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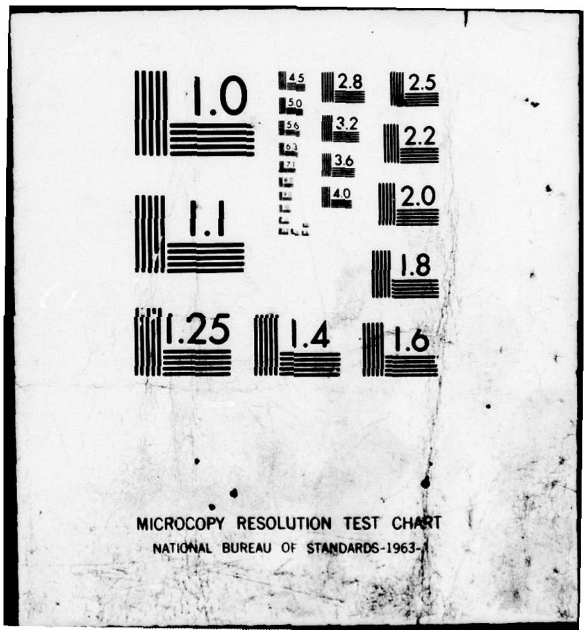
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SEVILLE
Technical
Report
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LEVEL II

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TRANSFER OF TRAINING EFFECTIVENESS EVALUATION (T^2E^2):

U.S. NAVY DEVICE 2B35

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July 1979

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Chief of Naval Education and Training Support
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T2E2

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

This report describes a four-phase transfer of training effectiveness evaluation (T^2E^2) for Navy Device 2B35. Device 2B35 is a computer-generated image visual display system that is used in the Advanced Jet phase of Navy Undergraduate Pilot Training (UPT). The 2B35 is used in integration with the 2F90 simulator for the TA-4J aircraft.

In Phase I of the effort, an evaluation plan was developed in which the training effectiveness of Device 2B35 was to be investigated for the

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20. Familiarization (FAM), Night Familiarization (NF), Weapons (WEP), and Carrier Qualification (FCLP/CQ) stages of Advanced Jet training. The design involved a control group at each stage and two simulator groups at FAM, NF, and CQ stages and one simulator group at the WEP stage. The two simulator groups at FAM, NF, and CQ stages received differing amounts of simulator instruction. Subjects were 60 student Naval aviators undergoing training at Chase Field, Texas. Special objective grade forms were developed for the gathering of both simulator and inflight performance data. Phase II was the data gathering effort, while Phases III and IV involved data analysis and reporting.

Results provide support for use of the 2B35 for FAM and WEP training stages, but not for the NF stage. Data for the CQ stage were insufficient to make a determination of effectiveness. Recommendations concerning 2B35 use and future use of visual simulation in Navy UPT are offered.

PREFACE

This report presents the results of a four-phase Transfer of Training Effectiveness Evaluation (T^2E^2) of U.S. Navy visual simulation Device 2B35. The general objective of the T^2E^2 effort has been to evaluate the effectiveness of the 2B35 in the Navy Advanced Jet training phase of Undergraduate Pilot Training (UPT). This report describes the work performed and makes recommendations concerning 2B35 use.

Device 2B35 is a computer-generated image (CGI) device that presents visual cues representing the extra-cockpit scene to which the pilot responds. The device, located at Chase Field, Texas, is one of three such devices used in the undergraduate training of Naval aviators by the Naval Air Training Command. As the importance (and cost) of simulation devices to military flight training programs has increased, there has developed an increasing concern over empirical determination of the training benefits accruing from use of such devices. This concern in the Navy emanates from the Chief of Naval Operations and is evident at all levels of command. The present effort represents the first in a series of such evaluation efforts projected by the Chief of Naval Education and Training (CNET). The ultimate outcome will be more effective management and employment of the Navy's valuable simulation resources.

As will be seen in reading this report, the evaluation was planned and conducted in consideration of a great variety of technical and pragmatic factors relevant to the UPT program in which the evaluation was carried out. Navy guidance emphasized the importance of both the technical and practical aspects of the evaluation.

While this report is a contractually required documentation of the efforts of the Seville Research Corporation project team, it must be noted that it represents the efforts of the larger Navy-Seville team, efforts that have been marked by an effective cooperative, interactive relationship. Project activities involved contractor interactions with literally scores of Navy personnel. The bulk of the project activities took place at CNATRA Headquarters, NAS Corpus Christi, Texas, and at NAS Chase Field, Texas.

It is not possible to acknowledge by name each of the persons who assisted the project, but their support has been invaluable. However, the direct support and guidance of the following U.S. Navy personnel has been especially useful:

--LCDR E. D. Beard, CNET, Contracting Officer's Technical Representative

--CDR A. D. Windsor, CNATRA, N-22

--Mr. D. N. Mealy, CNATRA, N-2A

--Dr. F. Schufletowski, CNATRA, N-003

--LT C. D. Murphy, TRAWING 3 Standardization

--CPT R. Rice, TRAWING 3 Standardization

--LT J. W. Alger, ATSU-3

--TD/1 W. O. Watkins, ATSU-3

In addition, the command guidance of the following persons has been crucial:

--CAPT T. C. Wimberly, Commander, TRAWING 3

--CAPT E. V. Teeter, Chief Staff Officer, TRAWING 3

--CDR R. L. Mock, Commander, ATSU-3

Without the inputs of these and other Navy personnel, it would have been difficult to develop and conduct an evaluation plan that met both the technical and practical criteria. Failure to meet either of these demanding requirement areas would have resulted in a T^2E^2 effort less effective and useful than desired by the Navy.

Seville's activities have been carried out under Naval Training Equipment Center Contract N61339-77-C-0164, with LCDR E. D. Beard, CNET, as Contracting Officer's Technical Representative. The effort has operated under the joint cognizance of the Chief of Naval Education and Training (CNET), the Chief of Naval Air Training (CNATRA), and the Chief of Naval Education and Training Support (CNETS).

The Seville project team's on-site activities at Corpus Christi and Chase Field have been under Dr. William V. Hagin, Project Director. Responsibility for the technical evaluation design was largely assigned to Dr. Frank R. Yekovich, while training and measurement development and on-site monitoring have been the responsibility of Mr. Winon E. Corley and Dr. Edwin P. Durall.

Wallace W. Prophet
Program Manager

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I. INTRODUCTION

BACKGROUND

This report presents results of a transfer of training effectiveness evaluation of a visual flight simulator, Navy Device 2B35. The 2B35 is an example of the class of devices that presents a representation of the extra-cockpit visual scene to the trainee. Such devices are receiving increasing attention as the Navy and the other services seek to extend the cost and training benefits of simulation devices to additional areas of training, i.e., to the training of those tasks whose performance is in whole or in part dependent upon external visual cues.

Ground training devices have become widely accepted within military flying training programs as an adjunct to airborne training, particularly for instrument and procedures training. While it is generally recognized that were such devices not available additional flying time might be required to meet training requirements, there is generally a strong resistance to replacing available flying time with simulator time. Such resistance is especially strong for visually cued training. This view is understandable, considering the relatively recent availability of good visual trainers and the lack of any substantial military experience or research data base regarding their training effectiveness.

Assurance of the military worth and training effectiveness of visual trainers has become of critical importance because of the significant increment visuals add to training system acquisition and operational costs. Further, assurance is required concerning their training transfer value, so that their use does not result in an unwitting decrement in training effectiveness.

DEVICE 2B35

The U.S. Navy was the first of the military services to incorporate a visual training device capability into its operational Undergraduate Pilot Training (UPT) program. In 1972, the Navy added a computer-generated image (CGI), wide-angle visual attachment to one of the 2F90 operational flight trainers being used in the Advanced Jet training phase of its UPT program. This prototype visual (referred to as the Advanced Development Model, or ADM), was installed at Kingsville NAS, Texas, and subjected to an engineering and pilot evaluation of its suitability to support Advanced Jet training.[1] While these analyses did not provide unequivocal support for large-scale substitutions of simulator training for flight time, they did suggest that the visual add-on offered sufficient training transfer potential to justify its use.

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[1] Human factors evaluation 2F90 visual system, contract: N61339-72-C-0192. Daytona Beach, Fla.: General Electric Company, May 1973.

Based on these assessments, a decision was made to procure two additional devices, somewhat improved over the ADM, for installation at the other two Advanced Jet training bases--Meridian NAS, Mississippi, and Chase Field NAS, Beeville, Texas--thus providing visual simulator capability at each of the three Navy Advanced Jet UPT installations. These new systems were designated as Device 2B35.[1] Following a second engineering and pilot evaluation of the system's potential for visual task training, the Advanced Jet UPT syllabus[2] was modified to provide device training for students during the Familiarization (FAM) and Weapons (WEP) stages of Advanced Jet training.[3] In the FAM stage, two aircraft flights were replaced by three periods in the trainer. For weapons training, no aircraft flights were deleted, but four simulator rides were added to improve the quality of training.

The 2B35 has been used for over 2 years, mostly to support FAM and WEP training.[4] This restriction to FAM and WEP stages was, in part, due to CGI visual data base limitations,[5] but it was principally due to device availability--i.e., the one trainer at each station could, at best, generate only 14 to 16 training hours per day on a two-shift schedule, an amount barely sufficient to support the FAM and WEP training loads created by the Navy's projected Pilot Training Requirement (PTR).

The 2B35 is a CGI visual display system integrated with the 2F90 operational flight trainer for the TA-4J aircraft. It has a field of view of approximately 60° x 210° and utilizes three rear-projection screens. Full color is provided, and the system is capable of generating special effects such as fog, haze, and ceiling. Both day and night scenes are possible. A three-screen CRT representation of the pilot's display is also provided at the instructional console. The usual repeater cockpit instrumentation is provided for the instructor. Data outputs from the simulator are provided through an X-Y ground track recorder, two four-channel strip recorders, and a teletype print-out of certain performance parameters, such as target miss distance and azimuth; bomb release altitude, airspeed, and dive angle; wire contact for carrier landing; vertical velocity at touchdown; and other parameters.

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[1]As used throughout this report, the term 2B35 also includes the 2F90 operational flight trainer to which the 2B35 visual has been added. The 2F90 is a conventional operational flight simulator for the TA-4J aircraft. It consists of a student cockpit station, which has a limited pitch, roll, and heave motion system, and an instructor/operator station. The 2F90 was introduced into Navy UPT in 1969 and has been used since that time to support instrument and emergency procedures training, as well as the instruction of routine cockpit procedures.

[2]The Navy utilizes three syllabus tracks or pipelines in its UPT. One is for the trainees who will becomes helicopter pilots (HELO), while a second (the MARITIME syllabus) is for those who will go into multi-engine propeller and larger jet aircraft. The third track, the STRIKE syllabus, is the one of concern here. It is the jet pipeline that feeds the fighter and attack aircraft communities.

[3]CNATRA INSTRUCTION 1542.20B. Curriculum, Advanced Jet (TA-4J), 20 September 1976.

[4]It was also used for limited support in the Carrier Qualification (CQ) stage, i.e., the provision of carrier deck emergency procedures training.

[5]The FAM and WEP cue generation programs were the most extensively developed.

NAVY CONCERNS WITH THE 2B35

Since the operational installation of the 2B35 devices, their use has been viewed by the Navy as an effective adjunct to WEP training. Instructors were generally of the opinion that students with the 2B35 WEP training were better prepared for their first weapons training flights than were those students who had not been so trained. In fact, students with device training were allowed to drop practice bombs on their first aircraft flight, while those without such experience were not.

The judged utility of FAM training in the device was another matter. Usefulness of the device for FAM training was seriously questioned, and many instructors were not only of the opinion that the 2B35 training was not beneficial, but that it was actually detrimental to the student's performance in the aircraft. Empirical confirmation or denial of these convictions was desired by the Navy.

The Navy was obviously concerned about the specific benefits, or lack thereof, of the 2B35 for the FAM, WEP, and other training stages. Decisions needed to be made regarding its best use in the Advanced Jet program, i.e., whether to continue present uses of the 2B35; or to plan other, more productive, exploitation of its capabilities; or, possibly, to discontinue its use altogether. Assuming that it was potentially useful, it was desired that approaches to device use be identified which would provide positive transfer for critical, high-value skills. It was also important that the methods of use for the device identified be practical and feasible for operational implementation in the CNATRA training system.

In addition, the Navy was also interested in an examination of the more general question of the utility of visual flight simulation at the undergraduate level of training. There was a need for information that would be helpful in future design and procurement decisions concerning visual simulation devices, particularly CGI devices.[1]

Valid answers to such questions required that a systematic evaluation of the 2B35 be conducted. The Navy recognized that technically sound evaluations of training devices in operational flight training programs are significantly more complex than simple laboratory-like experimental demonstrations of transfer of training. An operational evaluation not only must be scientifically defensible, i.e., structured so as to handle the variables of interest in a technically sound manner, but it must be conducted in reasonable conformity with a large number of practical considerations so as not to interfere unacceptably with ongoing training activities.

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[1]An example is the current procurement action contemplated by the Navy for the VTXTS training aircraft intended to replace both the T-2 aircraft used in the Basic Jet phase and the TA-4J aircraft used in the Advanced Jet phase of UPT. A part of the VTXTS procurement will involve the acquisition of various simulation devices to support training.

NAVY APPROACH

A transfer of training effectiveness evaluation was envisioned as the most effective approach. Such an effort would provide empirical data upon which to determine the best future use of the 2B35 and would also provide insights concerning the role of visual simulators for the next generation Navy UPT system.

The Navy subsequently contracted with Seville Research Corporation to perform the Transfer of Training Effectiveness Evaluation (T^2E^2)[1] of the 2B35, and this report presents the results of that evaluation. The effort was contractually divided into four phases: (1) Evaluation Plan Development; (2) On-Site Instructor Training; (3) Data Collection; and (4) Data Analysis and Reporting. The Phase 1 effort, with the projected work plan for the accomplishment of Phases 2-4, has previously been reported.[2] The present report covers the latter three phases, but it also treats Phase 1 activities, as necessary to the general exposition.

Seville's activities were performed under contract N61339-77-C-0164. Three Navy agencies were responsible for monitoring the contract effort and also took roles as active participants jointly with Seville. These agencies were: (1) Chief of Naval Education and Training (CNET); (2) Chief of Naval Air Training (CNATRA); and (3) Chief of Naval Education and Training Support (CNETS). Overall contract technical management was the responsibility of CNET, while CNETS was responsible for monitoring the technical adequacy of the effort. CNATRA played a major role in providing aviation training subject matter input to the effort and was responsible for the actual execution of Phase 3 of the effort, i.e., the administration of training and collection of data.

ORGANIZATION OF REPORT

Because of the contractual arrangement of study activities described above, the organization of this report is slightly different from that customary in technical research reports. It consists of four sections, of which this introduction is the first.

The second section describes the Phase 1 planning activities. These activities, while somewhat more extensive than might usually be the case, in essence were the equivalent of the activities and considerations typically described in the "methods section" of technical reports. The planning activities included familiarization with the content and management of Navy jet training, assessment of the 2B35's potential for training, and development of the study design. Also included were training task selection, development of instructional strategies, and data collection and analysis procedures.

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[1]The Navy has used the abbreviation "T^2E^2" to stand for "Transfer of Training Effectiveness Evaluation." This abbreviation will be used throughout this report as the title of this effort and as a descriptor of procedures or materials used in the effort.

[2]The Phase 1 effort was described in detail in Seville TR 78-02: Transfer of training effectiveness evaluation (T^2E^2): U.S. Navy device 2B35. Phase 1 report, evaluation plan, March 1978. That report was contractually required and provided the Navy with information concerning study design and work plans for Navy review and approval. Distribution was limited to contract monitoring personnel.

The third section presents the principal study results. It includes a description of student learning that resulted from 2B35 device training, and it presents the results of the statistical analyses of student performance in the aircraft that are basic to the determination of transfer effects.

The fourth and last section of this report discusses the implication of the study results for 2B35 use and the more general implications for visual simulation per se in future Navy UPT.

II. METHOD

INTRODUCTION

The study began with two concurrent preparatory activities: (1) an in-depth review of Navy UPT content and management; and (2) an assessment of the training potential of Device 2B35. The purpose of these two activities was not only to gain familiarization with training operations and device capability, but also to develop an initial inventory of candidate training activities.

Accomplishment of these two efforts was achieved through review of CNATRA syllabi and training materials, frequent interactions with the CNET and CNATRA staffs, and on-site observations of Advanced Jet training operations in the two Advanced Jet training squadrons (VT-24 and VT-25) at NAS Chase Field, Texas.[1] During the many on-site visits which were made, extensive interactions occurred with all levels of the training activity--from the Commander, TRAWING 3 and his staff, through the two Advanced Jet training squadron commanders, down to flight line and training device personnel. In this way, the effort was established as a joint Navy-Seville cooperative project.

REVIEW OF NAVY UPT

The Navy conducts Undergraduate Pilot Training as a multi-tracked, multi-phased program. After the Primary phase training in the T-28,[2] students proceed to one of the following: (1) the helicopter track; (2) the two-phase, multi-engine track; or (3) the two-phase jet track. The two jet phases are identified as Basic and Advanced Jet training, respectively. In the Basic Jet phase, the student receives flight training in the T-2, a relatively stable and forgiving airplane, and in Device 2F101, a relatively modern instrument flight simulator. In the Advanced Jet phase, he is trained in the TA-4J, an advanced aircraft with handling characteristics much like those of line fighter and attack aircraft; in the operational flight trainer, Device 2F90; and in the visual trainer, Device 2B35, the subject of this effort.

Advanced Jet Phase

Advanced Jet training is conducted at three Naval Air Stations, located at Meridian, Mississippi, Kingsville, Texas, and Beeville, Texas. Training at each of these stations is under the general surveillance of a Training Wing Commander, but is managed on a day-to-day basis at the training squadron level. It is at the squadron level that direct control over the students' training schedule and progress exist. Within the squadron, surveillance and control of the instructional process are maintained

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[1]Chase Field had been designated by the Navy as the study site.

[2]The subjects used in this study came from a T-28 Primary program. The T-28 is being phased out, and the T-34C has become the Primary phase training

through NATOPS[1] and NATIPS,[2] the CNATRA training syllabus, CNATRA Flight Training Instructions (FTI), and Squadron Briefing Guides. While these documents prescribe in detail the content and sequence of training activities and establish the basic parameters to be met, they leave much to the instructor's individual "technique."

Students are assigned both a "primary" and a "secondary" or backup instructor pilot (IP). In this way, continuity of instruction is somewhat assured. Since not all squadron instructors are qualified to teach in all Advanced Jet training stages, some instructor changes do occur. This happens most often in the latter part of the program during Air Combat Maneuvering, Weapons, and Carrier Qualification stages of training. Because the student has both a primary and secondary instructor, and because of the changes in instructors that frequently occur from one stage to another, the student is exposed to a variety of instructional techniques.[3]

The student entering Advanced Jet training has a considerable amount of contact and instrument flight training behind him, having had on the average 26 flight hours in the Primary phase and 118 flight hours in the Basic phase.[4] All the Basic phase flight hours are in the T-2 jet aircraft. The T-2 flying experience will have covered instruments, aerobatics, some weapons work, and day carrier qualification. In addition, the syllabus calls for 40.5 hours of 2F101 simulator instrument time in the Basic phase. As a result, by the end of the Basic phase, the student aviator has acquired substantial skill in flying jet aircraft.

The Advanced Jet phase runs 20 weeks, during which the student receives approximately 113 hours in the TA-4J, 52 hours in the 2F90 (instruments), and 12 hours in the 2B35 (visual).[5] Students enter and exit the program weekly, at a rate of approximately four per week.[6] As a result, there are few students grouped at any one place in the curriculum at any given point in time.

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[1]Naval Air Training and Operating Procedures Standardization Program.

[2]Naval Air Training Instructional Procedures System.

[3]While this does not necessarily impede student learning, these technique differences represented a possible source of difficulty for the study in controlling adequately the characteristics of training from instructor to instructor.

[4]These phase-hour relationships have been changed under the syllabus that was instituted with the advent of the T-34C. The information cited in the text, above, is applicable to all student subjects involved in the T^2E^2 study.

[5]These times are as prescribed in CNATRA Syllabus 1542.20B, dated 20 September 1976. All references in this report to the "CNATRA syllabus" or to the "Advanced Jet syllabus" refer to this 1976 syllabus. As noted in the preceding footnote, that syllabus has been modified as a result of the introduction of the T-34C as the Primary phase training aircraft.

[6]This flow rate varies somewhat as a function of student progress in the Basic phase, weather, the PTR, etc.

The student's first task in the Advanced Jet phase is to become an accomplished instrument pilot in the TA-4J, and to master the general handling characteristics of that aircraft. Next, he learns to use the aircraft in advanced formation, operational navigation, basic weapon delivery techniques, and elementary air combat maneuvering. Finally, he also must qualify on day carrier landings. Upon completion of the Advanced Jet phase, the student is designated a Naval Aviator and proceeds to a Fleet Readiness Training Squadron for qualification in an operational aircraft.

DEVICE 2B35 UTILIZATION

The Advanced Jet syllabus provides for Device 2B35 training during the Familiarization, Weapons, and Carrier Qualification stages. There are three trainer flights (3.9 hours) scheduled for FAM, four (6.0 hours) for WEP, and one (2.0 hours) for CQ. The 2B35 FAM training under this syllabus consists principally of practice on airwork and landings as appropriate for pre-solo training. The 2B35 WEP training involves weapons pattern flying and bombing practice. The 2B35 CQ training is limited to catapult launch and carrier deck emergency procedures familiarization; it does not treat carrier landings.

First-hand observation of this device training revealed several major problems with the way it was being given and with student/instructor confidence in its utility. The trainer was being used by most instructors much as they would use an aircraft. As a result, use of training features such as freeze and reinitialization was unsystematic and not productive. Further, available performance measurement information was infrequently utilized as feedback to the student in the instructional process. The only exception was the use of the computer printout of practice bomb scores during weapons training.

A number of instructors observed were judged to be quite effective in their use of the trainer, even though their use model was largely based on their airborne instructional techniques. Their effectiveness might be considered somewhat surprising, since IP training on how to use the 2B35 was found to have been mostly informal, unsystematic instruction given by "someone who knows how." Furthermore, few detailed, written operating procedures or instructions were available describing device setup procedures, use of special features, etc.[1]

The majority of these instructors were less than enthusiastic about the device's training value, particularly for FAM training, and their approach to its use reflected this attitude. This lack of enthusiasm was in part attributed to the fact that the device was often not working when needed for training. Whenever the device was inoperable, it created a problem for the instructor that often disrupted the training flow. Since there was only one Device 2B35, any extended maintenance problem or downtime required a procedure for continuing training without it. As a consequence, a provision existed for continuing training without the device if it was down, or expected to be down, for 48 hours or more.[2]

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[1]Seville had to prepare a console operations manual for its own use to insure the availability of some standard reference, since no such manual existed.

