copilot seat, and a separate jump seat, two trainees always occupied the device. Except during initial training sessions where instructor assistance may be required with aircraft control tasks, a second student, seated in the copilot seat, performs normal copilot duties under instructor supervision. In addition to permitting specialized copilot training, when the instructor is not required in the copilot seat, this exposure to the training of a fellow student has been shown, in other research (15, 16), to aid pilot trainees, particularly where procedural and communications skills are concerned.

All training in the course is functional with respect to operational requirements. The first training period in the device, for example, is modeled after flight tasks typical of instrument flights in the training aircraft. It consists of performance of necessary aircraft checks and starting and run-up procedures, an instrument take-off, climb to assigned altitude, compliance with radar steers, and initiation of a VHF omnidirectional range (VOR) approach. Typical training periods consisted of filing an IFR flight plan and executing, in the trainer, the prescribed flight. The widely practiced procedure of practicing "basic airwork" during early training periods is not followed in the new program.

Transition to the aircraft is designed to require minimum disruption in training. As trainees begin to become proficient in the device, they prepare to transition to the T-42. Using a very low-cost T-42 paper trainer developed by HumRRO, T-42 checklist procedures are practiced to mastery so that minimum aircraft time is lost because of unfamiliarity with the aircraft itself. As a result, the student spends less time in executing necessary procedures than he would lacking such training. Getting into the air during the first aircraft flight period requires no more time than for students who typically have 20 to 30 hours of experience in the T-42. Transition is further enhanced by the fact that students and instructors are already familiar with each other, and the only thing new about the situation is that the actual aircraft is now being used.

The first flight period in the aircraft is largely a repeat of the last flight in the device, using a similar IFR clearance. Since each trainee has demonstrated in the device that he can plan a flight, file a flight plan, and fly the flight within specified tolerances in the device, his task during the first aircraft period is that of doing the same thing in the aircraft. In other words, the portion of the new training program conducted in the aircraft is primarily that of transitioning to the aircraft and polishing skills already acquired in the trainer.

There are, of course, aircraft control skill requirements that cannot be practiced in the device and have to be learned in the aircraft itself. These skills largely relate to control of the aircraft by external visual reference. A portion of the flight training in the aircraft, therefore, must be devoted to development of these VFR skills.

The VFR training also is conducted in a functional context. The usual practice of scheduling periods of VFR training early in the course in order to check out the trainee in the aircraft before instrument training begins is not followed in the new program. Instead, the required VFR training is conducted, as occurs in actual practice, as a part of a practice IFR cross-country flight. For example, at destination, students fly traffic patterns and land the aircraft in accordance with simulated or actual ATC instructions. This is a type of application of the integrated contact-instrument flight training concept studied in previous HumRRO research (6). As with all other training in the new program, the VFR training in the aircraft is accomplished on a proficiency basis. The instructor is required to train to specified performance objectives and there are no hour or experience requirements involved.

Thus, there are four principal training features of the new training program that distinguish it from the existing course—features that, for the most part, are made feasible by the correspondence between the device and the training aircraft. These training features are (a) provision of full mission training in the device, (b) the training of pilot and copilot skills within a crew training context, (c) the conduct of all training within a functional context, and (d) the continuity of training conducted in the device and in the aircraft.

PROFICIENCY ADVANCEMENT

There were other distinguishing aspects of the new program, in addition to administrative and training content features. One of these, the individualization of instruction through proficiency advancement techniques, already has been identified. All training—device, academic, and flight—is conducted on a proficiency advancement basis in the new course, and there are no requirements that a student receive a stated amount of training of any kind at any time.

Advancement of students from one block of instruction to another is accomplished in an objective manner. Maneuver performance records (MPR) were developed to facilitate this. The MPRs enabled the flight instructor to attend to each parameter of student performance during execution of a maneuver in the device and to record each deviation from the required performance objective. Using the MPRs, the instructor advances trainees from maneuver to maneuver in an objective manner that precludes unnecessary practice beyond required levels of mastery. An example of an MPR is shown in Figure D-1.

The MPR serves another important function as well. It provides detailed descriptions of trainee performance throughout his training in the device. The descriptions are an excellent means of providing knowledge of performance to the trainee, since they can be (and are) reviewed with him following each maneuver he performs. Specific, detailed information is thus available to both the instructor and the student concerning errors in student performance, progress over trials, and the changes in performance yet required before the necessary performance objective is reached.

In this new course, trainees are required to demonstrate appropriate skills in a progressively functional manner. Before any maneuver is performed by a trainee in the device, for example, he is required to describe all relevant aspects of that maneuver in detail to his flight instructor. Before the same maneuver is performed in the aircraft, it must have been performed without error in the device. The MPRs are of considerable value to both the instructor and the student in accomplishing this progressive training.