[2]This provision was contained in the Advanced Jet syllabus. The syllabus provided in FAM a "visual syllabus" (i.e., utilizing the "visual" 2B35), and a "nonvisual syllabus" (i.e., FAM instruction without the 2B35). The nonvisual FAM syllabus provided two extra aircraft flights (1.4 hours each) over the five flights (1.4 hours each) provided in the visual syllabus.

It would appear that nonavailability or nonutilization of the device occurred with some frequency. Review of simulator utilization reports from Chase Field for the 12-month period November 1976-October 1977, showed that 1,389 periods were available for squadron use, but only 614 were actually used by the squadrons. A further examination of student records showed that the average student actually received only about 5.4 hours in the 2B35 rather than the 11.9 hours called for in the syllabus. These data raised serious question concerning whether the device could have any substantial impact on Advanced Jet training at this level of utilization.

IP and Student Attitudes

In order to gain some further insight into observed IP and student negative attitudes toward the 2B35 and the ongoing device utilization practices just described, a questionnaire was developed and administered to a sample of students and instructors from the two squadrons. The questionnaire was intended to tap their experiences with the 2B35 and to explore their attitudes concerning its use. Even though the sample was small, the responses of students and instructors showed marked consistency concerning the frequency with which various visual maneuvers were performed in the 2B35. Further, their responses showed inter-maneuver differences in frequency that were consistent. For example, in the FAM stage both student and IP groups reported that the Taxi, Takeoff, Entry and Break, and Crosswind maneuvers were typically performed by students in the 2B35 between zero and five times. In fact, these reports indicated there were virtually no instances of usage of the device to teach crosswind techniques. Upper airwork maneuvers exhibited relatively low usage also.

In contrast, the Landing and Traffic Pattern maneuvers showed modal performance frequencies in the 6-10 range, with some respondents reporting frequencies of 20 or greater. Thus, the differences across maneuvers indicated a degree of selectivity in the utilization of Device 2B35, while the pattern across instructors and students was fairly consistent.

The attitudinal expressions on the questionnaires showed a strong trend toward "It's nice for procedures, but not too good for training actual visual flight skills." The consistency with which these attitudes were expressed, and even their wording, reflected almost an institutionalization of this pessimistic point of view. It was clear from these data, and the interactions with the training squadrons, that the device was being used with limited acceptance in the FAM stage. There, its use was viewed as a chore, at best, and, at worst, as a source of negative training transfer. In contrast, the 2B35 was relatively well regarded for WEP training and for CQ deck emergency procedures training.

Deficiencies in 2B35 Performance

The most common complaints dealt with the power responses of the trainer and difficulties in ball tracking during landing approaches.[1] The validity of these concerns was largely confirmed after further observations of both students and instructors flying the device's field and carrier landing approaches. Excessive "stick-pumping" seemed to

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[1]Maintaining center ball on the Fresnel Lens Optical Landing System (FLOLS) and the prescribed angle of attack are critical to successful carrier landing approaches. Problems with the 2B35 in this regard had for some time been documented by both training squadrons and at TRAWING 3 level.

be the only way the ball could be maintained anywhere near center. Even this 'poor'[1] technique proved to be mostly ineffective during the latter part of the approach as the aircraft neared touchdown. Obviously, the 2B35 either was not providing the right cues or not eliciting the correct responses, or both. The implications for the T^2E^2 effort were clear--such problems had to be identified, and those most critical to training corrected before an empirical transfer of training assessment would be profitable.

As a first approach to understanding the power-response and ball-tracking problems, the study team had several expert TA-4J pilots fly a large number of field and carrier approaches while the device strip recorders were being used to plot stick movement, angle of attack, airspeed, etc. At the conclusion of these trials, it was quite evident that the IP subjective reports were well founded. Not only was consistent ball tracking impossible, but there appeared to be little relationship between the control of the appropriate flight parameters (as reflected from inspection of the strip recorder data) and a 'successful' approach and touchdown. Whether or not the pilot got a 'trap' on a carrier approach appeared to be more a matter of chance than pilot skill. These results convinced the study team that the device as it was operating would not provide positive transfer to the airplane for the critical visual training tasks of interest.

Corrective Actions

In-depth discussions with local maintenance personnel led to a consensus that the problems were engineering or software in nature (as opposed to being due to improper maintenance or calibration), and that correcting them was beyond the capabilities of the local personnel. In addition, action toward correction of the problems was beyond the scope of the transfer study evaluation itself. As a consequence, the situation was discussed with the CNET, CNATRA, and CNETS contract monitors, and engineering assistance from the Naval Training Equipment Center was requested. Corrective action on these problems was essential if the study were to proceed. The problems identified by the study team as of particular concern were:

(1) Ball tracking

(2) Stick/throttle response

(3) Carrier scale and wake modeling

(4) Carrier 'trapping'

(5) Light valve sparing

(6) Airfield perspective cues.

As a result of these discussions, a plan was developed whereby the Navy's engineering and maintenance support staff could effect appropriate corrective actions in time for the evaluation proper to begin on schedule. Appendix A provides copies of Navy memoranda which summarize the corrective actions taken.

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[1] 'Stick-pumping' was unanimously identified by IPs as a poor control technique, one which they did not allow in the airplane.

DEVICE 2B35 TASK TRAINING POTENTIAL

Before proceeding further to develop the evaluation design, it was necessary to identify those training stages and tasks for which the 2B35 might reasonably be expected to have training value based on an analytic assessment of its cue-generation and display capabilities and limitations. An empirical examination of device transfer of training potential obviously would be inappropriate for tasks which required cues that the 2B35 produced marginally or not at all. Two aspects of the 2B35 visual cueing capability were of prime concern. These were the image generation and cue saliency aspects of the device and the display field of view, resolution, and brightness.

The 210° x 60° field of view of the 2B35 was judged by the project team as adequate for providing at least the minimum cues for most of the visual tasks in the syllabus. Likewise, resolution and brightness of the visual display were considered acceptable for the majority of these visual tasks. Notable exceptions in this regard, principally due to field of view and display resolution limitations, were air-to-air gunnery and related Air Combat Maneuvering tasks. The 2B35 was judged marginal for the maneuvering envelopes and target sizes involved in these tasks and it was concluded that the amount of basic fighter/attack maneuvering training that could be included profitably in the evaluation would be severely limited by these constraints.

The device was also found to have limited potential for Formation flight training, since a lead aircraft for Formation flying could only be flown from a second cockpit in the four-cockpit complex. There was no provision for flying lead from the 2B35 console, either manually or by computer.[1] This, coupled with the stark, unrealistic configuration of the modeled aircraft, did not make Formation an attractive candidate task.

The 2B35's image generating capability was restricted mainly by the state of development of the computer data bases. When originally introduced into operational training, it had acceptable image generating data bases for both the FAM and WEP stages. During the two years of operational use, the data bases to support task training in these two stages had been further refined, and data bases were developed as well for Night Familiarization (NF), Operational Navigation (ON), Formation (FORM), and Field Carrier Landing Practice/Carrier Qualification (FCLP/CQ). Of these four stages, data base development was least adequate for FORM and ON, and these two data bases were judged to require more software generation effort than was expected to be available in the time frame of the evaluation effort. This left FAM, NF, WEP, and FCLP/CQ as the stages for which the 2B35 had acceptable display capability and workable data bases, and for which it appeared to have sufficient task training potential to warrant their possible inclusion in the study.

Concentration on these four stages for specific training task selection was further supported by an examination of student grade folders and CNATRA attrition data. FAM, WEP, and FCLP/CQ were obvious "pressure" points, of which the most acute was

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[1]The 2B35 was installed on one of the four 2F90s which make up a trainer complex, or "deck." The lead aircraft would have to be flown on instruments.

FCLP/CQ. It was in these stages that the students appeared to have the most difficulty and to receive the greatest number of "downs."[1] Thus, a demonstration of the transfer potential of the 2B35 for critical tasks within any or all of these stages would be of significant value to the Navy. In addition, the use of the night scene during NF stage training was also of interest. There were no major problems in planning the T^2E^2 for FAM, NF, and WEP, but the problems with the 2B35 that involved ball tracking and carrier "trapping" were of such magnitude that a final decision to include CQ in the evaluation could not be made until these problems had been identified, solutions effected, and TRAWING 3 LSOs[2] had endorsed the solutions as acceptable.

In order not to delay the planned May 1978 start date for the second phase of the effort, it was decided to go ahead on the assumption that all major 2B35 deficiencies would be corrected in time (as they, in fact, were). Should all items not be resolved satisfactorily at that time, the design could be modified appropriately and the study could proceed on schedule, or the start date extended if appropriate.

EVALUATION DESIGN DEVELOPMENT

General Considerations

Development of the device evaluation design involved many considerations. Obviously, the design had to provide a valid evaluation of the major variables related to acquisition of visual flight skills in the 2B35 and their transfer to the criterion or flight situation. More specifically, the questions to be addressed were: (1) whether visual skills training given in Device 2B35 would produce demonstrable learning; (2) whether such learning (assuming its existence) would transfer to performance in the TA-4J aircraft; and (3) the nature and amount of such transfer (assuming its value to be other than zero). Further, the design should allow a determination of the transfer effects of two other factors of major interest: (1) the nature or type of flight skill involved; and (2) the amount and sequence of device training provided.

There was another general consideration that had a major effect on the overall study design. This consideration involved the Navy's desires that the results be of practical as well as theoretical value and that the training regimens employed during the evaluation be readily implementable (assuming positive and practical transfer were demonstrated). This concern dictated that the training strategies employed be compatible with established Navy training program management and training administration practices and procedures. This would assure operational utility of the study results and would significantly enhance the likelihood of long-term application within the Navy's Advanced Jet training program.

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[1] A down is a failing grade for a training flight.

[2] The Landing Signal Officer (LSO) is the individual who provides detailed radio guidance to the Navy pilot concerning his approach path, speed, and angle of attack during the approach to carrier landing or to FCLP. The LSO is located on board the carrier (or at the end of the runway for FCLP) and derives his guidance from direct visual observation of the aircraft's approach and actions.

There were, of course, numerous other factors that influenced determination of the most appropriate evaluation design. Critical among these were matters such as the number of students available, the number of device hours that could be provided, the workload of the instructor pilots, and TRAWING 3 administrative support capability. The scope of the evaluation design ultimately selected would obviously be affected by these factors.

Two design options were entertained. One utilized an individualized, train-to-proficiency training regimen, while the other involved a lock-step, constant-time, training strategy. The first option had the advantage of providing information about time or trials required to train and would allow computation of both transfer ratios (TRs) and transfer effectiveness ratios (TERs). While such direct assessment of transfer effects was attractive, the second option, the fixed-time treatment approach, was more compatible with the ongoing syllabus and schedule procedures. This second option was selected because it was the strategy in operational use in Navy UPT, and it had the advantage of requiring minimum departure from the existing CNATRA syllabus, it would allow the use of existing scheduling and sequencing procedures, and it would simplify both TRAWING 3's management workload and T^2E^2 instructor pilot training. The Navy had emphasized that minimizing IP workload was a major consideration because of the extreme shortage of IPs that existed at that time, a shortage that was expected to prevail throughout the effort.

After weighing the above factors, design options, management concerns, and Navy desires, it was decided to structure the evaluation design as a series of stage evaluations, sequenced in accord with the existing syllabus: FAM, NF, WEP, and FCLP/CQ. This procedure would also allow maximum use of existing training support materials.

Evaluation Design

The evaluation design which best met all of the above considerations was basically a three-group design. It provided for three levels of the simulator time variable at each of the FAM, NF, and FCLP/CQ stages (including zero hours). At the WEP stage, however, the design called for only two major groups, a simulator group and a nonsimulator control group.

The decision to use only two groups for the WEP evaluation was basically driven by the maximum number of students (N=60) anticipated to be available during the time span of the study. This would allow an N of 20 for each of the three FAM treatments. By using only two WEP treatments--device-plus-aircraft training vs. all-aircraft training--and by assigning equal numbers of subjects to each of the WEP groups from the preceding FAM treatments--the interaction effects between FAM and WEP could be examined with an N of 10 for each subgroup. Then, by similarly assigning equal numbers of subjects from the two WEP groups to each of the FCLP/CQ groups, the design would allow an examination of the interactions between the three FCLP/CQ treatments and the preceding WEP training.

A flow chart of the design is presented in Figure 1. The major treatment groups at each stage level are shown in the bold-lined boxes, while the interaction subgroups at the WEP and CQ stages are shown by thin lines. The levels of the independent variable (amount of device instruction) are designated by the upper case letters following each stage name abbreviation. The upper case letter 'A' denotes the highest

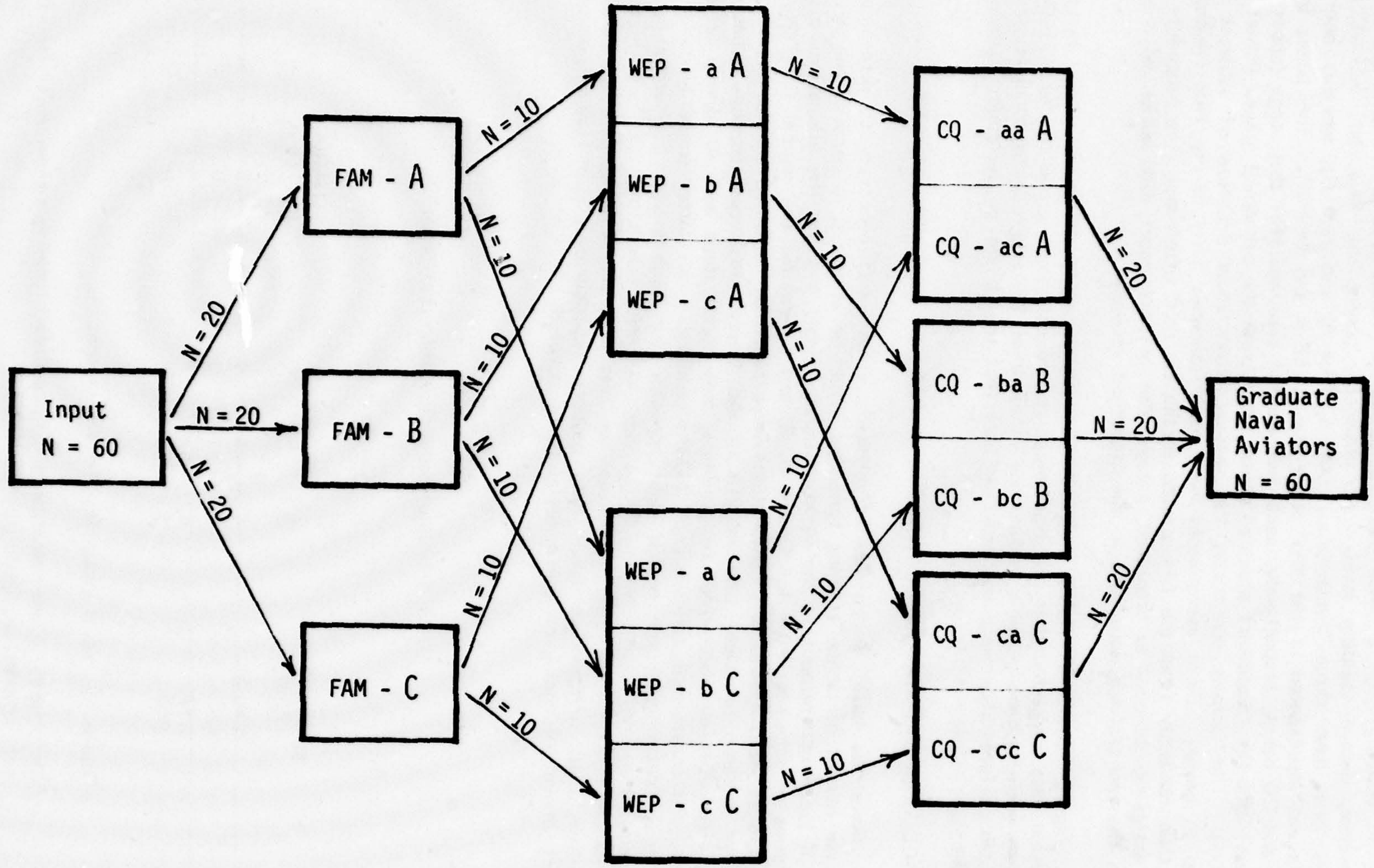

Figure 1. Schematic Representation of Recommended Evaluation Design (with No Attrition).

level of training, "B" a lesser amount of device training, and "C" the control, or zero-time, device training level. As previously noted, the FAM, NF, and FCLP/CQ stages each have three levels (e.g., FAM A, FAM B, and FAM C), whereas only two levels are represented at the WEP Stage (i.e., WEP A and WEP C). The labels in the WEP and CQ boxes, respectively, each indicate the treatment for that stage (upper case letters) and the treatments provided these subjects in the preceding stages (lower case letters). The arrows connecting the various boxes show the flow of subjects from group to group. These assignments were made randomly first to the FAM treatments, and then randomly from the FAM groups to the six WEP subgroups. The procedure used for assigning subjects to treatment groups also assured equal distribution of subjects from the two training squadrons to the treatment groups.

Figure 1 does not show any subject losses due to attrition. Navy historical attrition data suggested that attrition might reduce the major group Ns for WEP by one or two subjects, and possibly reduce one or more of the subgroup Ns to eight or nine. Attrition effects thus were not expected to affect the design in any major fashion.

DEVICE TRAINING TIME ALLOCATION

Once the basic design was established, it was next necessary to determine the precise amount of device training time that would be allocated to each of the design A and B treatments groups at the various stages. Table 1 shows the allocations selected in terms of schedule hours for Groups A, B, and C, and for the regular CNATRA visual syllabus as well. These T^2E^2 allocations were based on combined considerations of the current syllabus practices, the analysis of the device's task cue-response capabilities, total device time expected to be available, meaningful steps between device treatment times, and operational efficiency of 2B35 scheduling. This latter concern was a major factor in determining the device time available for each group. In order to avoid unmanageable conflicts between device and aircraft scheduling, 2B35 training was scheduled in the same 2-hour modules as was aircraft training. It was expected, however, that each module would only produce approximately 1.5 training hours, the exact amount depending on the material to be covered.

Table 1

2B35 Schedule Hours by Group and Stage

Stage	Group A	Group B	Group C	CNATRA Syllabus
FAM	8	4	0	6
NF	4	2	0	0
WEP	6	na[a]	0	6
CQ[b]	3	1	0	0
				12

[a]There was no B group for the WEP stage.

[b]The 2B35 deck emergency procedures training given all students is not included in these figures.

The numbers of device schedule and training hours which this schedule hour allocation provided for each of the treatment groups are shown in Table 2. As can be seen, two of the groups (AAA and ACA) would receive somewhat more 2B35 time (9.9 hours excluding the deck emergencies training) than the amount the students would receive under the CNATRA syllabus, one group (BAB) about the same amount, two groups (BCB and CAC) somewhat less, and one group (CCC) markedly less, i.e., none at all. Thus, while the evaluation design examined only three, two, and three device training levels at the three stage levels of concern, it covered six different instructional regimens. The device training schedule used in the study (as shown in Tables 1 and 2) actually required slightly fewer total device hours to support than did the operational CNATRA syllabus.

Table 2

2B35 Schedule and Training Hours by Group

Group[a]	Schedule Hours[b]	Training Hours
AAA	24.00	18.00
ACA	16.00	12.00
BAB	13.00	9.75
BCB	7.00	5.25
CAC	6.00	4.50
CCC	0.00	0.00

[a]Letters denote stage-group condition. The first letter denotes the FAM/NF stage group, the second denotes the WEP stage group, and the third denotes the CQ stage group.

[b]This does not include the two hours all students receive in the 2B35 for deck emergency procedure training during CQ.

STAGE CONTENT SELECTION

Having established the basic design for evaluation of 2B35 transfer in the four training stages of interest, and the amount of device time for each treatment, the next step was identification of the flight tasks within each of the stages to be included in the evaluation. Training managers and line instructors interviewed, as well as the TRAWING 3 project officer, were virtually unanimous in their opinion that the most critical and difficult tasks confronting the Advanced Jet student were those involved in (a) tracking the ball during day or night field and carrier landing approaches, (b) setting up a weapons pattern, and (c) releasing practice bombs at the correct flight parameter points. The evaluation team, therefore, gave first priority to maneuvers which addressed these skills. Second priority was given to maneuvers which had high visual content such as Takeoff and selected aerobatics.

Maneuver/task selection also was subject to the very practical consideration of device time availability. As has previously been pointed out, the number of device training hours available was limited. Spreading these hours over too many training tasks would restrict the number of practices per event and, as a consequence, might not produce measurable learning on any task. Such spreading out of device time might be useful for maneuver "demonstration" purposes, in which the student is not expected to learn, but it would not be appropriate for a training transfer evaluation in which there must be sufficient task repetitions for learning to occur.

Maneuvers Selected

The maneuvers finally selected were judged to provide a comprehensive sampling of the visual flight skills that must be mastered in the Advanced Jet training phase. Furthermore, since they were unanimously recognized as high-value syllabus tasks, evidence of positive training transfer for one or more of these tasks would support continued use of the 2B35 in training. Conversely, evidence of negative transfer for any task would suggest discontinuing such training in the 2B35. Further, since these tasks are representative of the spectrum of jet piloting tasks, some generalizations could be made regarding the potential of visual devices for Advanced Jet UPT.

FAM/NF Landing Maneuvers. Since ball tracking is a skill common to FAM, NF, and FCLP/CQ, it was reasoned that the long-term usefulness and acceptance of the 2B35 would be materially enhanced if meaningful transfer could be demonstrated for the landing maneuver. Equally important, if negative transfer were, in fact, a consequence of device training on tasks involving ball tracking, this needed to be documented. As a result of these considerations, day and night landing approaches and the Full Flap Landing became the first priority tasks for the T^2E^2 effort.

WEP Dive Pattern and Release. While there was general satisfaction with the device as an aid to Weapons training, there was little or no information about its real contribution in terms of its effect on weapons delivery patterns or practice bomb scores. The 30° dive pattern entry and release were therefore selected as the second priority tasks for the T^2E^2.

FAM Barrel Roll. Although the 2B35 device had been judged unsuitable for Air Combat Maneuvering training, aerobatics such as the Barrel Roll and Cuban Eight do involve many display-control relationships similar to those required in ACM. For example, in both cases, the aircraft is moving about the roll and pitch axes at rapidly changing rates of speed. While aerobatics in themselves were not considered to be high-value tasks, their relationship to the high-value ACM tasks suggested that at least one such maneuver should be included. The Barrel Roll was selected as the third priority target task because it sampled the student's skill at aircraft control throughout the range of speed and pitch/roll rates characteristic of ACM maneuvers. Also, since it was practiced on most FAM flights, it provided a number of measurement opportunities.

FAM Straight-In Precautionary Approach. The Straight-In Precautionary Approach (SIPA) maneuver starts with a simulated engine emergency and requires that the student plan his return to base using only flaps, speed brakes, and landing gear drag to control his rate of descent. Use of the throttle by the student is prohibited until landing on the runway has been assured (unless safety considerations indicate otherwise). The SIPA thus provided a training and measurement task which was not only highly visual in content, but was stressful as an emergency procedure.

FAM Takeoff. The Takeoff was not considered a particularly high-value task in terms of training difficulty, but like the Barrel Roll, it was practiced on every flight and provided repeated measurement opportunity. It was also considered to be sensitive to pilot control and visual tracking behaviors.

FCLP/CQ Landing Practice. As noted earlier, carrier qualification is perhaps the most critical task faced by the jet pipeline trainee. This stage[1] normally occurs near the end of the training program, and failure in CQ means elimination from the program and the loss by the Navy of a substantial investment in the student's training to that point. The FCLP/CQ stage landing practice (bounce flight) was therefore selected as an extremely high-value maneuver. Attention was also concentrated on the bounce flight because it was a potential source of repeated measures, not only in the trainer, but also in the airplane. During the 13 scheduled FCLP periods, some 75 or more landings are made. The student is required to make two touch-and-go landings and six arrested landings on the carrier during period CQ 14 to be considered "carrier qualified."

PERFORMANCE MEASUREMENT

The design presumed a repetitive measurement scheme in which the maneuvers of concern were measured during each period in which they were instructed. Some maneuvers, such as the FAM Barrel Roll and Full Flap Landing, the WEP pattern, and the FCLP/CQ landing were measured more than once during an instructional period. To the extent possible, the same measures were made in the 2B35 and in the airplane. For example, during each FAM instructional period in the 2B35, performance data were gathered for the FAM maneuver set. Then, when the student's FAM instruction moved to the aircraft, the same maneuver set was evaluated during each FAM dual aircraft instructional flight.

In this fashion, data could be developed for the device and for the aircraft for each maneuver (e.g., landing), for selected performatory dimensions of the maneuver (e.g., airspeed control), and for the aggregate of the maneuver set (e.g., the combined maneuvers in the FAM set). These data would provide a means of assessing the aircraft performance of each trainer group in terms of its relationship to the performance of the nontrainer control group.

Two principal sources of daily performance data were considered. These were (1) the existing performance assessment system; and (2) specially developed objective measures.

Operational Navy Grading Practices

The operational Navy UPT grading system evaluates student pilot performance on a four-point scale: Unsatisfactory (1); Below Average (2); Average (3); and Above Average (4). Examination of student grade folders showed a marked clustering of these grades around the Average rating, with slightly more Above Average ratings than Below Average or Unsatisfactory grades. In the judgment of the IPs, "good" students generally received a 3.08-3.12 grade average, while passing students were being given grades in the 3.00-3.08 range. Students receiving below the 3.00 figure, while usually able to complete the program, were looked on as "marginal." The range of scores from the weak to the good students, therefore, was small and did not provide a high degree of discrimination between students.

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[1]Some 14 aircraft flights are scheduled in FCLP/CQ. Thirteen of these are FCLP landing practice periods (so-called "bounces"), while the last scheduled flight (CQ 14x) is the actual Carrier Qualification on the carrier. Of the 13 FCLP periods, 10 are scheduled during daytime and 3 at night.

These grades were probably adequate for student management purposes on a day-to-day basis. However, they were not sufficiently discriminating to be of use in the 2B35 evaluation. Another source of data was required.

Objective Performance Recording

Contractual guidance and study resources precluded an extensive or elaborate performance measurement development effort. Only those techniques which had been found successful in other evaluation efforts could be seriously entertained. Review of the various objective performance recording systems used previously in similar research and evaluation efforts[1] suggested that meaningful information and inter-student discrimination could be obtained from scores reflecting student deviations from prescribed maneuver parameters. Such scores could be obtained from appropriately designed maneuver performance recording forms on which instructor pilots record their observations of key aircraft parameters during the student's performance of each maneuver. The measures developed for FAM, NF and WEP are provided in Appendix B. Each flight parameter to be observed was identified on the score sheet (e.g., Airspeed, Angle of Attack, etc.), and a three-, four-, or five-point objective scale was shown for each parameter. The optimum or desired parameter value was located at the center of the scale, and allowable deviation ranges were shown on each side of the desired value. Additional deviation ranges above and below the desired tolerance range were also shown, as appropriate. The various performance parameters were observed at specified times during the maneuver, and the IP was required to mark a vertical line through the range mark on the scale corresponding to the student's performance at that point in time. For example, on Takeoff rotation airspeed, if the aircraft were within $\pm$ 5 knots of the desired airspeed, the IP would mark the center point of the scale. If the aircraft were moving at more than 5, but less than 10, knots faster or slower than the optimum airspeed, the IP would place a mark in the first range above or below the desired range, thereby indicating an error in airspeed. The desired parameter values and deviation ranges were developed through joint Navy-Seville consultation.

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[1] See, for example, the following:

(a) Smith, J. F., Flexman, R. E., and Houston, R. C. Development of an objective method of recording flight performance (Tech. Rep. HRRC 52-15). Lackland AFB, Tex.: USAF HRRC, December 1952.

(b) Caro, P. W. Flight evaluation procedures and quality control of training (HumRRO Tech. Rep. 68-3). Alexandria, Va.: Human Resources Research Organization, March 1968.

(c) Prophet, W. W. Performance measurement in helicopter training and operations (HumRRO Professional Paper 10-72). Alexandria, Va.: Human Resources Research Organization, April 1972.

(d) Povenmire, H. K., Alvares, K. M., and Damos, D. L. Observer-observer flight check reliability (Tech. Rep. LF-70-2). Savoy, Ill.: Aviation Research Laboratory, University of Illinois, October 1970.

From a count of the marks placed on the score sheet, the number of correct and incorrect performance items could be determined for each flight parameter. Since flying, in many respects, is essentially an error-nulling process, the number of errors committed and their reduction across training flights provide an index of performance and of learning. The data used for the multivariate and univariate analyses were, therefore, the number of errors committed by the subjects on each maneuver. If error data were missing, they were compensated for according to the procedure described on page 28.

Subjective Performance Recording

In addition to recording the student's performance with reference to prescribed flight parameters on certain FAM, NF, and WEP maneuvers, the T^2E^2 performance measurement booklet also provided for a modified subjective evaluation of student performance. This provision consisted of displaying an expanded version of the standard CNATRA four-point grading scale on the score sheet, with the Below Average, Average, and Above Average positions divided into + and - categories. The result was a seven-point subjective grading scale which can be seen at the end of each maneuver score sheet displayed in Appendix B.

Using the seven-point scale, the IP was asked to evaluate the student's performance on each maneuver for which objective data were recorded, and was requested to use end-of-stage performance as the criterion for this grade. This grade, therefore, was to be different from the customary daily grade which is based on IP judgment of average student performance at that particular point (i.e., time level) in training. The T^2E^2 booklet subjective grade also differed in that a separate grade was given for each performance of a maneuver, rather than an aggregate grade covering all performances of that maneuver on a given flight.

This measurement approach involving the objective observations was appropriate for FAM, NF and WEP flights.[1] These flights were dual, and in-cockpit IP observation and recording of student behavior was feasible. Such a procedure was, however, not practical for FCLP or CQ. Except for the first of the 13 FCLP bounce flights, all FCLP and CQ training was accomplished with the student flying solo, but under the radio control and guidance of the LSO who directly observes each student's FCLP/CQ pattern and landing--in particular from final turn to touchdown.

A major problem faced in gathering students' FCLP and CQ performance data was in the recording of such information. The LSOs were adamant in their resistance to any special data-recording procedures that might be a distraction from their normal instructional practices. However, they were already routinely recording descriptive information about each pass, using the notational shorthand prescribed in the NATOPS LSO Manual,[2] which they maintained could provide criterion-referenced objective error data. This information was used by the LSOs during debriefing and as a basis for

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[1]Practice bomb scores were also available for WEP.

[2]NATOPS manual: Landing signal officer. Department of the Navy, Office of Chief of Naval Operations, 15 November 1975.

determining the student's overall grade. The utility of this type of data for use in the T^2E^2 effort was supported by previous research on night carrier landing training,[1] so a decision was made to use the LSO data. It was necessary, though, to establish a procedure for making this information available in a standardized form appropriate for analysis. The FCLP/CQ Landing Trend Analysis form, as described in the LSO Manual, was well suited for this purpose, and student performance data were transcribed from the LSO's record book to the Landing Trend Analysis form. A sample Landing Trend Analysis form is also provided in Appendix B.

TRAINING REGIMENS

Having selected the maneuver/tasks for which the 2B35 might be expected to provide training transfer, and having developed the measures required, the next step was the development of appropriate training regimens for each of the four stages of interest. It was also necessary to establish the procedures whereby each regimen could be implemented and controlled within the Navy's ongoing Advanced Jet program.

At each stage, a training regimen involving a combination of 2B35 training and aircraft training was established for the various treatment groups. Differences in the A, B, and C groups with reference to 2B35 training flights and amount of device time have already been discussed. There were no differences in the aircraft training regimens, either in terms of content or flight time, for the various treatment groups with one exception: the FAM C group received seven FAM aircraft flights (9.8 hours) as compared with only five flights (7.0 hours) for the FAM A and FAM B groups. These flight hours were in accord with the standard CNATRA nonvisual and visual syllabi, respectively. The various training regimens for stages and treatment groups are summarized in Table 3.

Table 3

Training Regimens by Stage and Group

Stage	Group	2B35 Training		Aircraft Training	
		Flights	Hours	Flights	Hours
FAM	A	4	6.0	5	7.0
	B	2	3.0	5	7.0
	C	0	0.0	7	9.8
NF	A	2	3.0	2	2.8
	B	1	1.5	2	2.8
	C	0	0.0	2	2.8
WEP	A	4	6,0	4	4.4
	C	0	0.0	4	4.4
CQ	A	3	3.0	14	13.0
	B	2	2.0	14	13.0
	C	0	0.0	14	13.0

[1] Brictson, C. A., & Burger, W. J. Transfer of training effectiveness: A-7E night carrier landing trainer (NCLT) device 2B103. NAVTRAEQUIPCEN 74-C-0079-1, August 1976.

Control Procedures

It was clear that a successful study would depend on the instructor pilot's ability to administer the specific training treatments and to gather the required student performance data. Therefore, procedures were kept as simple as possible, consistent with the study requirements. Procedural simplicity was consistent with Navy contractual guidance that training procedures should be implementable within CNATRA's resources, not be overly disruptive to the ongoing Advanced Jet training program, and be suitable for continued use by the Navy after the evaluation has been completed.

The importance of minimizing complexity during the study was reinforced by reactions from CNATRA, TRAWING 3 and the two training squadrons. At each level it was stressed that, while the effort would receive the fullest cooperation, priority in the use of the limited training resources available would necessarily be given to the primary mission--preparing future Naval aviators for fleet duty.

The CNATRA Syllabus and Scheduling Guidelines plus the Squadron Briefing Guides were used as the basic T^2E^2 controlling mechanisms. The instructor's daily training activities are governed by these documents, particularly the Squadron Briefing Guides which are the equivalent of daily lesson plans. While they specify the content of instruction for the particular flight to be flown, they leave considerable leeway to the instructor's judgment concerning the emphasis placed on specific maneuvers and the number of practice trials required for any given event. The Squadron Briefing Guides were a recognized and accepted part of the routine instructional process and were familiar to all--managers, instructors, and students. Furthermore, as squadron-level documents, modifications and supplements required to support the present evaluation could be negotiated directly.

The baseline briefing guides for each stage were those in being for the nonvisual and visual FAM and WEP aircraft flights. Those guides were modified as appropriate for the device and in-flight instructional and data-gathering purposes of the study.

2B35 training. The existing briefing guides for the 2B35 flights were substantially supplemented to implement a degree of systematization of instruction and control over the sequence and frequency of student practice in the device. This was necessary because the available briefing guides for 2B35 FAM and WEP flights were, for all practical purposes, like those used for airborne training. These guides approached instructional utilization of the device as though it were an airplane, and as a result, did not exploit the device's full training potential. The specific T^2E^2 guides used with the 2B35 are provided in Appendix C.

Aircraft training. Since the focus of this evaluation was to determine the transfer relationships between the device and the existing aircraft syllabus, few changes were made in the manner in which aircraft instruction was given, its training content, or its basic sequencing. The principal changes made in the aircraft flights were specification of a minimum number of maneuver repetitions (to insure some commonality of air practice for transfer demonstration) and standardization of data-gathering practices for the evaluation (i.e., the use of the special data instruments on a predetermined schedule). This allowed the conduct of all aircraft training generally in accord with the established squadron briefing guides, but with the addition of T^2E^2 supplements. These supplements are also shown in Appendix C.

IMPLEMENTATION PROCEDURES

Study implementation consisted of the development and administration of an instructor training program covering the student training regimens and the data collection procedures. Then, the student training programs and the collection of the requisite evaluation data were carried out by the Navy. Seville administered the ground-based instructor training and maintained surveillance over Navy in-flight instructor training. In addition, Seville monitored the student training and data collection activities of the Navy personnel. It must be stressed, however, that Seville's role during these training and data-collecting activities was largely limited to monitoring the Navy's implementation. Departures from the prescribed procedures were noted and called to the Navy's attention through the TRAWING 3 liaison officer who then advised the squadron personnel concerned of the corrective actions required. Direct contact between Seville and the training squadrons was not allowed.

The chain-of-command relationship that prevailed protected the integrity of the Navy's responsibilities for the conduct of all Phase 3 training activities, and in particular for the administration of the T^2E^2 program. However, it proved unwieldy for controlling T^2E^2 in that there were often delays in "passing the word" that sometimes allowed departures from the prescribed scenarios to continue longer than was desirable. Most of these departures were relatively minor in their impact on the evaluation, but a number of the deviations were significant and resulted in serious losses of data and the loss of subjects from the study. The loss of subjects was an inconvenience in that it required entering new subjects into the program. This created obvious cost and schedule problems, but did not create nearly as serious a problem for the study as that resulting from the losses of data.[1]

Instructor Training

Instructor pilots must be thoroughly trained in the operation of the TA-4J and on the content of the Advanced Jet syllabus before they are allowed to fly with students. By the time they have completed the squadron's instructor training program, they are proficient in all aspects of the training stage concerned; know the syllabus, the *Briefing Guides and Flight Training Instructions* in detail; have developed their own instructional techniques; and have become familiar with the approved Navy flight grading procedures.

As has been noted, the approach taken to instructor training for the evaluation was one of building upon the instructor's established expertise and of using familiar instructional materials as much as possible. This approach was based on recognition that current IP workloads precluded any extensive added training, and that major changes in procedure would meet strong resistance. It was also recognized that complex instructional and operational procedures would likely not be retained by the IP over the many months of his involvement in the evaluation effort.

The instructor training program involved 4 hours of classroom instruction, emphasizing use of the T^2E^2 briefing guides and performance measuring instruments, followed by 4 hours of hands-on instruction and data-recording practice on the 2B35. All of this ground instruction was administered by Seville staff members.

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[1] The procedures used to cope with the missing data problem and their effect on the planned analysis are described on page 28.

Upon completion of the ground instruction, each IP was provided one TA-4J flight during which he was to practice airborne administration of the objective performance recording instruments. For safety reasons, another IP flew the mission profile, simulating as best he could the levels of performance characteristic of students. The IP being trained recorded his observations of the simulated student behaviors.

This amount of instruction was far less than was desired for ideal control over the training and measurement procedures involved. However, there were insufficient instructor resources available within TRAWING 3 to allow for more IP training time without seriously jeopardizing student training, an outcome that would not be permissible.

The material used for IP training is provided in Appendix D. The Briefing Guides of Appendix C and the performance measures of Appendix B were also part of the IP instructional materials.

It was initially conceived that only a fairly limited number of IPs would have to be trained to deliver the appropriate FAM, NF, WEP, and FCLP/CQ training regimens and to follow the required performance measurement routines. It became apparent, almost from the start of IP training, however, that because of the shortage of instructors, every squadron pilot eligible to instruct a particular stage would have to be acquainted with the training and data-recording procedures appropriate for that phase. To do otherwise would have created a major scheduling problem for the squadrons. As a consequence, approximately 45 IPs[1] were trained initially, prior to the start of actual data collection.

A significant turnover among duty IPs occurred midway through the study. This was in part due to rotational reassignments and in part to a larger than expected number of IP resignations from the Navy. This turnover, along with the extension of the data collection resulting from decreased student flow, required several additional training sessions to qualify replacement IPs for T^2E^2 participation. In all, approximately 55 IPs received qualification training and participated in the training and data collection activities from their start in July 1978 to their completion in March 1979.[2]

Student Training

The procedures for administration of the specific training regimens were as follows. When a Group A or B student entered one of the stages (FAM, NF, WEP, or FCLP/CQ) in which he was to receive 2B35 training, the student first received that 2B35 training prescribed for his group. Upon completion of the device regimen scheduled, he proceeded to the aircraft for that in-flight training pertinent to the particular stage and group involved. Except for one period[3] in the CQ stage for Group

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[1]This included the COs of the two squadrons involved and their operations officers.

[2]Data collection was originally scheduled to run from May 1978 through November 1978. Delays and reductions in programmed student input required extension of the data collection phase.

[3]This exception will be described in the Results section.

A, all device training for a given stage was completed before any aircraft training was scheduled. Group C students, of course, began all their training for each stage in the aircraft. That training was conducted in accord with the existing CNATRA nonvisual, all-aircraft training syllabus.

Class Instruction Flow

The general flow of instructional events for the T^2E^2 program is shown in Figure 2. All of the Advanced Jet stages are depicted, starting with Ground School (GS) and ending with Carrier Qualification. The 2B35 training events are denoted by the letter "V" preceding the FAM, NF, WEP, and FCLP/CQ stages.[1] The evaluation design called for no active intervention with the student's instructional sequence until about the 9th week of his training, when the FAM 2B35 instruction began. About 8 weeks after the first class began its FAM instruction (i.e., their 17th training week as shown in Figure 2), all stages of the device instruction were occurring simultaneously, in one class or another, because of the weekly or bi-weekly entry schedule of new classes.

The flow of students within a stage and from stage to stage was controlled by the CNATRA Scheduling Guideline specially developed for the study. This guideline is presented in Appendix E. The intent of this guideline was to provide for the orderly sequencing of student training in the study and assure the integrity of each stage for which data were being collected. Also, by controlling the nature of the other training events--before, during, and after each T^2E^2 stage--the capacity of the experimental design to address interaction effects would be maintained.

As originally planned, instruction and data collection were to have been accomplished over approximately a 5-month period. However, due to a substantial change in the rate of student flow, data collection required almost 9 months. The design itself was sufficiently flexible to adjust to such a contingency, although, as noted, the extension did create a major problem in maintaining a cadre of T^2E^2 qualified instructor pilots.

Unplanned Deviations

Unfortunately, several of the departures from the T^2E^2 procedural rules which occurred during the study involved deviations that changed the flow of training events from that planned (and required) for keeping relatively pure sets of training treatments both within and between the four stages of direct concern. In this regard, FCLP/CQ was the stage most seriously affected. It had been expected that students would be scheduled for FCLP/CQ very near the end of their Advanced Jet training program. At the least, it had been anticipated that FCLP/CQ training would not begin until the subjects had completed the FAM, NF, and WEP stage training regimens. Unfortunately, it did not work out this way in practice.

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[1] Additional stage designations used in Figure 2 include the following: Basic Instruments (BI); Radio Instruments (RI); Airways Navigation (AN); Formation (FORM); Tactical Formation (TACF); Operational Navigation (ON); and Air Combat Maneuvering (ACM).

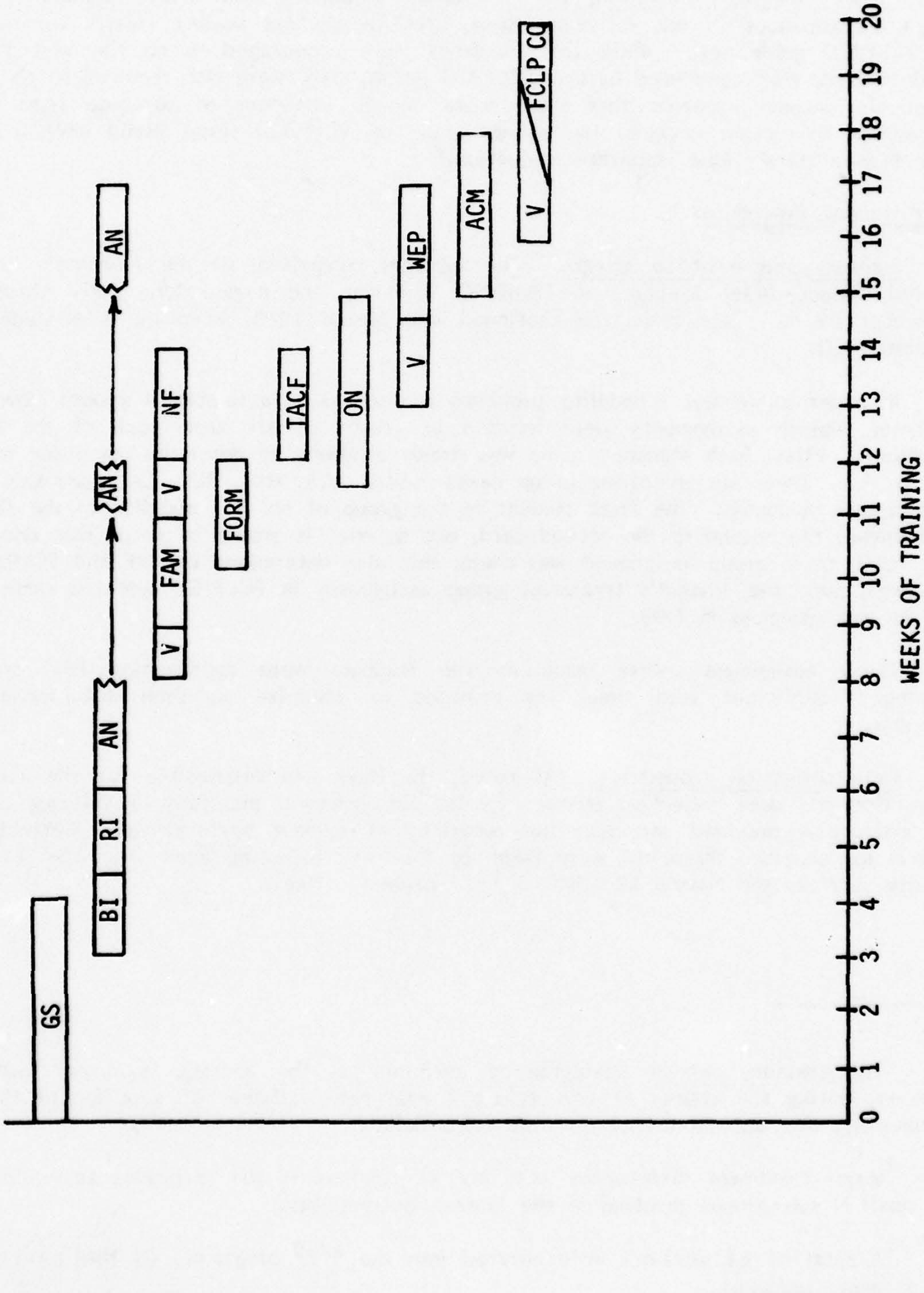

Figure 2. Typical Class Flow (Advanced Jet Phase).