Maneuver Performance Record (Sample)

Single Engine Procedures
(Cruise)

Student ______________________ Sheet No. 1

Date	11/2	11/3	11/4		
Power (as required)	X	✓	✓		
Identified dead engine	✓	✓	✓		
Throttle (dead engine) closed	✓	✓	✓		
Prop lever (dead engine) feather	✓	✓	✓		
Gear (as required)	✓	✓	✓		
Flaps (as required)	✓	✓	✓		
Power (as required)	✓	✓	✓		
Trim	✓	✓	✓		
Cowl flaps (as required)	✓	✓	✓		
Fuel quantity switch & selectors (as required)	✓	✓	✓		
Alternator (dead engine) off	✓	✓	✓		
Airspeed 102 kts min.	✓	✓	✓		
Altitude (±100′)	X	X	✓		
Direction (±10°)	X	X	✓		
Errors	3	2	0		
Total prior time:	1st trial	15:00		Criteria reached	17:00

Figure D-1

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Two studies were conducted to evaluate a fixed-wing instrument procedures training device and to develop a training program for use with the device. In the first study, a group of trainees at the U.S. Army Aviation School who received synthetic instrument flight training with the new device were compared with a control group of trainees who did not. Men trained with the new device tended to perform more satisfactorily than the control

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group. The second study was concerned with development and evaluation of an instrument flight training program designed especially for use with the new device. Results showed a 40% reduction in number of flight hours required to attain the twin-engine transition and instrument flight objectives of the course. It appears that the training concepts used in developing the training program using the training device have application not only to other flight training courses for both fixed and rotary wing aircraft but in other programs utilizing training devices.

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1	ACADEMIC LIB FT HARRISON
1	DCS PERSONNEL DA ATTN CHF C&S DIV
1	DIR OF PLNS STUDIES & BUDGET ODCSPER
1	ASST CHF OF STAFF FOR FORCE DEVEL ATTN CHF TNG DIV
1	HQ ARMY MAT COMD R&D DIRECTORATE AMCRD-RC
1	CHF OF PERSNL OPS DA ATTN OPSC
1	DA OPO ATTN MOS SEC (NEW EQUIP) OPOPMO
12	ADMIN DDC CAMERON STA
1	CHF OF R & D ATTN CHF TECH & INDUST LIAISON OFC DA
1	TNG & DEV DIV ODCSPER, DA
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1	USA LIB DIV TAGO ATTN ASDIRS
1	PRES USA AVN TEST BD
1	CDR USA TRADOC ATTN ATTS-ITR
15	CG FORCES COMD ATTN AFOP-RE FT MCPHERSON GA
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1	CG 82ND ABN INF DIV ATTN ACOFS G3
1	CG XVIII ABN CORPS ATTN ACOFS G3
1	CO USA TNG DEVICE AGCY
1	DIR ARMY LIB
1	CHF OF MIL HISTORY DA ATTN GEN REF BR
1	USA GEN EQUIP ATTN TECH LIB FT LEE
1	CO USA RESCH OFC DURHAM NC
1	BSO SCI DIV ARD
1	RSCH CONTRACTS & GRANTS BR ARI
1	TECH LIB PERS 11B BUR OF NAV PERSNL
2	DIR PERSNL RSCH DIV BUR OF NAV PERSNL
1	TECH LIB BUR OF SHIPS CODE 210L
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1	CO US NAV AIR DEV CTR ATTN NADC LIB
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1	DIR US NAV RSCH LAB ATTN CODE 5120
1	DIR NAV RSCH LAB ATTN LIB CODE 2029 (ONRL)
1	CHF OF NAV AIR TNG TNG RSCH DEPT NAV AIR STA
1	DIR AEROSPACE CREW EQUIP LAB NADC
1	OFCR IN CHARGE US NAV PERS RSCH ACTIVITY SAN DIEGO
1	COMDT HQS, US MARINE CORP CODE AOIM
1	DIR MARINE CORPS INST ATTN EVAL UNIT
1	CHF NAV AIR TECH TNG NAV AIR STAT MEMPHIS
1	DIR OPS EVAL GP OFC OF CHF OF NAV OPS OPO3EG
2	COMDT PTP USCG HDQ WASH DC
1	SUPT USCG ACAD NEW LONDON CONN
1	HQ ATC ATTES RANDOLPH AFB TEXAS
1	TECH DIR TECH TNG DIV (HRD) AFHRL LOWRY AFB
1	DEPT OF THE AF HQS ATTN AFCIN-3D1
1	CHF SCI DIV DIRCT SCI & TECHNOLOGY AFRSTA
1	FAA DIR OF PLNS & OPS DCS/P&O
1	RSCH & ANALYSIS DIV HQ USAF
1	ATC ATXRQ RANDOLPH AFB
1	AFHRL/TT ATTN CAPTAIN WAYNE SELLMAN LOWRY AFB
1	AIR FORCE MIL TNG CTR XRS LACKLAND AFB
2	AFHRL (HRT) WRIGHT-PAT AFB
1	HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
1	AF HUMAN RES LAB MANPOWER DEV ATTN COL RATLIFFE
1	DIR AIR UNIV LIB ATTN AUL3T-63-253 MAXWELL AFB
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1	TECH TNG CEN (LMTC/OP-I-L1) LOWRY AFB
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1	AFHRL (FT) WILLIAMS AFB ARIZ
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