The carrier dates[1] around which the FCLP/CQ program is developed represent scheduling pressure points for the squadron that are severe. The response is to get students to the carrier at the earliest possible date so as not to jeopardize meeting the PTR. The consequences of starting a student too early on FCLP/CQ appear less severe, managerially speaking, than those of having a student's planned completion date for UPT delayed by FCLP/CQ. After analyzing the scheduling problems that would result from rigorously following the scheduling guidelines and after examining the design consequences of not following them, CNATRA decided against rigidly enforcing the FCLP/CQ guidelines. While the squadrons were encouraged to do the best they could to have WEP completed before FCLP/CQ began, they were not required to do so. It quickly became apparent that there were enough instances of variance from the sequencing instruction between the groups that the FCLP/CQ stage would have to be treated as a stand-alone, separate evaluation.[2]

Miscellaneous Procedures

Subject assignment to groups. The subjects comprised all the students[3] who entered Advanced Jet training at TRAWING 3 during the period June 1978 through September 1978. Data collection continued into March 1979, when the last students completed CQ.

In order to prevent scheduling problems and to assure a relatively smooth flow of students, subject assignments were handled in groups of six from each of the two squadrons. First, each student's name was drawn randomly to determine an order from one to six. Then, six treatment group cards--AAA, ACA, BAB, BCB, CAC, and CCC--were drawn randomly. The first student in the group of six was matched to the first card drawn, the second to the second card, and so on. It should be noted that once a FAM A, B, or C group assignment was made, this also determined the NF and FCLP/CQ groupings, i.e., the student's treatment group assignment in FCLP/CQ was the same as that he was assigned in FAM.

These assignments were made as the students were approaching FAM stage training. Sufficient lead time was provided to minimize squadron administrative problems.

Data collection procedures. As noted, the Navy was responsible for the actual instruction and data collection phase. Seville did, however, maintain surveillance over the instruction provided and over the recording of student performance. Corrective actions for observed anomalies were taken by the Navy following input from the Seville on-site staff to the Navy's TRAWING 3 T^2E^2 project officer.

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[1] The training carrier Lexington is available on the average once per month. However, during the course of this effort it was not available for a period of time. Fortunately, this did not create a major study delay.

[2] Major treatment differences were not as sensitive to the variations as would be the small N sub-groups involved in the interaction analyses.

[3] A total of 64 students were entered into the T^2E^2 program. Of this total, all but 5 were graduated.

Close tracking of the daily training schedules by Seville, along with frequent monitoring of the quality of the data gathering procedures within TRAWING 3, minimized the number of significant discrepancies in the implementation. However, four problems of significance were encountered, problems which adversely affected the quality of the data and could be expected to present serious difficulties for the planned analyses. These problems are described in the following paragraphs.

Missing booklets. A number of trainer and aircraft flights were flown during which the data booklet was either not used, or following which the booklet was lost.

Failure to fly the prescribed treatment scenario. A number of instances occurred wherein the scheduled device training was missed. Many of the departures from the treatment regimens were unavoidable due to equipment downtime or pressures to meet the prescribed PTR. Such deviations were provided for in the revised T^2E^2 scheduling guidelines agreed to before the data collection phase began. Unfortunately, other deviations were the result of scheduling errors and/or squadron level misunderstandings about the regimens to be flown.

Failure to comply with booklet recording procedures. In some cases, "straight-lined" entries were made for entire maneuvers by marking a continuous line from the top of the page to the bottom. Such marking was not in accord with the instructions given IPs and suggested that individual items may not have been observed with appropriate precision.

Missing data. For a variety of valid reasons, some data were missing from some of the scoring booklets. Occasionally an IP would miss an observation, or for safety reasons, be unable to record an observation. In landing maneuvers, for example, an IP-directed or fouled-deck waveoff would result in a number of missing data points. In WEP flights, weather problems such as low ceilings sometimes resulted in an IP's inability to record certain observations related to the 30° bombing pattern.

Inspection of the entire array of data suggested that statistical compensation for these missing data would be appropriate, although it was recognized that every missing data point would have some detrimental effect on the precision of the analyses to be performed. In performing the multivariate and univariate analyses of the error scores, the computer program algorithmically generated values to replace any data points missing from the measurement booklets. Two different procedures were used to accomplish this: (1) In the event a portion of the data for a particular maneuver was available, the mean of those available data points on that maneuver for each student was used to replace any missing values for that student; (2) when data for an entire maneuver were missing for any student, the mean performance of the other students in the same group, on a parameter-by-parameter basis, was used for each missing data point. These procedures were the ones judged to have the least biasing effect on the data.

Each problem noted was carefully reviewed, and in several instances the subjects had to be dropped from the study and replaced. Such action was, of course, mandatory if the discrepancy involved a trainer or aircraft treatment for either FAM, NF, or WEP. If, however, the deviation occurred during CQ, the subject was included in the FAM, NF, and WEP analyses, but not in CQ.

III. RESULTS

INTRODUCTION

The T^2E^2 study had three general objectives: (1) To determine whether Device 2B35 visual training would produce demonstrable learning; (2) to discover whether such learning as was found to occur would transfer to the TA-4J aircraft; and (3) to identify those syllabus stages wherein 2B35 training could be of greatest utility--assuming that meaningful transfer were obtained.

As described earlier, there were four stages of the Advanced Jet Phase for which the 2B35 was judged, on an analytical basis, to have significant transfer potential: FAM, NF, WEP, and FCLP/CQ. Two of these, the FAM and WEP stages, already involved some 2B35 training; the other two did not. Thus, it was important both to evaluate the utility of current device training activity and to examine the potential of the device for added utilization in NF and FCLP/CQ stages.

Within the constraint of not interfering markedly with ongoing operational training, data were gathered to describe student performance during the above four stages in two principal areas of research interest, learning in the device, and learning in the aircraft (with and without prior simulator training). Two types of data were obtained, the objective data based on instructor pilot recordings of observed performance, and subjective data reflecting the instructor pilot's evaluative judgements of student behaviors. The subjective data[1] were found to be of insufficient discriminating power to be useful in the T^2E^2 analyses, with the possible exception of the LSO grades on each FCLP/CQ landing pass which were based on a Navy-wide LSO evaluative schema. As a consequence, the analyses presented in this section for FAM, NF, WEP, and FCLP/CQ are based on the objective data scores described in Section II, Method, with the exception of the subjective LSO grades included for FCLP/CQ.

DATA ANALYSES

The objective data for FAM, NF, WEP, and FCLP/CQ were analyzed as follows: The data from the FAM, NF, and WEP booklets and the derived error scores from the FCLP/CQ Landing Trend Analysis forms were analyzed on the Univac 1100 computer at the Arizona State University Computer Center. The program 'Multivariance' (National Educational Resources, Inc., 1972) was used for the univariate and multivariate analyses of variance, covariance, and regression. Supplementary analyses were performed on the Univac 1100 using the Statistical Package for the Social Sciences, Release 6.03.[2]

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[1]This included both the standard CNATRA four-point scale grades and the expanded seven-point scale rating at the end of the objective grading booklets. In the latter case, the IPs apparently could not apply the end-of-course criterion as their rating framework.

[2]The computer printouts from all analyses have been retained in the Seville T^2E^2 project file.

Multivariance was chosen as the analysis approach for these T^2E^2 objective error scores, since this technique provided the most efficient means for accomplishing analysis of these types of data. Multivariate analysis first tests the data for significant main effects. In the event no significant main effects are found (in this study that would be either an effect due to the three treatment conditions or to the sequence of flights flown), no further statistical analyses are warranted. But, whenever significant main effects are discovered, the univariate tests are then examined to gain further insight into the nature of the factors which contributed to these effects. The .05 level of significance was selected as the cutoff point for all of the analyses used in this study. The multivariate analysis program employed provided direct comparisons between treatment A versus treatment C and, similarly, direct comparisons between treatment B versus treatment C. Those comparisons were the ones of primary interest.

These multivariate analyses provided tests of the statistical significance of the effects of the device training treatments on subsequent TA-4J aircraft performance (transfer), of the maneuver learning that resulted from flight to flight in the aircraft, and of the possible interrelationships existing between the three treatments administered and subsequent student learning on the five flights flown (interactions). Selected post-hoc analyses were performed whenever it was believed such analyses would provide assistance in better understanding the results. Only those results which met the .05 criterion for significance are presented in this section.

Two other types of data were available, practice bomb scores from each WEP flight and LSO grades for each FCLP/CQ bounce flight. The WEP practice bomb score data were analyzed separately using univariate analyses and correlated $\underline{t}$ tests. These WEP data were analyzed first as circular error data and then, by trigonometric conversion, as the vertical and horizontal components of the circular error. LSO grades available from the FCLP/CQ flights were analyzed by either univariate analyses or correlated $\underline{t}$ tests, as appropriate.

Presentation of Results

In order to relate the findings of the various analyses directly to the training stages examined, the remainder of this report section has been divided into four main parts. Each part corresponds directly to one of the four stages: FAM, NF, WEP, and FCLP/CQ. Within each of these four subsections, the first topic addressed is an analysis of learning in the simulator. This discussion is then followed by an examination of transfer of training effects, in combination with an analysis of the nature of the subsequent learning in the aircraft.

To present the results in the most readily understandable form, graphic displays of the data analyses have been used extensively. These displays take the form of learning curves and statistical graphs of performance. Curves have been included to describe both device and aircraft learning by treatment groups and over flights. These graphs have been employed wherever possible as a substitute for tabular presentations in an attempt to facilitate the reader's understanding of the 2B35 T^2E^2 data and the implications of the data for training. This emphasis on graphic presentation of the results has substantially reduced the number of tabular presentations needed.

FAMILIARIZATION STAGE

Three different training regimens were used in the FAM stage.[1] The A group received four sessions in the 2B35, followed by four training flights and the safe-for-solo checkride in the aircraft. The B group received two sessions in the 2B35 (content identical to the four sessions of the A group), followed by four training flights and the checkride in the TA-4J. The C group received no 2B35 training and flew six training flights and the checkride in the aircraft. In the discussion that follows, these training flights and checkrides are identified by the flight numbers assigned to them in the CNATRA FAM syllabus.

The CNATRA syllabus FAM flight numbering system is a potential source of confusion for one not intimately familiar with it. It is derived from the fact that there are two separate FAM training programs, the visual syllabus and the nonvisual syllabus, each of which has its own flight numbering system. The visual syllabus numbering system starts with the three 2B35 device sessions. These periods are numbered as FAM 1V, 2V, and 3V (the "V" suffix denotes a visual 2B35 training period). Then, the first aircraft flight is numbered FAM 4. The nonvisual, all-aircraft syllabus starts with the first aircraft flight as FAM 1. For both syllabi, the "x" suffix designation denotes the safe-for-solo checkride. The FAM trainer and aircraft periods in the two current CNATRA syllabi are numbered as follows:

Syllabus	2B35 Sessions	Aircraft Flights
FAM Visual	1V 2V 3V	4 5 6 7 8x
FAM Nonvisual	--None--	1 2 3 4 5 6 7x

For the purposes of T^2E^2, the CNATRA FAM visual syllabus was altered to include a fourth simulator session for the A group, but only two simulator sessions for the B group. The aircraft flights retain the same numbering as the standard CNATRA visual syllabus for groups A and B, and for the CNATRA nonvisual syllabus for Group C. The flight numbers in the three syllabi used for the T^2E^2 study, therefore, were arranged as follows:

Group	2B35 Sessions	Aircraft Flights
A	1V 2V 3V 4V	4 5 6 7 8x
B	1V 2V -- --	4 5 6 7 8x
C	----None----	1 2 3 4 5 6 7x

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[1]For a recap of the training for all stages, the reader is referred to Table 3.

Learning in the 2B35

Student learning in the 2B35 for the four FAM maneuvers--Takeoff, Barrel Roll, Straight-in Precautionary Approach, and Full Flap Landing--is displayed graphically in Figure 3. The data points used to plot these learning curves were group percent error scores based on the total errors committed on two trials flown for each maneuver. Since the numbers of measurements and subjects sometimes varied between groups, the raw error totals for each group were converted to percentages in order to derive these learning curves.

Inspection of these four learning curves shows that the two 2B35 trained groups, A and B, showed essentially the same learning pattern over the first two simulator flights. This was to be expected, since these two groups received the same device training during these first two sessions. While the A and B groups showed statistically significant learning between periods 1 and 2 only for the Takeoff maneuver, the A treatment group did improve significantly in performance from the first session to the fourth session on all maneuvers but the Barrel Roll.

While it appears that the A treatment group improved somewhat with the two additional sessions over those provided Group B, the general shape of these four maneuver learning curves suggests that the first three 2B35 sessions produced most of the A group learning effect. The fourth device session did not contribute substantially to FAM maneuver skills development in the device.

The effects of additional periods on learning was examined further by comparison of the performance of the A group on its fourth simulator session with that of the B group on its second session. Analysis of these data shows that, for all four maneuvers, fourth-session performance of the A group was not significantly different from second-session performance of the B group. Thus, in terms of error reduction on FAM skills taught in the 2B35, it appears that a point of diminishing returns is reached, apparently, after the second or third simulator session.

Based on the general shapes of these learning curves for all four maneuvers flown, it is clear that learning did occur in the simulator. Across the four simulator sessions, the reduction in errors by the A group was statistically significant for three of the four maneuvers (all but the Barrel Roll), and even though the reduction in errors across two simulator sessions by the B group was statistically significant for only one maneuver (the Takeoff), their second-session performance was not significantly different from fourth-session performance of the A group.

Inspection of these four learning curves also shows that learning the Takeoff maneuver in the 2B35 occurred relatively rapidly, and that added practice (as reflected by the A group's performance in the third and fourth periods) produced relatively little additional change. In contrast, learning the other maneuvers in the 2B35 was not as rapid. These observations suggest that 2B35 training might place relatively less emphasis on the Takeoff, and relatively greater emphasis on the more difficult maneuvers.

Obviously, there were differences in learning rates and in absolute performance levels achieved across these maneuvers, but there remains little doubt that the device can be used to perform these and similar visually cued maneuvers. The critical issue is, of course, how does performance manifested in the 2B35 influence subsequent student in-flight skills?

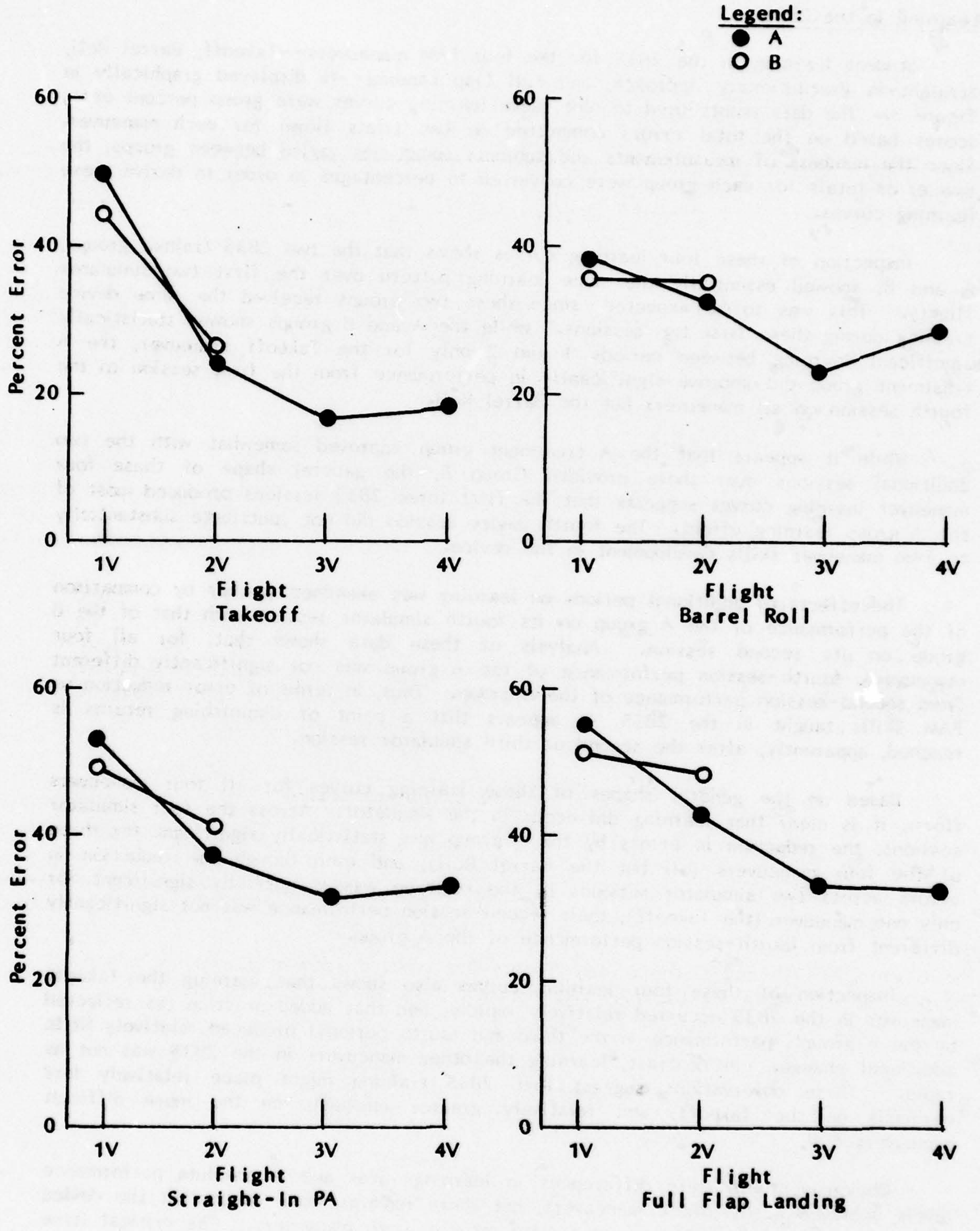

Figure 3. Percent Error on FAM Maneuvers by Group and Simulator Flight.

Learning in the Aircraft

The FAM TA-4J aircraft training involved four training flights and the safe-for-solo check flight for the A and B groups, and six training flights and the check flight for the all-aircraft C group. The maneuvers scored on the aircraft flights were the same as the ones practiced in the simulator. Only one Takeoff and one Straight-In PA were scored on each flight, but two trials each were scored for the Barrel Roll and the Full Flap Landing. Each maneuver flown in the aircraft was treated as a separate dependent variable in the analysis. For example, Barrel Roll 1 and Barrel Roll 2 represent the first and second trials of that maneuver on each flight and were treated in the multivariate analysis as separate dependent variables.

This procedure thus provided six dependent FAM maneuver variables: The Takeoff; Barrel Rolls 1 and 2; the Straight-in Precautionary Approach; and Full Flap Landings 1 and 2. Because the Straight-in Precautionary Approach was first flown by all three groups on the second aircraft flight,[1] this maneuver was handled by a separate multivariate analysis.

Transfer Effects (Comparison Arrangement One)

The customary test of transfer effects from a training device to an aircraft requires comparisons of treatment groups across equivalent aircraft criterion flights. In the present instance, however, two paradigms for examining transfer were available.

The first of these comparison paradigms involves comparing the A and B groups' first four training flights with the C group's first four training flights. Then, since the groups all presumably received comparable safe-for-solo check flights, comparisons across these check flights would be appropriate. Using the CNATRA syllabus numbers, this comparison arrangement for Groups A and B with those of Group C can be displayed as follows:

Group	Syllabus Flight Number
A/B	4 5 6 7 8x
C	1 2 3 4 7x

The C group's fifth and sixth training flights are omitted from this analysis scheme. The percent error data for the four FAM maneuvers are displayed in Figures 4-7.

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[1]One in-flight demonstration of this maneuver was required before the IP felt safe in allowing the student to perform it.

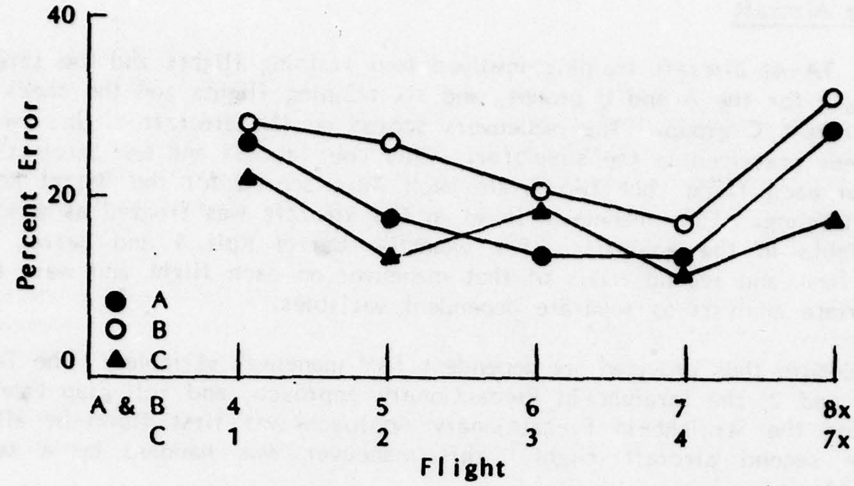

Figure 4. Percent Error by Group and Flight: FAM Takeoff (Comparison 1).

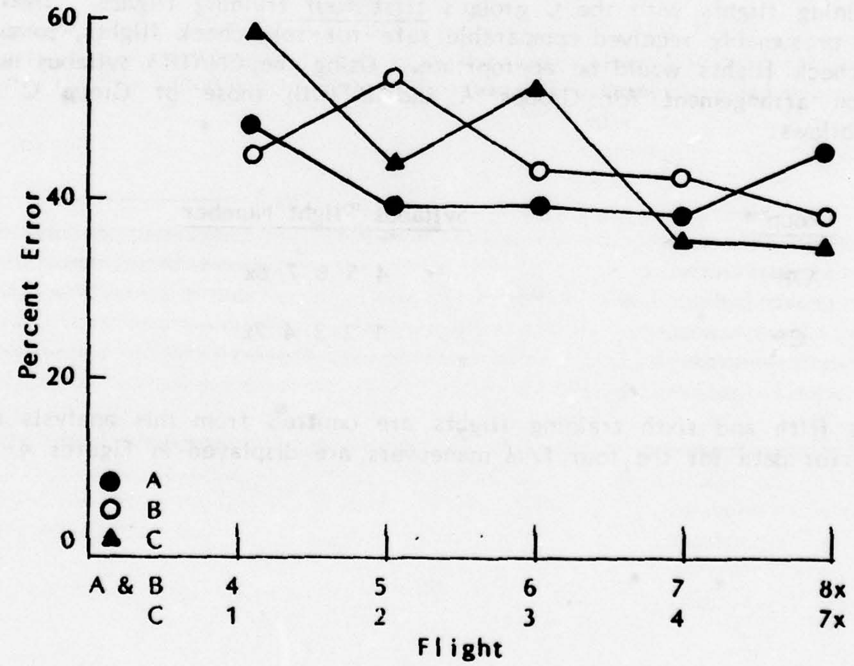

Figure 5. Percent Error by Group and Flight: FAM Barrel Roll (Comparison 1).

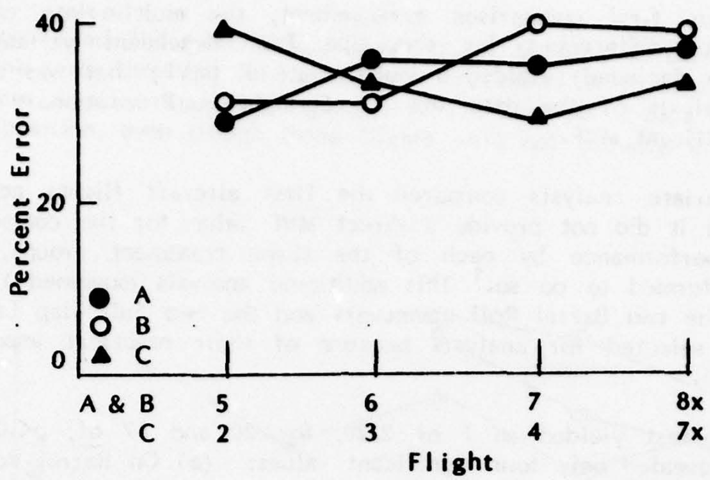

Figure 6. Percent Error by Group and Flight: FAM SIPA (Comparison 1).

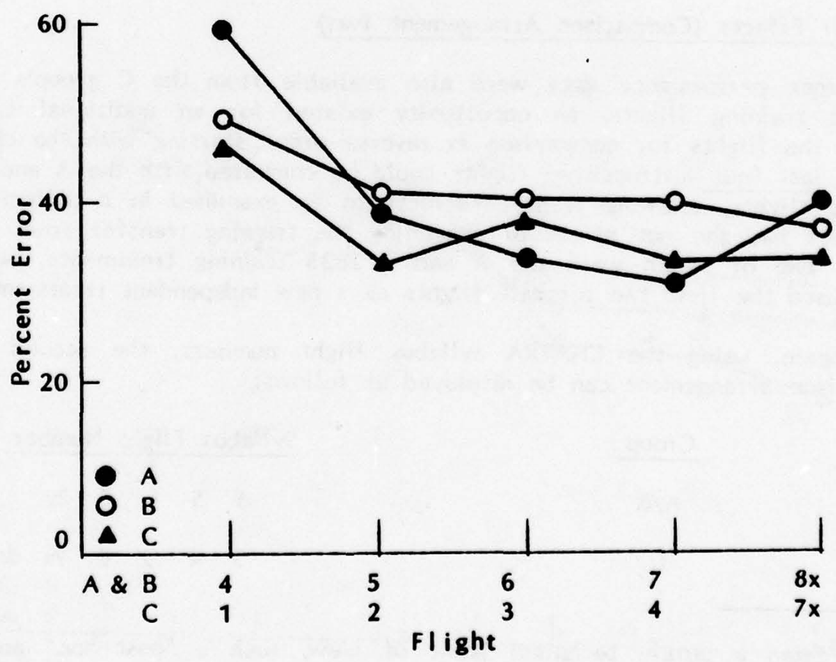

Figure 7. Percent Error by Group and Flight: FAM Full Flap Landing (Comparison 1).

Utilizing this first comparison arrangement, the multivariate analysis of the between-treatments differences for the five FAM dependent variables (the SIPA maneuver was not included) yielded a multivariate F (MVF) that was not significant. The separate analysis of the data for the Straight-in Precautionary Approach also yielded a nonsignificant MVF.

The multivariate analysis compared the first aircraft flights across all three groups, but since it did not provide a direct MVF value for the comparison of first aircraft flight performance by each of the three treatment groups, an additional analysis was performed to do so.[1] This additional analysis examined treatment group differences for the two Barrel Roll maneuvers and the two Full Flap Landings. These maneuvers were selected for analysis because of their practical importance to the T^2E^2 of the 2B35.

The overall test yielded an F of 2.20, for 20 and 37 df; $p<.02$. Univariate tests, however, revealed only four significant values: (a) On Barrel Roll 2, Flight 2, Group A was superior to Group C; (b) on Full Flap Landing 1, Flight 4, Group A was again better than the Group C; (c) on Barrel Roll 2, on the checkride, Group C was superior to Group A; and (d) on the Full Flap Landing 1, Flight 1 Group C was superior to Group B. None of the remaining 36 comparisons[2] reflected statistically significant differences favoring any of the treatment groups. Thus, the overall evidence from these analyses of transfer differences between the treatment groups indicates that no case can be made for any one treatment group's having exhibited superior FAM performance in the aircraft.[3]

Transfer Effects (Comparison Arrangement Two)

Since performance data were also available from the C group's fifth and sixth aircraft training flights, an opportunity existed for an additional comparison. By pairing the flights for comparison in reverse order starting with the checkride, the C group's last four instructional flights could be compared with the A and B groups' four training flights, allowing transfer effects to be examined in a different light. This procedure had the net effect of examining the training transfer from three treatment groups, two of which were the A and B 2B35 training treatments, but the other of which used the first two aircraft flights as a new independent treatment variable.

Again, using the CNATRA syllabus flight numbers, the second aircraft flight comparison arrangement can be displayed as follows:

Group	Syllabus Flight Number				
A/B	4	5	6	7	8x
C	3	4	5	6	7x

[1] From a purely technical point of view, such a 'post-hoc' analysis could be questioned. However, in view of the practical importance to the Navy of the T^2E^2, this analysis was pursued in order to display any possibly informative findings regarding treatment effects.

[2] An overall total of 40 comparisons were made: 20 for A vs. C, and 20 for B vs. C.

[3] The case for A over B can, of course, be made on the basis of flights saved.

Flights 1 and 2 for the C group would not be used in this comparison analysis. The percent error data for this comparison are shown in Figures 8-11. It should be noted in these displays that the C group's FAM 1 and FAM 2 data are shown for completeness of exposition, even though those flights were not included in the analysis.

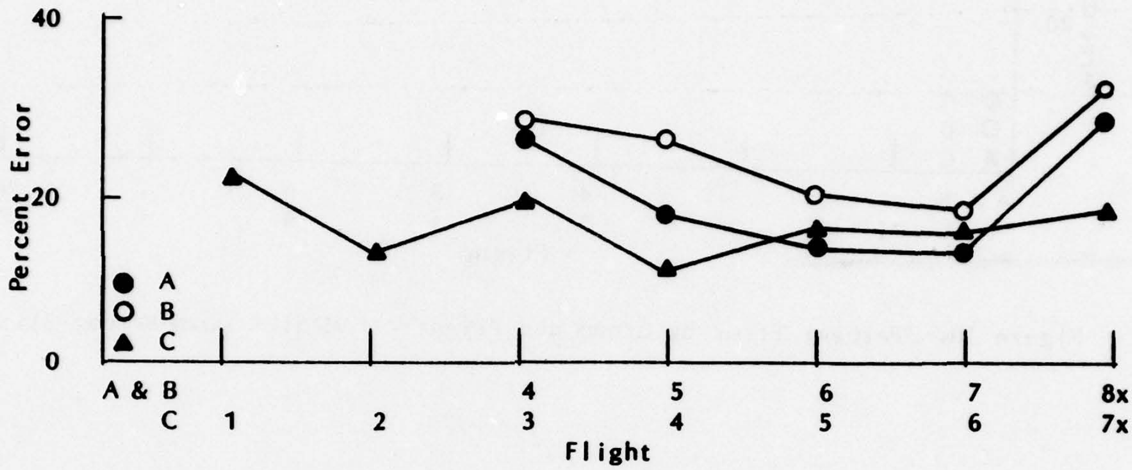

Figure 8. Percent Error by Group and Flight: FAM Takeoff (Comparison 2).

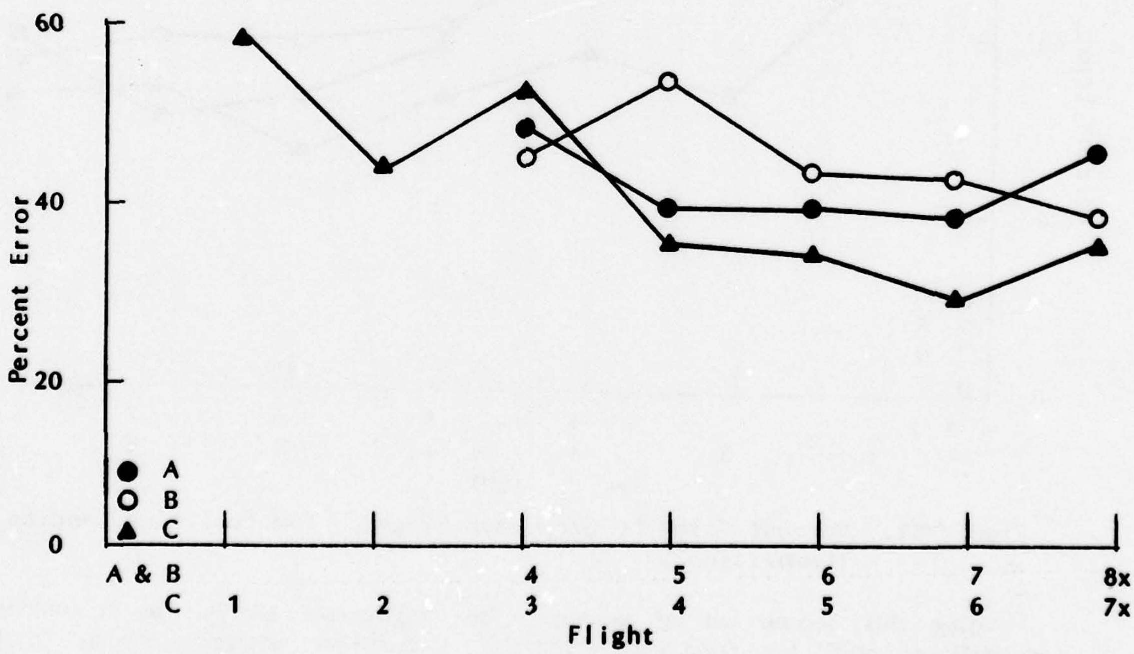

Figure 9. Percent Error by Group and Flight: FAM Barrel Roll (Comparison 2).

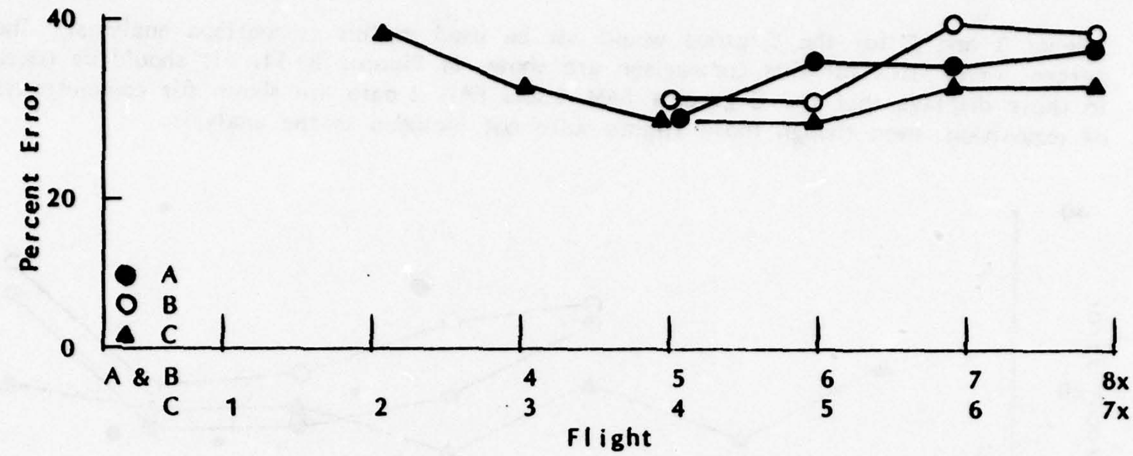

Figure 10. *Percent Error by Group and Flight:* FAM SIPA (Comparison 2).

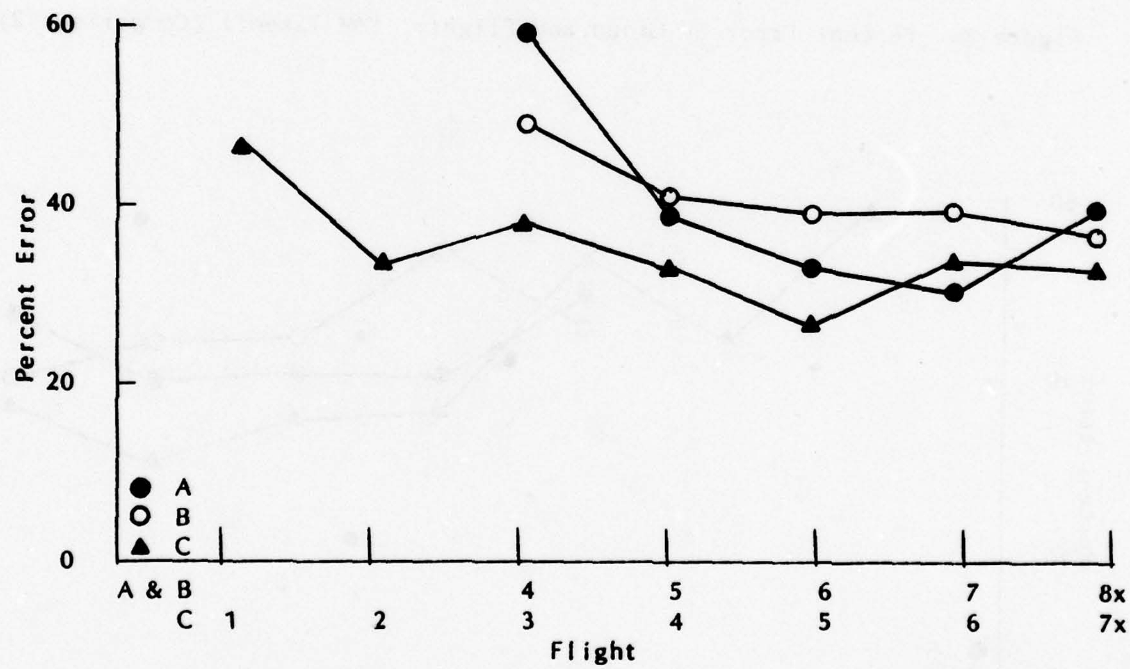

Figure 11. Percent Error by Group and Flight: FAM Full Flap Landing (Comparison 2).

Using this second set of pairings, the multivariate analysis again yielded a nonsignificant MVF for treatment effects. A post-hoc analysis, similar to that performed for the comparison arrangement 1 revealed that C was better than A on the checkride Barrel Roll 2 and better than B on the first Full Flap Landing, Flights 1 and 3, and one of the two Barrel Rolls flown on Flights 3 and 4.

Even in this comparison between treatments A and B and C, the C group cannot be shown to hold any clear advantage over Groups A and B. There is also no basis for preferring A over B, or vice versa, based on aircraft performance. Again, no case can be made for any one treatment group over the others, indicating that the two extra aircraft flights flown by the C group did not result in performance that was superior to either of the simulator-trained groups.

Flight and Trial Effects

Flight and trial effects were examined for the Comparison One data. The multivariate analysis for that comparison showed significant flight effects (MVF=2.16; df=20,37; $p<.03$). Significant flight effects were found for Takeoff, Barrel Rolls 1 and 2, and the Full Flap Landings 1 and 2, but not for Straight-In PA. Figure 12 presents this information graphically, in terms of percent error for all within-subject variables together, i.e., for all treatment groups combined.[1] Of some interest is the general increase in percent error on Takeoff from Flight 4 to Flight 5. This may be due to the fact that Flight 5 is a check flight with a different instructor and may produce some adverse stress effects ("check-itis").

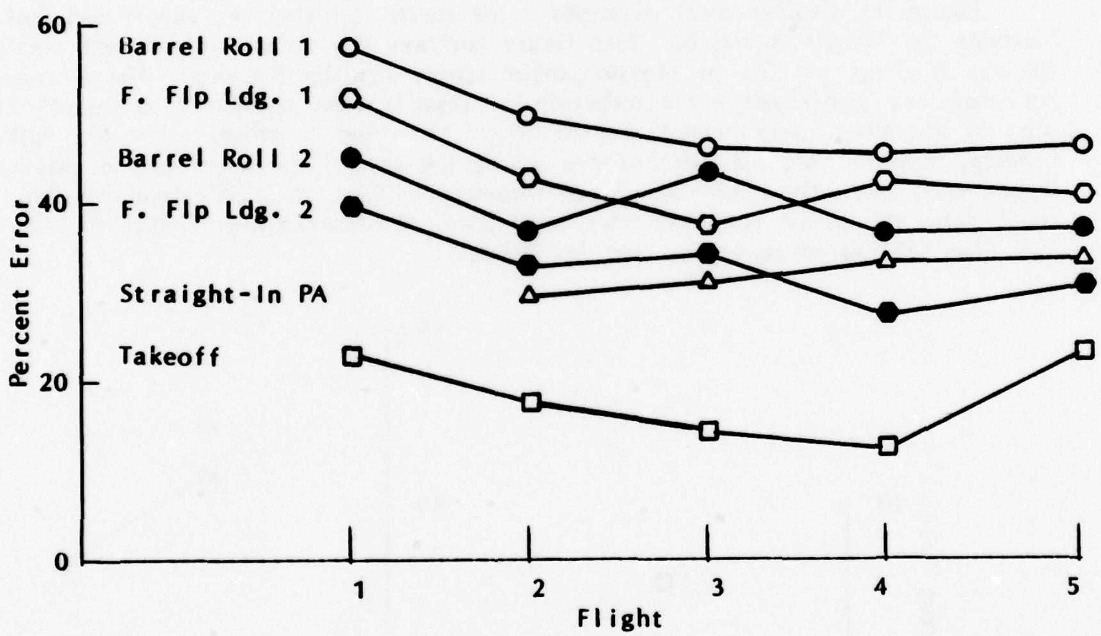

Figure 12. Overall Percent Error for All FAM Maneuvers by Flight (Comparison 1).

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[1] Such combining of treatment groups is justified in view of the lack of significant treatment group differences.

While Takeoff is apparently the easiest of the FAM maneuvers, Barrel Roll is the hardest. Also evident from these maneuver curves is that the first trials within a flight on a maneuver are consistently more difficult than the second. These reduced second trial percent error scores are a reflection of learning during the flight, i.e., within-flight learning, while the first trial scores across flights reflect retention of learning from flight to flight.

NIGHT FAMILIARIZATION STAGE

Prior to flying the TA-4J in the NF stage, the A group received two training sessions in the 2B35, and the B group received one session. In each NF simulator session, two Takeoffs and two Full Flap Landings were scored. In the aircraft, only one training flight and the safe-for-solo check flight were involved, and one Takeoff and two Full Flap Landings were scored. As with day FAM, learning curves were derived based on group mean error scores for display of learning in the simulator and learning in the aircraft, and statistical analyses were performed as appropriate to address training transfer.

Learning in the 2B35

Figure 13 displays total maneuver error scores for the NF Takeoff and Full Flap Landings for Groups A and B. This figure portrays the reduced error over two trials for the A group and the one-session error scores for the B group. The A group did not show any significant error reduction on Takeoff from session 1 to session 2, nor was its session 1 performance any different from the B group. For the Full Flap Landing, however, A group performance during the second simulator session did improve significantly over the first-session performance. Thus, to the extent possible from these data, it may be concluded that some learning occurred over flights for the night Full Flap Landing maneuver, but not for Takeoff.

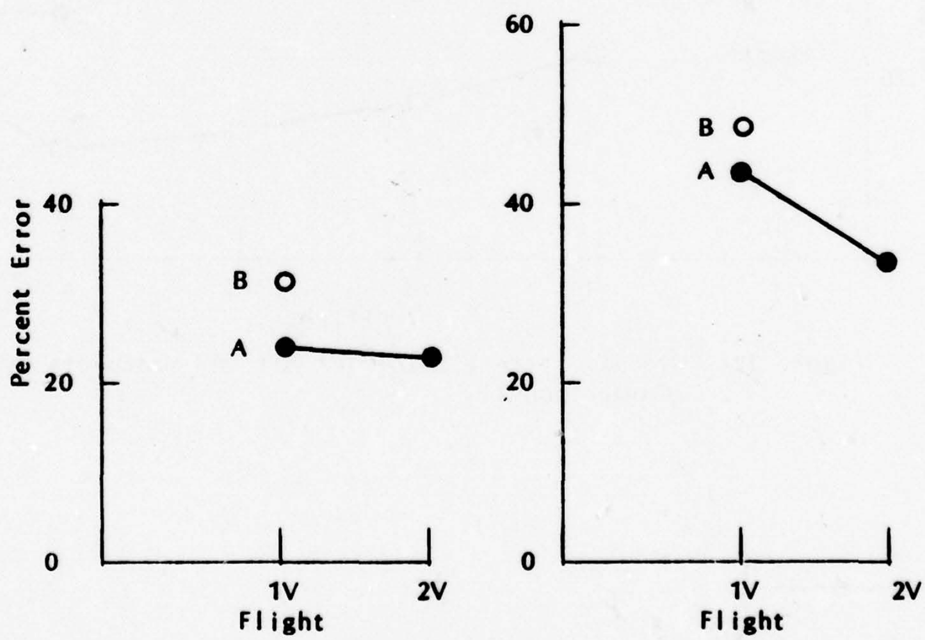

Figure 13. Percent Error on NF Maneuvers by Group and Flight: Simulator Training.

The Takeoff results are not surprising in view of the day FAM data for this maneuver. As appeared to be the case with the day Takeoff, the error scores found here for 2B35 training suggest that Takeoff technique has already been relatively well mastered. Further refinement in Takeoff skill is unlikely, even for the night Takeoff. Performance of the night landing maneuver in the device, however, does benefit from added practice.

Learning in the Aircraft

The students in the three treatment groups all received identical NF aircraft training; one dual ride with their instructor followed by the NF safe-for-solo checkride. Their aircraft performance is depicted in Figure 14. The multivariate analysis of the NF percent error data from the three treatment groups yielded a MVF value of 2.84 for 6, and 110 df, $p<.02$. The dependent variables Full Flap Landing 1 and Full Flap Landing 2 were significantly affected, with Group C performing better than Groups A and B. Group B was generally poorer than Group A. Therefore, in view of this evidence in favor of Group C, it would appear that use of the 2B35 for NF training cannot be supported.

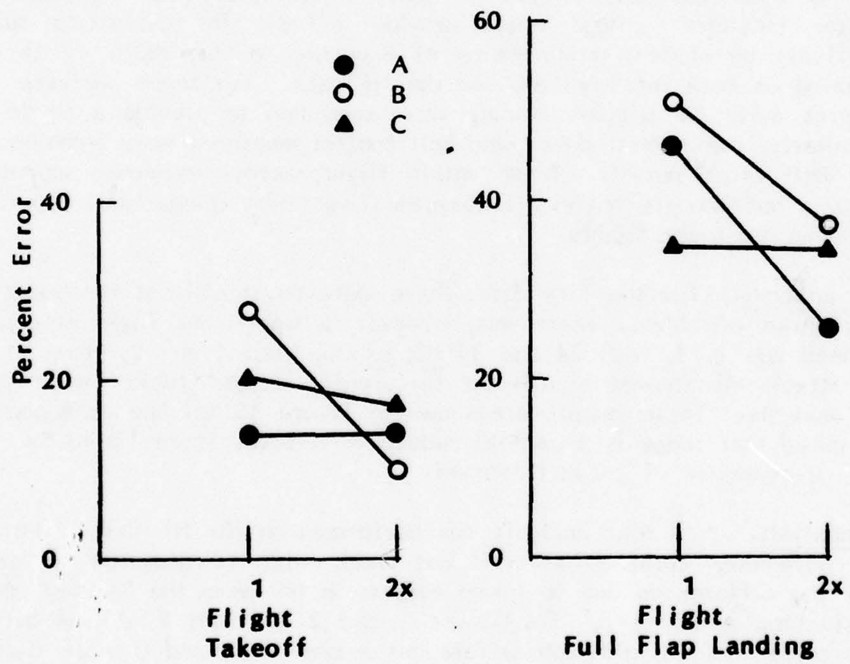

Figure 14. Percent Error on NF Maneuvers by Group and Flight: Aircraft Training.

Learning Over Trials

Full Flap Landing 1, Full Flap Landing 2, and Takeoff did show significant Flight 1 to Flight 2 gains in the aircraft, although there were significant flight-by-treatment interactions. This flight-learning result was not unexpected in view of the results from the day FAM analyses which showed learning from flight to flight. It should also be noted that these findings cast further doubt on the worth of using the 2B35 for Takeoff training, since the maneuver is relatively easy and little change is shown from Flight 1 to Flight 2.

FAM/NF Power Control and Ball Tracking

During the preliminary assessments of the 2B35 training potential made early in the study, serious concern had been expressed over the possibility that 2B35 training would provide negative transfer, particularly for the critical skills of power control and ball tracking--two skills which are key components of the Navy's standard technique for landing approaches, both at the field and on the carrier. Some instructors even had stated that several aircraft flights were sometimes required after 2B35 training before students were again able to perform these tasks correctly.

As was pointed out in Section I, many hardware and software refinements were made to the 2B35 before the T^2E^2 data collection began (see Appendix A). In view of the originally perceived magnitude of these problems, there was an interest in determining whether or not these corrective actions had eliminated the potential for negative transfer from the 2B35 to the TA-4J for these two critical skills.

The three variables, angle of attack (AOA)[1], power control (Power), and ball tracking (Ball) were measured several times during both the day and night Full Flap Landings. As a consequence, analysis of these parameters comparing the performances of the three treatment groups would provide a basis for evaluating such possible negative effects on student performance of exposure to the 2B35. Such an analysis was performed on both the day FAM and the NF data. For these analyses, the several AOA measures made on a given landing were combined to provide a single AOA error score. Similarly, the several power and ball control measures were combined to provide Power and Ball error scores. These within-flight, across-maneuver scores were then subjected to a multivariate analysis across the five (first comparison) day flights flown and across the two night flights.

FAM analysis. For the FAM data, there were no significant treatment effects on any of the three variables. There was, however, a significant flight effect. The MVF value obtained was 3.74, with 24 and 33 df; $p<.01$. Ball 1 and 2, Power 1 and 2, and Angle of Attack all showed significant differences across flights when subjected to univariate analysis. These results are shown in Figure 15 for the combined groups. It should be noted that there is a general reduction in error scores from the first to the last flight, irrespective of group treatment.

NF analysis. A similar analysis was performed on the NF Ball, Power, and Angle of Attack parameter data. The MVF was 3.00, with 12 and 104 df; $p<.01$. The sources of the differences due to group effects in NF were the summed power control and ball tracking parameters. For Power 1 and 2 and Ball 2, A was better than C, and C was better than B, although differences among A, B, and C were slight.

In view of these outcomes, there would seem to be no reason to believe that the 2B35 training given groups A and B resulted in any real negative effects on these critical skills. While the evidence from these analyses cannot be used as a basis to support the use of the 2B35, it can be used to support the conclusion that subjects with 2B35 time are not different from their all-aircraft peers with respect to these ball and power control skills.

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[1] AOA was included in the analysis because of its relationship to an undesirable flight behavior, 'stick pumping.'

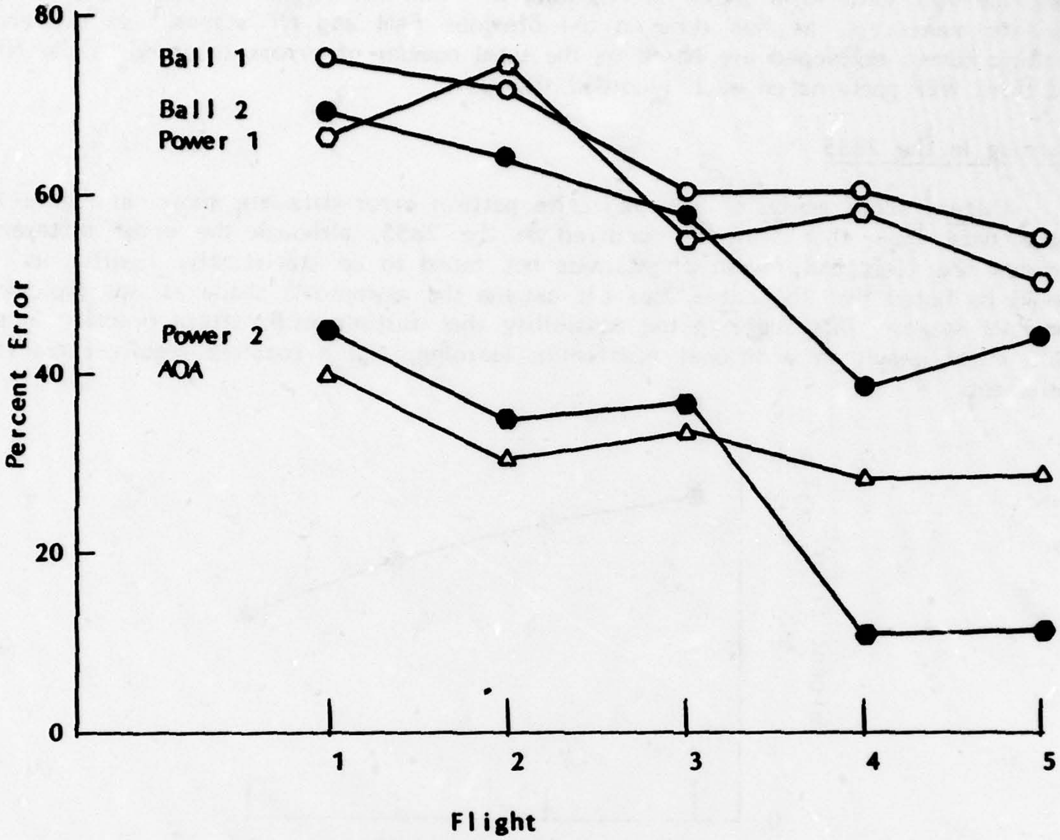

Figure 15. Significant Flight Effects (FAM): Ball Control, Power Control, and AOA.

WEAPONS STAGE

For the WEP stage of T^2E^2 training, the students were divided into only two treatment groups; the A group which received four simulator sessions, and the C group which received no training in the 2B35. These two treatments were essentially the same as specified by the current CNATRA operational visual and nonvisual syllabi. The principal differences from the CNATRA syllabus were the control of practice in the 2B35 that was exercised in the T^2E^2 syllabus and the fact that the nonvisual (Group C) T^2E^2 students dropped practice bombs on their first aircraft ride, a practice not allowed in the CNATRA nonvisual syllabus. The dual-flight aircraft phase of WEP training, during which T^2E^2 data were gathered, consisted of two WEP training flights, the WEP 7x safe-for-solo check flight, and the WEP 11x qualification flight.[1] The remaining flights in the WEP stage were solo, and no data other than practice bomb drop scores could be gathered.

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[1]The objective WEP pattern data were gathered on flights WEP 5, WEP 6, and WEP 7x only. Due to a procedural misunderstanding, the number of students on whom data were gathered on WEP 11x was not sufficient for meaningful analysis.

The same items were scored by the IP in both the simulator and the aircraft using the WEP data form shown in Appendix B. The WEP flights were not divided into separate maneuvers, as was done in the previous FAM and NF stages,[1] so the error learning curves developed are based on the total number of errors recorded on the first and third WEP patterns on each recorded flight.

Learning in the 2B35

Pattern score analysis. The objective pattern error data are shown in Figure 16. These data show that learning occurred in the 2B35, although the error difference between the first and fourth flights was not found to be statistically significant. It should be noted that the curve does not assume the asymptotic shape as was typical in the FAM stage. This suggests the possibility that further WEP pattern practice in the 2B35 might result in additional worthwhile learning, and a possible resultant transfer increment.

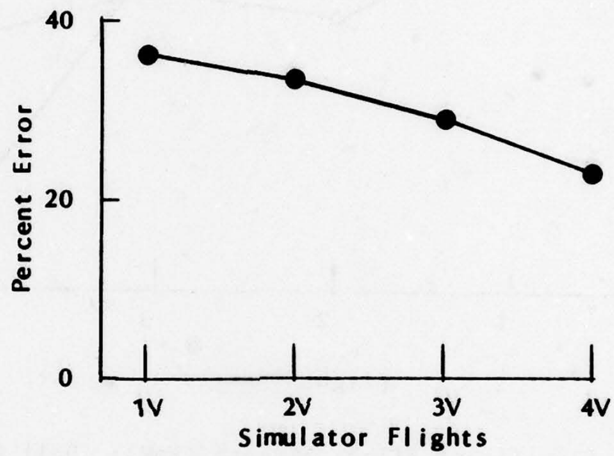

Figure 16. Percent Error on WEP Simulator Training Flights (A Group).

Practice bomb score analysis. The student's simulator practice bomb scores were examined first in terms of simple miss distance, and then by trigonometric conversion as the horizontal and vertical components of that miss (Distance off x sine of clock angle = horizontal component; Distance off x cosine of clock angle = vertical component).

A score for each student for each simulator flight was derived by calculating the mean vertical, horizontal, and actual miss distances recorded for drops one and six of the flight (these were the two simulator patterns in each flight on which error data were gathered). The mean miss distances and their vertical and horizontal components from the four WEP simulator sessions are shown in Figure 17. Examination of these data from the simulator flights reveals a pattern similar to that of the error data, improvement over flights with no indication of performance having reached an asymptotic level. As can be seen also, the vertical error component is approximately twice the size of the horizontal component over all flights.

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[1]The WEP delivery pattern was in effect the equivalent of a maneuver such as the Full Flap Landing. Each had several critical elements wherein 'snapshot' recordings of error on specific parameters could provide a basis for a total maneuver/pattern score.

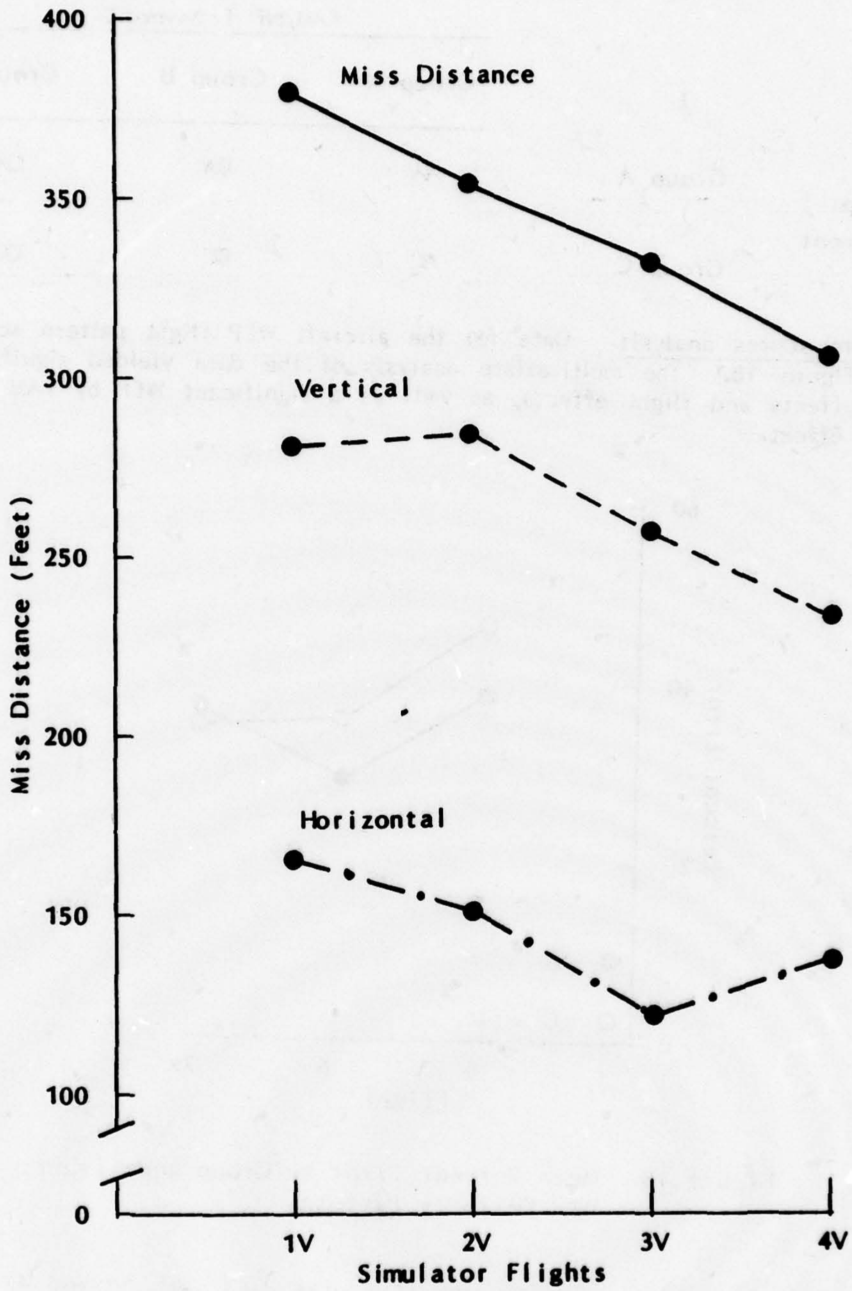

Figure 17. Mean Practice Bomb Miss Distance and Vertical and Horizontal Components by Simulator Flight (A Group).

Learning in the Aircraft

The WEP multivariate analysis of the aircraft data not only addressed the WEP treatment effects, but also was concerned about the possible effects of previous FAM/NF Device 2B35 exposure. Thus, for the WEP multivariate analysis, the six groups involved were analyzed as a 2 x 3 design, as shown below.

		FAM/NF Treatment		
		Group A	Group B	Group C
WEP Treatment	Group A	AA	BA	CA
	Group C	AC	BC	CC

Pattern scores analysis. Data for the aircraft WEP flight pattern scores[1] are shown in Figure 18. The multivariate analysis of the data yielded significant WEP treatment effects and flight effects, as well as a significant WEP by FAM treatment interaction effect.

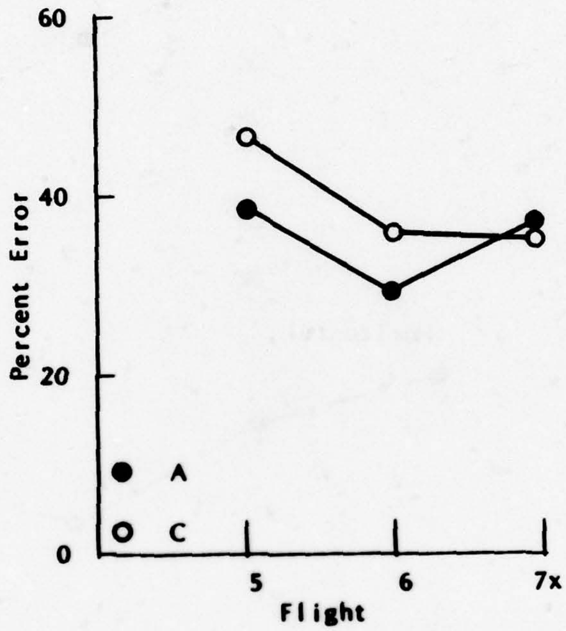

Figure 18. Mean Percent Error by Group and Flight: WEP Delivery Pattern.

The MVF for WEP main treatment effect was 2.63 with 10 and 47 df; $p<.02$. This indicates that WEP treatment A was generally superior to treatment C. It is noted, though, that on flight 7x the two groups converge. The MVF for flight effect was 2.75 with 20 and 37 df; $p<.01$. This indicates a general trend toward performance improvement over the three flights. While the simple WEP treatment by flight interaction was not significant, the more complex interaction of flight with the various WEP-FAM treatment combinations yielded an MVF of 1.65 with 40 and 74 df; $p<.03$.

[1] As previously noted, objective pattern error data were collected on WEP flights 5, 6, and 7x.

The pattern of these interactions suggests that, while the WEP A treatment positively influences WEP pattern performance, having had the previous 2B35 FAM/NF Group A training was perhaps slightly disadvantageous to later WEP flight performance; FAM Group B membership had no clear effect on WEP performance; and Group C FAM/NF training was advantageous to later WEP performance. While one may speculate that students and IPs who had already spent substantial time in the 2B35 (FAM Group A) may approach further exposure to the device in WEP training less positively than those who are being introduced to it for the first time, the exact cause of such interactions cannot be determined.

Practice bomb score analysis. The student's aircraft practice bomb scores were analyzed in terms of simple miss distance and in terms of the horizontal and vertical error components as previously described.

Scores for each flight were derived by calculating the mean vertical, horizontal, and actual distances recorded for the six drops in the flight (in those cases where less than six drops were made, the student means were based on the actual number of drops involved). Any student who recorded less than two drops was not included in the analysis.

Figure 19 summarizes the group means for miss distance, horizontal error component, and vertical component. None of the treatment group differences was significant. The advantage to the A group of 2B35 training apparent from the WEP objective pattern data analyses did not significantly influence their accuracy. However, it is noted that Group A errors tend to be generally less than those of Group C. Variance in these scores is such that the differences are not significant.

Flight effects on these scores were provocative. While the horizontal error component did not improve over flights, there was a marked *improvement* in the vertical component. In addition, the horizontal miss distances were significantly less than the vertical miss distances. The data suggest a "floor" effect on the horizontal data, i.e., that there simply was not much room for improvement in horizontal accuracy. The relatively greater vertical error component likely is related to the more difficult WEP pattern elements such as dive angle and release.

CARRIER QUALIFICATION STAGE

As discussed in Section I, it was not certain at the start of the T^2E^2 that FCLP/CQ could be included. This uncertainty was due both to problems with 2B35 FCLP/CQ displays and to LSO concerns over possible interference between 2B35 training and their intense FCLP/CQ scheduling problems. A decision was made, however, to include a limited 2B35 FCLP/CQ exposure for the A and B groups prior to the start of FCLP. Group A received a total of three simulator sessions, two flown prior to the first FCLP/CQ flight, and the third flown just prior to Flight 13. The first simulator session consisted of eight bounces using the day FCLP scene and eight bounces using

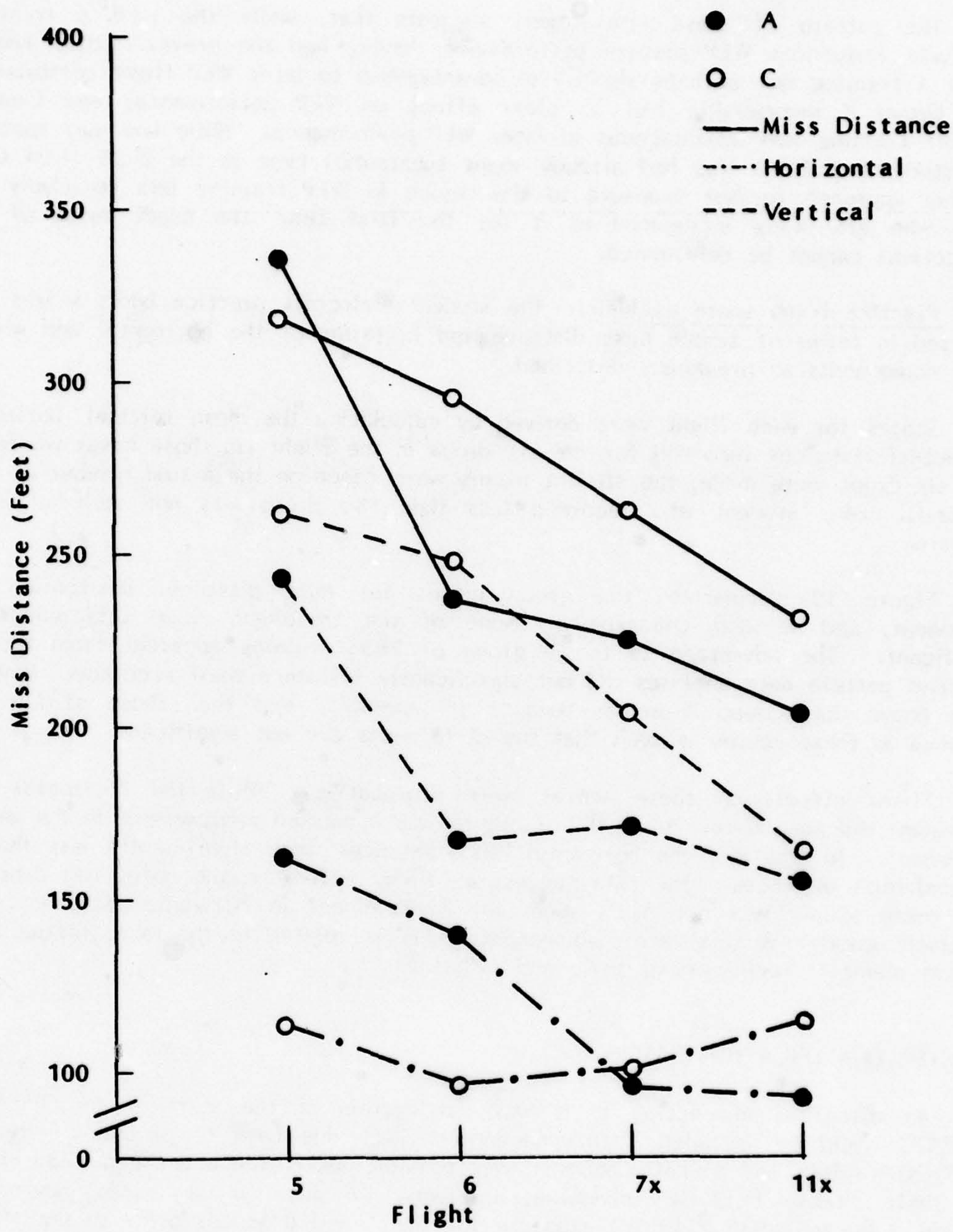

Figure 19. Mean Practice Bomb Miss Distance and Vertical and Horizontal Components by Group and Aircraft Flight.

the night FCLP scene.[1] The second trainer session consisted of 16 bounces, all using the night FCLP scene.[2] Following these two sessions, the A group moved to the aircraft for FCLP practice. The third simulator session given the A group (prior to the 13th FCLP flight) consisted of eight bounces utilizing the day carrier scene. The student then flew FCLP 13 before going to the carrier on CQ 14.[3]

The B group received only one simulator session prior to the first aircraft FCLP flight. It consisted of eight bounces using the day FCLP scene and eight bounces using the night FCLP scene, the same treatment as that received by the A group on their first session. This completed their 2B35 CQ training.

FCLP/CQ Data

Student performance in FCLP/CQ was evaluated by the LSOs in relation to the optimum pattern and glideslope required for an arrested carrier landing, and deviations from this optimum were recorded using both objective and subjective observation systems as described in the NATOPS manual. Both types of observations were then transferred to a slightly modified NATOPS trend analysis sheet which showed, for each student, the data generated by the LSO on the student's performance on each bounce for all 14 flights. A sample trend analysis sheet, including data for a hypothetical FCLP flight, is shown in Appendix B.

Objective data. Through consultation with both wing and squadron LSOs, it was determined that deviations from acceptable performance in CQ could be attributed to six basic types of errors:

Pattern
Attitude Control
Speed Control
Power Control
Glideslope Control
Lineup/Wings

With the assistance of the LSOs, each of the observable deviations was classified into one of these six categories, so that a simple count could be made of the number of times each deviation occurred during each flight.

Each flight usually consisted of eight bounces, but in some cases, students completed only five bounces. In order to standardize the data, therefore, the decision was made to count the number of errors committed by each student during the first five bounces in each flight. Test waveoffs and waveoffs for a fouled deck were not

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[1] A landing is referred to as a "bounce." The FCLP scene is a presentation of an airport runway with painted carrier deck markings. This was in contrast with the "carrier scene," which presents a view of a carrier underway at sea with a wake representation.

[2] Both day and night scenes were used since the FCLP aircraft training included both day and night flights. The actual carrier qualification period (CQ 14x) involved only day carrier landings.

[3] This was because the LSOs did not feel confident in taking a student to the carrier directly from the trainer.

included, however, and if either of these situations occurred in the first five bounces, the next bounce was scored. The objective data used in both simulator and aircraft training in FCLP/CQ, then, consisted of the sum of the errors committed within each of the six categories during the first five scorable bounces in each flight.

Subjective data. The subjective grades prescribed in NATOPS were modified slightly to obtain the following seven-point grading scale:

Cut pass	= 0
Waveoff	= 1
Safe pass	= 2
Bolter	= 3
(OK)	= 4
OK	= 5
OK	= 6

The numerical equivalent of the NATOPS grades for the first five bounces on each flight were summed to obtain a total grade for that flight. These grade-point totals for each student were then used in the analysis of the subjective grades.

Learning in the 2B35

Missing data present a significant problem in terms of describing FCLP/CQ learning in the simulator. Because of several scheduling conflicts between either flying the 2B35 or flying a TA-4J flight, and because of absence of complete trend analysis sheets for numerous simulator sessions, simulator data for only 10 A group students and 12 B students were available for this analysis.[1] These small group sizes must be kept in mind, therefore, when interpreting the FCLP/CQ results.

For the first 2B35 session, during which the A and B groups received the same visual training, analyses for all six error categories on the trend analysis sheets and for LSO subjective grades showed no significant group differences for either day or night data. Comparison of the A group's night data across the two 2B35 sessions, i.e., across flights, showed no significant differences in any of the trend analysis error categories, but a significant improvement in LSO subjective grades was shown (t = 4.15, df = 9; p <.01). Thus, the subjective data give some indication that learning did result from practice in the 2B35.

The A group's third simulator flight was composed of eight bounces after FCLP 12 and used the day carrier scene. As a result of the difference in scene used, it is not reasonable to show 2B35 learning across the three simulator CQ flights. Since only one flight involved the carrier scene, insufficient data were available for statistical analysis of learning during the carrier scene training sessions.

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[1]Carrier scheduling pressure probably caused these discrepancies. It was a matter of priority--finish FCLP/CQ or delay getting to the carrier. In either case, T^2E^2 data would be degraded.

Learning in the Aircraft

In an effort to increase stability of the data from the aircraft portion of FCLP/CQ training, the errors in each of the six categories were summed for the following groups of flights:

Flights 1, 2, and 3

The three night flights

Flights 11, 12, 13x.

Flight 14x, qualification on the carrier, was treated singly.

The mean number of errors committed in each category for each of these four groups of flights is shown in Figure 20, while LSO subjective grade data are shown in Figure 21. The error data were subjected to the MANOVA analysis, while the total subjective grade points for the same groups of flights were subjected to a univariate analysis. Missing data again created a problem. Because of scheduling errors and cancellation of some simulator sessions due to the pressure of the impending arrival of the carrier, five A group students and two B group students did not receive the prescribed number of simulator flights and were necessarily dropped from the FCLP/CQ aircraft analysis.

The multivariate analysis of the LSO-derived error data showed no significant effects due to either treatments or flights, indicating that there was no evidence of any differences between simulator and nonsimulator training in the aircraft portion of FCLP/CQ, and no significant change in performance from early FCLP flights to the later flights, i.e., these data provide no evidence of CQ skills learning in the aircraft.

Analysis was then made of the subjective grades assigned to each student's performance on each FCLP/CQ flight. The same groups of flights were used in this analysis as were used in the error analysis. Univariate analysis of the LSO's grades again indicated no treatment effect between the three groups. All three groups, however, did make significant gains from their first three FCLP flights to their last three FCLP flights (A group: $\underline{t} = 2.51$, $\underline{df} = 14$, $\underline{p} < .01$; B group: $\underline{t} = 5.08$, $\underline{df} = 17$, $\underline{p} < .01$; C group: $\underline{t} = 5.2$, $\underline{df} = 19$, $\underline{p} < .01$).

The aircraft FCLP/CQ data revealed no significant differences, other than the improvement over flights shown in the LSO subjective grades. Whether the failure to find even across-flight differences in the trend analysis error scores means that there was little or no learning shown (by any group) during FCLP, or whether it indicates that the LSO error notations are not really criterion-referenced cannot be determined here. It would seem likely that student performance would change over the 13 FCLP periods; if so, the results may reflect deficiencies in the data. If not, it raises questions about the efficacy of FCLP training. In any event, no case can be made from these data to support 2B35 use in FCLP/CQ training.

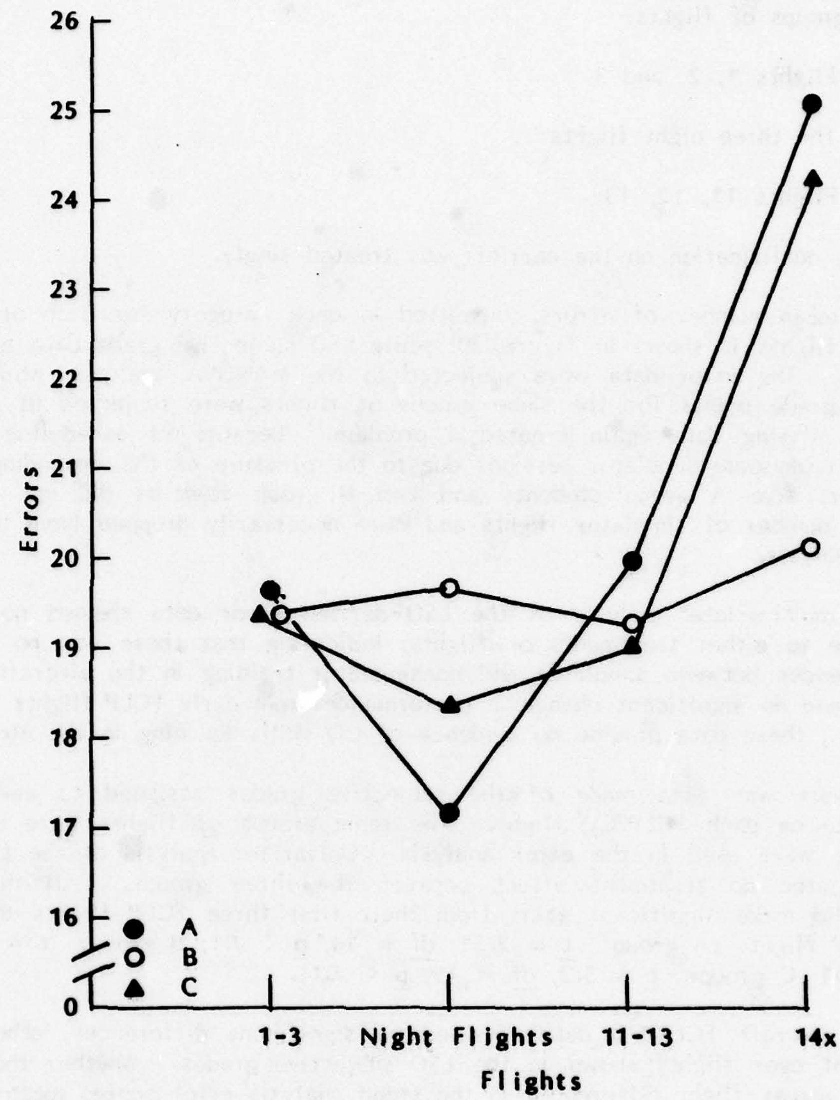

Figure 20. Mean Errors by Group and Flight: FCLP/CQ.

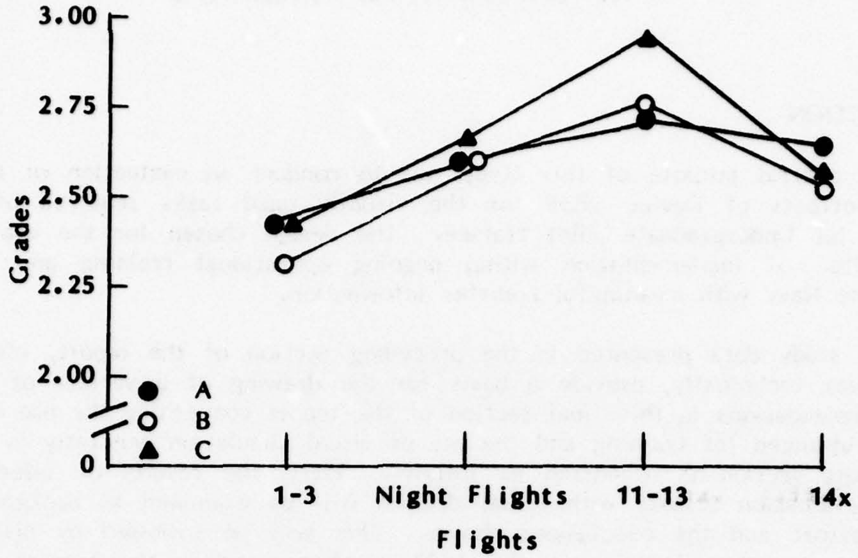

Figure 21. Mean Grades by Group and Flight: FCLP/CQ.

ATTRITION

Attrition experience during the effort was also of interest. However, because of the small number of attrited students during the program, attrition data do not provide a meaningful index for the evaluation and, therefore, were not analyzed.

There were 64 students involved in the T^2E^2 study, of whom five (7.8%) were attrited for various reasons before completion of the study. Three of these attrites were from the A group: One was attrited at the end of NF because of an accident in a stage of training not involved in T^2E^2; the second had completed CQ but was dropped upon his own request during WEP; and the third was attrited at CQ 14x for flight deficiency. Two B group students were attrited: One at the end of FAM for flight deficiency; the second during WEP because of a medical problem. There were no attrites in the C group. It is noted that the overall attrition observed here (7.8%) was less than had been experienced during recent years for Advanced Jet training.

IV. DISCUSSION AND CONCLUSIONS

INTRODUCTION

The central purpose of this study was to conduct an evaluation of the training transfer effects of Device 2B35 for the visually cued tasks required of the Navy Advanced Jet Undergraduate Pilot trainee. The design chosen for the evaluation was one feasible of implementation within ongoing operational training and that would provide the Navy with meaningful transfer information.

The study data presented in the preceding section of the report, while involved and complex technically, provide a basis for the drawing of a variety of conclusions and recommendations in this final section of the report concerning the use of the 2B35 in Navy Advanced Jet training and the use of visual simulation generally in UPT. This final report section is organized as follows. First, the results of selected related research/evaluation efforts with visual devices will be examined as background to the present effort and the conclusions drawn. This will be followed by discussion and conclusions regarding learning in the 2B35 as determined in the present effort, and then discussion and conclusions relating to the transfer results of the T^2E^2 study. In addition, conclusions and recommendations in several closely related areas are developed from these results and the general T^2E^2 study experience. Next, a series of specific recommendations based on the present effort will be presented. Finally, there is a discussion of the implications of these results for future Navy UPT efforts.

RELATED STUDIES

As noted earlier, Device 2B35 was the first CGI, wide-angle visual simulator to be introduced into an operational military flying training program. Since its introduction, there have been several specialized pilot training visual devices developed by industry and government research and development groups, and study and evaluation efforts have been conducted with them. Noteworthy among these, perhaps, are the TAC ACES program at Vought[1] and the USAF Simulator for Air-to-Air Combat (SAAC) at Luke AFB, Arizona[2]. In each of these programs the reported effects of the visual simulator use have been favorable.

The studies most directly relevant to the present effort, though, are several efforts carried out at the Air Force Human Resources Laboratory utilizing the Advanced Simulator for Pilot Training (ASPT). Like the 2B35, the ASPT utilizes a wide-angle CGI visual system, *though it is a much more sophisticated simulator, overall,* than is the 2B35.

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[1] USAF Tactical Air Command. Final Report: Tactical Air Command special project to develop and evaluate a simulator air combat(Phase I)(TAC ACES I). Nellis AFB, Nev.: Tactical Fighter Weapons Center, February, 1977.

[2] USAF Tactical Air Command. A continuation training program using the simulator for air-to-air combat (SAAC). Nellis AFB, Nev.: Tactical Fighter Weapons Center, March 1976.

Two ASPT studies with UPT subject populations are of interest. In the first,[1] transfer of basic contact skills from the ASPT to the T-37 primary jet training aircraft was examined, while the second[2] examined transfer for aerobatic maneuvers. In both studies, evidence of positive transfer was obtained, but the transfer effects were modest. Also, neither study found a significant motion system effect. Their results are similar to those of the present study and are interpreted as providing support for the use of visual simulation as an enhancement to UPT training.

In addition to these efforts dealing with UPT training, there have been several other research studies addressing the transfer of training potential of visual simulators for tasks similar to those examined in the present evaluation. The most directly relevant are those studies which have examined transfer effects for basic fighter maneuvers, aerobatics, transition skills, weapons delivery, and fleet carrier qualification training. For example, one such study[3] conducted in a well-controlled experimental situation found a consistent trend toward positive training transfer by Navy F-4 pilots on basic fighter maneuvering tasks--but, except for one maneuver, none of the effects was large enough to be statistically significant. Similar results were obtained by the Air Force during their evaluation[4] of the SAAC; a small positive trend, but not of statistical significance. Their transfer results are similar to those of the present T^2E^2 effort.

Several other AFHRL studies have found significant training transfer effects for air-to-ground weapons delivery training in simulators. The first of these studies[5] is of interest in that it found positive transfer for visual skills and also that the presence of platform motion did not influence transfer--positively or negatively.

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[1] Martin, E. L., & Waag, W. L. Contributions of platform motion to simulator training effectiveness: Study I-basic contact (AFHRL-TR-78-15). Williams AFB, Ariz.: Flying Training Division, Air Force Human Resources Laboratory, 1978.

[2] Martin, E. L., & Waag, W. L. Contributions of platform motion to simulator training effectiveness: Study II-aerobatics (AFHRL-TR-78-52). Williams AFB, Ariz.: Flying Training Division, Air Force Human Resources Laboratory, 1978.

[3] Payne, T. A., Kirsch, D. L., & Temple, C. A. Experiments to evaluate advanced flight simulation in air combat pilot training, Volume of learning experiment. Hawthorne, Calif.: Northrop Corporation, 1976.

[4] USAF Tactical Air Command. Evaluation of the simulator for air-to-air combat (SAAC) FOT&E. Final Report: TAC Project 75A0400. Eglin AFB, Fla.: Tactical Air Warfare Center, 1977.

[5] Gray, T. H., & Fuller, R. R. Effects of simulator training and platform motion on air-to-surface weapons delivery training (AFHRL-TR-77-29). Williams AFB, Ariz.: Flying Training Division, Air Force Human Resources Laboratory, July 1977.

The second AFHRL weapons study is also of interest in the present context. It provides supporting evidence that device effectiveness diminishes somewhat after four or so training sessions, and it also shows that students with simulator weapons delivery training do as well on their first flights as nondevice-trained students on their third or fourth aircraft rides.[1]

In another study of relevance, night carrier landing training was examined at the Fleet Readiness Squadron level.[2] In contrast with the generally negative results of the FCLP/CQ portion of the present effort, this study found a significant transfer effect for the Night Carrier Landing Trainer to night carrier qualification. The divergence between that study's findings and the T^2E^2 results possibly can be explained on the basis of differences in the way the device was used and the difference between day and night CQ. In contrast, with the relative simplicity of general night flying skills (as discussed in the Results section), night CQ is usually acknowledged as the most difficult and stressful flight task faced by the Naval aviator.

While this brief description of other visual simulation studies is not intended as a review of the literature, the efforts cited are generally those of greatest pertinence to the present discussion. As can be seen from these efforts, the use of visual simulation has produced moderately positive results for transition/familiarization type skills, and much stronger positive results for weapon delivery skills. These studies should be considered as background to the discussions in the following sections in which the T^2E^2 results are addressed and conclusions drawn therefrom.

LEARNING IN THE 2B35

The results of the T^2E^2 device training show clearly that students learn in the 2B35. While some of the maneuvers showed greater learning than did others, all reflected some improvement in task performance as a function of practice. Such learning is prerequisite to any transfer of device skills to the aircraft. It is apparent also that some of the device training tasks were relatively easy, while others were relatively difficult. This finding has implications for device use. Tasks easy to learn in the device--for example, Takeoff--probably should not be given much emphasis. This would be especially the case if the device time so consumed could be spent on the harder to learn tasks, particularly those tasks which also appear to be harder to perform in the aircraft. Device practice should continue, generally, on a maneuver until an asymptotic level is reached, assuming there is evidence of transfer for the maneuver. Repetition beyond this point should be only as necessary to assure retention of that skill level as the student moves to the aircraft.

With reference to this last point, it is noted that for the FAM maneuvers, the asymptotic level appears to be reached after three or four training periods in the device, a finding generally in accord with the time allocation in the current CNATRA syllabus. For Night FAM, little learning or performance change is noted in the device

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[1] This information was obtained during a site visit by one of the authors to AFHRL/FT, Williams AFB, Ariz. It pertains to a study, as yet unpublished, of use of the ASPT to support weapons training for the A-10 aircraft.

[2] Brictson, C. A., & Burger, W. J. Transfer of training effectiveness: A-7E night carrier landing trainer (NCLT) device 2F103. NAVTRAEQUIPCEN 74-C-0079-1, August 1976.

for the Takeoff maneuver, but for the Full Flap Landing maneuver there is no indication that asymptotic level has been reached after the two device sessions. While the lack of transfer evidence for NF skills might make further device training on the landing maneuver inadvisable, the results do suggest there is room for further learning here.

The most interesting 2B35 learning result, perhaps, is with reference to WEP training. For both the flight pattern skills and for practice bombing miss distance, it is clear that asymptote has not been reached at the end of four trainer periods. This, in combination with the positive transfer evidence and the fact that there is still room for considerable improvement in the practice bombing flight skills, suggests that additional 2B35 WEP training beyond the four periods might be beneficial.

Because of the variety of problems that developed with reference to the use of the 2B35 for FCLP/CQ training--e.g., missing data, apparent lack of discrimination in the landing trend analysis error data, and the nature of the training regimens themselves--no firm basis exists for drawing conclusions

TRANSFER TO THE AIRCRAFT

The fact that learning occurred in the 2B35, as was just discussed, tells us little concerning transfer of the skills acquired in the 2B35 to the TA-4J aircraft, except that a necessary condition for transfer has been met. The transfer results presented previously do provide support for the continued utilization of the 2B35 in Navy Advanced Jet training. However, such support requires qualification with reference to the skills and tasks to be taught. Those results support the use of the device for FAM maneuvers, but not without some qualifications. On the other hand, the results offer no support to the use of the device for Night FAM instruction. The clearest support for 2B35 utility is in the WEP training area, but no conclusion can reasonably be drawn in favor of use of the device in FCLP/CQ stage training.

Transfer data will be discussed in the following paragraphs with reference to each of these training content areas, and the bases will be developed for the specific recommendations that appear later in this section.

FAM Stage

Overall, the transfer data from the present study neither strongly support nor refute the use of the 2B35 for the various FAM stage maneuvers. The device-trained groups do not show any flight advantage over the all-aircraft control group. But neither do the data support the concern over possible negative transfer that had been expressed by some of the instructors with reference to the critical skills of ball and power control; however, this can scarcely be considered as reason to use the device. In contrast, though, the finding that device-trained students achieve in five aircraft flights a skill level that is at least the equivalent of that achieved by control students in seven flights can be construed as supportive of continued use of the 2B35 for FAM instruction. A savings of two aircraft flights is a savings of some consequence. It is possible, of course, that students who received neither the two extra flights nor the 2B35 training might perform equally well. In fact, the Group C data for flights FAM 1 - FAM 5 lend support to such a possibility. However, the existing data do not allow us to determine what the effects of such a shortened all-aircraft training regimen would have been on the FAM 7x checkride or on subsequent training stage performance. Such a determination would have required a second control group, a requirement beyond present study resources.

Based on all these considerations, it is concluded that continued use of the 2B35 for FAM training is warranted and that such use should be generally in accord with the present CNATRA FAM visual syllabus or the Group A syllabus utilized in the present effort. A long-term decision to continue FAM 2B35 training will be driven by cost and related management considerations. Should device operating and maintenance costs increase[1] to a point where the cost savings of the two aircraft flights are largely lost, the administrative problems of scheduling and managing 2B35 training might be sufficient that its use in FAM would not be warranted. Under present circumstances, though, the conclusion stated in support of the continued use of the device for FAM instruction is reasonable.

Night FAM Stage

That the 2B35 was no more effective in NF than the transfer results showed is, at first thought, perplexing. On a purely analytical basis, the cue-response commonality of the device's night scene with that of the aircraft is quite high, perhaps more so than for any other task area investigated. However, when one considers the student's level of experience as he enters NF and the nature of the NF Takeoff and Full Flap Landing tasks on which transfer was evaluated, the results are more readily understandable.

By the NF stage, the student has become quite familiar with the TA-4J aircraft and has practiced a significant number of takeoffs and landings in the aircraft. As has already been noted, the day Takeoff is among the easier flight tasks for the Advanced Jet student, so it is reasonable to expect that the night Takeoff might be similarly easy. As a consequence, there would be relatively little new learning which could transfer.

The case is not so obvious with reference to the night Full Flap Landing. But, the day landing is also a well practiced maneuver for the student at the NF level. The difference in scene cue structure between day and night might lead one to expect a significant degree of new learning to be required for night landings, but the nature of the basic Navy "bounce" landing technique probably results in a much higher commonality between day and night landings than might at first be presumed. The Navy emphasis on use of the Fresnel Lens Optical Landing System for both day and night landings and the nature of the bounce landing technique itself (as opposed to the flared landing) reduce the cue-response differences between day and night landings considerably. Perspective relationships and runway texture cues that are relatively important to the flared landing (and which might present significant night learning problems) are much less important to the bounce landing, whereas the critical FLOLS cues are much the same, whether in day or night conditions.

While the above analysis may provide a rationale for understanding the Night FAM maneuvers' being relatively easy to learn, the fact that the CNATRA syllabus dedicates only one instructional period to night instruction (NF 1) prior to the night safe-for-solo checkride (NF 2x) is direct evidence of the relatively low difficulty of the night tasks covered. It is also evidence that little new instructional content is introduced. The previously acquired day FAM skills apparently transfer relatively easily and quickly to the night environment.

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[1] The 2F90 is an older device, and the 2B35 represents an obsoleting technology. In combination, system reliability and maintenance status for these two devices might degrade to the point at which they are no longer cost effective.

In view of the apparent lack of difficulty with the NF maneuvers, and since the control group showed some flight advantage over the trainer groups, it is concluded that the 2B35 will not provide significant training benefit in the NF stage of Advanced Jet training.

WEP Stage

The results of the T^2E^2 effort with reference to 2B35 use in WEP training provide strong support for continued use of the device in this stage. The acquisition of WEP flight pattern skills in the aircraft is clearly enhanced by 2B35 training. It is of some interest to note, though, that the improvement in WEP aircraft flight pattern skills that results from the 2B35 training is not accompanied by an equally reliable difference in practice bomb scores. While the bomb data do generally favor the simulator group, the magnitude of the difference was not sufficient to be statistically significant.

The data concerning vertical and horizontal error components of practice bomb scores are of interest in terms of instructional emphasis. This finding, in combination with the fact that asymptotic performance level does not appear to have been reached in either the trainer or the aircraft, suggests that further 2B35 WEP training might be beneficial. Because of the obvious relevance of dive angle and release to the vertical error component, it would seem they should be emphasized in instruction.

It is concluded that continued use of the 2B35 in WEP training is supported. Transfer evidence is clearer in this area of 2B35 use than in any of the others investigated. It is further concluded that additional device WEP training could be useful and that a device use strategy is warranted that attends more closely to the use of feedback concerning dive angle and release. It might be beneficial to provide additional device instruction after the WEP 7x checkride in which specific procedural and performance errors noted in the first aircraft flights might be addressed. While the present CNATRA WEP visual syllabus is beneficial, the possibility of additional device time should be considered by the Navy, at least enough additional time to reach asymptotic performance level.

FCLP/CQ Stage

When the 2B35 was originally procured, its use to support that stage of Navy UPT that is generally acknowledged to be the most difficult, Carrier Qualification, was viewed as an area of great promise. While the fact that Navy instructional personnel had not made routine instructional use of the carrier landing feature of the device for some time (for the reasons previously described) suggested a possible lack of utility in this area, the results of the present T^2E^2 effort in the FCLP/CQ area must be considered disappointing on two grounds. First, there was no evidence to support the existence of useful transfer from the device to the aircraft; second, the execution of the design plan in the FCLP/CQ stage left much to be desired. Deviations from planned instructional sequencing, missing data, and the general quality of the data were more significant problems at this stage than at any other.

In developing the 2B35 FCLP/CQ training regimens and the data collection instruments jointly with the LSOs, they were generally convinced that the 2B35 (with the corrective changes accomplished) could benefit the FCLP/CQ stage of training. While they were relatively more enthusiastic about the night scene than the day scene, they agreed to use both since the FCLP aircraft flights involve both day and night conditions. However, the night scene received relatively more emphasis in the 2B35 training regimens developed.

The LSOs were hesitant, though, to institute any training regimen that they judged might interfere with getting the students ready for the carrier. Thus, they resisted a greater emphasis on use of the carrier scene (as opposed to the airport FCLP scene) and insisted on having the last flight (CQ 13) scheduled between the 2B35 carrier scene period (CQ 3V for Group A) and the actual trip to the carrier at CQ 14x. Their position can be justified on the basis of the pressures to meet the PTR and the necessity that maximum advantage be taken of each scheduled carrier date, and it was accepted as such by the Navy. However, that position did not aid the interests of the T^2E^2 effort with reference to evaluating the 2B35 for FCLP/CQ stage training.

In view of the problems experienced in the FCLP/CQ stage of the study and the lack of adequate data, no firm conclusion is drawn relative to the use of the 2B35 to support FCLP/CQ stage training. On an analytical basis, the device would seem to have potential for such use, but on the basis of the empirical results of the present effort, such use must be considered problematic. Further evaluation of the 2B35 for CQ use would be reasonable, but because of measurement concerns (to be discussed in a subsequent paragraph) and the effects that the intensive pressures to meet carrier dates have on evaluation design execution, such evaluation would not appear advisable unless appropriate changes could be made.

The matter of FCLP training merits some further discussion. If one accepts the error data derived from the Landing Trend Analysis forms at face value, it would appear that little or no learning takes place over the 13 FCLP training periods--students averaged about 19.5 errors on each of the first three FCLP periods, and about the same number on FCLP periods 11-13x; at the carrier on period CQ 14x, they averaged about 23 errors each.[1] While it would seem unlikely that this extended amount of practice would result in no learning, such is, of course, possible. One clear implication of these results is the need for improved performance measurement. However, these data also suggest that a systematic examination of the long-accepted Field Carrier Landing Practice as an effective means of teaching required CQ skills would be desirable. It was beyond the scope of the present effort to investigate such matters, and the observations offered here are presented for possible Navy consideration, as appropriate.

RELATED AREAS OF DISCUSSION

While not directly a part of the preceding discussion of device learning and transfer, there are several closely related areas that would seem to warrant some discussion and the stating of several conclusions. These areas of discussion are based on the general experiences that accrued during the conduct of the T^2E^2 effort and are discussed here because of their general importance to future Navy UPT and to the conduct of future device or program evaluation efforts.

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[1]There were, of course, no significant differences among the three treatment groups on these measures. In fact, group means were very nearly identical.

Evaluation Design

The basic evaluation design developed, while rigorous from a technical viewpoint, was sufficiently flexible to accommodate most of the operational contingencies which developed during the effort. The evaluation design and the implementation procedures were generally well suited for the conduct of an evaluation of a training device--or a training program--within the context of ongoing, real-world training activity. In spite of this, however, there were several problems that developed that weakened the precision of the results and the conclusions that can be drawn. These problems were most severe in the FCLP/CQ stage. For the reasons previously discussed, pursuit of further device evaluation in the CQ stage would not be recommended unless certain changes could be made. However, overall, considering the operational setting, the shortage of instructors, and the perceived PTR and carrier pressures, the CNATRA personnel executed the design well, and the quality of the output data was generally good. Thus, with the exception of the FCLP/CQ stage, the T^2E^2 effort has resulted in a sound and fair evaluation of the 2B35.

Another aspect of the design worth noting is that the principal findings of the 2B35 T^2E^2 effort are immediately implementable. There is no requirement to convert to a Transfer Ratio, a Transfer Effectiveness Ratio, or any other index of effectiveness to events and procedures in the syllabus flow, nor is there a need for further development or adaptation of available support materials for operational use. The procedures and materials employed in this study were developed to fit the context of Navy Undergraduate Pilot training and can be used essentially "as is."

Measurement

The results of the evaluation could only be as strong as the performance measurement system employed would allow. As anticipated, the operational Navy subjective student evaluation system was of little utility for the T^2E^2 study, with the possible exception of the LSO's subjective grades for the FCLP/CQ bounce flights. In contrast, the objective performance recording system developed in the effort and employed during FAM, NF and WEP stages did provide useful data. While the limited amount of IP training on the use of the objective forms, in combination with the protracted data collection period, probably had a qualitatively detrimental effect on the results obtained, the resulting data did reflect learning and group differences. Thus, the objective measures for FAM, NF, and WEP were satisfactory for the purposes intended. However, the FCLP/CQ data must be considered less than satisfactory for the evaluation's purposes, even though they may be quite adequate to the LSO's instructing needs.

One clear conclusion from this study is that the Navy needs an improved operational grading system if it is to enhance its capacity for training system or program evaluation and for training management. The current subjective normative grading system is less informative and useful than would be a criterion-referenced procedure. Recommendations for continued use (or non-use) of training devices such as the 2B35 would be better if based on criterion-referenced data than if based on subjective data. Lacking automated, instrumented performance recording systems, most research and evaluation efforts have utilized an approach similar to that taken in the present effort. However, whatever alternative approaches might be considered, it is concluded that the performance measurement area is one well worth serious Navy consideration. Appropriate change would benefit the entire UPT program and its management.

Device 2B35 Operating Characteristics

One of the most valuable outcomes from this research resulted before the evaluation proper began, i.e., the analysis of the 2B35's operating characteristics and performance problems that led to the various corrective actions taken. The study team found early in the effort that the 2B35, as it then performed, was unsuitable for effective training on critical visual tasks, particularly the field and carrier landing tasks. Even though user instructor pilots had complained repeatedly that the device was producing negative training for the ball-tracking and power control aspects of the TA-4J landing maneuver, a systematic approach to identifying the reasons for these complaints had not occurred during the nearly 2 years of Device 2B35 operational utilization. As a consequence, the main thrust of the local "corrective" activity prior to the T^2E^2 study was to push for discontinuing use of the device for the tasks of major concern. A secondary result of this widespread negativism about the 2B35 was a general degradation of the device's calibration and maintenance.

There seems to be little doubt that the device had been providing inappropriate cues and eliciting incorrect responses. This is clear from the nature of the corrective actions taken (see Appendix A). This finding is also supported by the fact that the IPs reported no noteworthy student problems with ball tracking or power control in the TA-4J after the corrective actions were taken. In addition, the analyses of the objective data on the ball and power control factors gathered during the study confirmed that there was no negative transfer from the 2B35 to the aircraft for these TA-4J landing subtasks.

Based on these experiences, it is concluded that 2B35 device maintenance must be given careful attention. The 2F90 simulator is relatively old and its effective integration with the 2B35 visual system requires that the whole system receive appropriate maintenance attention. Not only will degradation of device operating characteristics produce severe negative attitudinal effects (such as existed at the beginning of this effort), it will erode or even destroy the device's training effectiveness potential.

It should be noted that the 2B35 was carefully maintained during the T^2E^2 effort, and special logistic support was provided. There is a strong likelihood that such effectiveness as was demonstrated for the device during the present study would degrade in the future should the device not be properly maintained and allowed to revert to its previous performance state.

Motion vs. No-Motion

The T^2E^2 study was not designed to address the motion vs. no-motion issue.[1] In fact, it was not designed to address any particular hardware issue, such as motion, visual field of view, display resolution, or console design. However, it is appropriate to record several observations regarding device motion that resulted from the study.

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[1]Motion, as used here, refers to physical platform motion. It should be noted, though, that significant motion information is acquired from the visual scene display of the 2B35.

As noted earlier in the description of the 2B35, the basic 2F90 trainer on which the visual device has been mounted, has a limited travel, roll, pitch and heave motion system. The evaluation procedures employed required that motion operate during the FAM, NF and FCLP/CQ device training sessions, but be off during the WEP training. Use of the motion system during WEP training produced an uncoordinated jiggle of the sight picture so that target acquisition and tracking would have been impossible. Consequently, motion was left off during WEP training.

The need for motion[1] appeared to be of minor concern to either the IPs or their students for the tasks involved in the T^2E^2 effort. There were occasions during which the IP forgot to turn the motion on at the start of the FAM, NF, or FCLP/CQ training session, but remembered it in the course of instruction. On other occasions it was forgotten completely. Student performance was not noticeably affected.

It is noted, though, that the most significant transfer effect found was obtained in the WEP stage where the motion was necessarily off. While this does not lead to a conclusion that motion is of no benefit, it does indicate that significant transfer for some visual tasks can be obtained without a platform motion system.[2]

Device 2B35 Maintenance/Operator Needs

During the T^2E^2 study, a 2B35 maintenance/operator specialist was in the immediate area during every scheduled training session to assist the IPs with trainer setup and console operation. Availability of this specialist was a key factor both to effective 2B35 training and to carrying out the evaluation design. His presence often allowed visual display anomalies--such as a 'disappearing' building,[3] streaking, etc.--to be dealt with in real time, and a training flight continued that otherwise might have been cut short. In addition, some IPs did not retain acceptable proficiency in console operation over time and required back-up assistance from the maintenance/operator.

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[1]For discussion of the relationships between training and motion requirements, see:

Caro, P. W. Platform motion and simulator training effectiveness. 10th NTEC/Industry Conference Proceedings. Orlando, Fla.: Naval Training Equipment Center, November 1977.

Hagin, W. V. Platform motion in flight simulators: Critical or nice? Proceedings of the Society for Applied Learning Technology. Washington, D. C., 1976.

[2]This observation is consonant with findings noted by others. For discussion, see:

Scientific Advisory Board, U.S. Air Force. USAF Scientific Advisory Board report of the ad hoc committee on Air Force simulation needs. Scientific Advisory Board, U.S. Air Force, January 1973.

[3]This was not the normal edge-priority dropout characteristic of CGI systems, but a transient malfunction.

Based on these experiences, it is concluded that effective use of the 2B35 can be greatly enhanced by assuring the continuing presence of a qualified 2B35 maintenance/operator specialist to assist the IP. In the opinion of the study team, this is felt to be a matter of considerable importance.

Regardless of what device staffing plan is preferred for administrative manpower, or cost considerations, it is essential that this personnel/skill need be met adequately. Otherwise, the Navy cannot be assured of continued exploitation of the 2B35's (or any other device's) training potential.

Instructor Training

A final related discussion area is that of instructor training. As suggested in the previous discussion, the IPs often showed deficiencies with reference to the rudiments of operating the 2B35 console. Such lack can be remedied, to a degree, through the maintenance/operator backup support suggested. More serious, however, was the lack of training and skill in how to use the 2B35 effectively for training purposes. Many of the IPs in the T^2E^2 study had received very little formal orientation toward the effective use of the 2B35 as a training system. As noted elsewhere, their model for its instructional use was generally that of their instructional approach in the aircraft, an approach not always best suited for the simulator.

While the general training of Navy UPT flight instructors is somewhat beyond the proper scope of concern for the present effort, their training to use simulation effectively is a matter of appropriate concern. In view of the variety of experiences from this effort concerning simulator instruction (some experiences described; others only alluded to), it is concluded that the Navy UPT program would derive a considerable benefit from the development and institution of an effective program of instructor training in the use of simulation. Lacking such a systematic approach, it is unlikely that the 2B35, or other devices, will produce the training benefits of which they may be capable.

The simulator is a complex system that represents a considerable investment. For that investment to be protected properly and maximum benefit assured, the instructor requires no less preparation than would be accorded his functioning in another costly, complex system--the aircraft.

RECOMMENDATIONS

Based on the T^2E^2 results and the discussions and conclusions stated, the following recommendations are offered for Navy consideration:

1. FAM Instruction. It is recommended that Device 2B35 continue to be used for FAM instruction. Such use should provide no less than the three instructional periods covered in the present CNATRA FAM visual syllabus, and perhaps more. While relatively greater emphasis should be given to device instruction on the more difficult FAM maneuvers, sufficient repetitions of each maneuver instructed should be provided so as to allow maneuver learning to continue to the asymptotic level. Instruction should be standardized to the degree provided in the T^2E^2 2B35 briefing guides.

2. NF Instruction. It is recommended that Device 2B35 not be considered for support of NF instruction.

3. WEP Instruction. It is recommended that Device 2B35 use in support WEP instruction be continued. The amount of instruction should be extended to include at least one additional period of device WEP training (i.e., a total of five periods). Emphasis should be on diagnostic feedback to the student concerning vertical error components of bombing accuracy. Student performance data should be compiled and monitored to provide a record of learning progress and as a means of feedback to the student.

4. FCLP/CQ Instruction. It is recommended that Device 2B35 not be considered at this time for support of FCLP/CQ instruction.

5. Performance Measurement. It is recommended that the Navy give consideration to development and implementation of a criterion-referenced flight performance measurement system.

6. 2B35 Maintenance. It is recommended that special attention be devoted to maintaining Device 2B35 in accord with established performance standards and that adequate logistic support be provided to minimize periods of its nonavailability for training.

7. Maintenance/Operator Support. It is recommended that a 2B35 maintenance/operator be on site and readily available to support all 2B35 instructional periods.

8. Instructor Training. It is recommended that the Navy develop and implement a program of instruction for instructor pilots dealing with techniques of effective use of Device 2B35 in the instructional setting.

While a variety of other recommendations could be drawn from this effort, the preceding ones cover the action areas of major concern to the Navy. However, areas such as the development of a detailed training manual or instructor's handbook for the 2B35, the institution of an active educational and command emphasis effort to develop more positive attitudes toward simulator use, and examination of training sequence effects on CQ would all be worthy of Navy attention. The questions raised concerning the efficacy of FCLP instruction for CQ are clearly of an importance that warrants their investigation by the Navy, as is the possibility of further investigation of the 2B35's use for CQ training. With regard to the latter, however, the caveat against such investigation without better means of data acquisition and experimental control should again be noted.

IMPLICATIONS FOR THE FUTURE

The Navy is moving toward procurement of a new UPT training aircraft (the VTXTS) to replace the present T-2 and TA-4J aircraft used in the Basic and Advanced Jet phases, respectively. It is clear that simulators will be an important part of this new training system procurement. The present T^2E^2 effort offers some implications for that procurement, as well as for the use of visual simulation in UPT generally.

This effort adds support to the growing body of literature that shows visual simulation can provide a positive contribution to the meeting of numerous training requirements, in particular in the areas of contact transition or familiarization training and visual weapons delivery. However, it also indicates that use of visual devices should be based on a careful analysis of the task training requirements, the device's capabilities, and the training system in which it will be employed.

It would seem likely that a visual device to support a VTXTS instructional program would have a greater potential to provide training cost savings and for contributing to training effectiveness because it can be employed at a much earlier level of skill development than was the case in the present effort. Such employment might alter the utility of the device for the simpler maneuvers, such as Takeoff, or for the instructing of night familiarization skills.

The future implications of recommendations 5-7, above, are worth noting. It is obvious that any devices--present or future--need adequate maintenance and personnel support. However, the needs for an improved performance measurement system and for instructor training in effective use of simulation are not so obvious. To secure a training system as sophisticated as the VTXTS without adequately preparing the Navy's training management and instructor support systems would not be an optimal approach. Effective implementation and integration of advanced training technology into Navy UPT will require certain changes, some of which have been highlighted in the present effort. The result of making such changes or preparations for the future can be an improved UPT graduate Naval aviator, one who is better prepared to transition to fleet aircraft. Further, an effective implementation of advanced training technologies, such as visual simulation devices, offers the possibility of achieving such a result in the most cost-effective fashion.

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APPENDIX A

2B35 DEFICIENCIES AND

CORRECTIVE ACTIONS TAKEN

Exhibit A-1 is an internal CNATRA memorandum summarizing the minutes of the 19 January CNET, CNET Support, CNATRA and Seville Research Corporation meeting held to identify 2B35 problems and solutions required to support the T^2E^2. Exhibits A-2 and A-3 are additional internal CNATRA memoranda providing progress report information and corrective actions effected.

EXHIBIT A-1

ETL21:DRM
DV 2B35
25 January 1978

MEMORANDUM

From: Donald R. Mathis
FER NAS Meridian
To: ETL
SFER Pensacola, Don Brassfield

Subj: Field Report for the 2B35 Evaluation Conference

A conference was held at CNATRA, Corpus Christi, Texas, 19 January 1978, for the purpose of defining existing problems on the 2B35 Visual System and the effect the problem areas will have on the Transfer of Training Effectiveness Evaluation program presently being conducted by Seville Research Corporation, Pensacola, Florida.

Persons Contacted

Dr. Wallace Prophet	Seville Research Corporation
Dr. Frank Yekovich	Seville Research Corporation
Dr. William Hagin	Seville Research Corporation
Lt. Cmdr. Gene Beard	CNET
Dr. C. R. Havens	CNETS
Dr. Bill Rowe	CNETS
Lt. Dave Norman	CNETS
Cmdr. Dave Windsor	CNATRA
Mr. Ed Antoine	SFER Corpus Christi
Mr. Jim Burns	NTEC

Major Topics Discussed

Logistics Support
Data Base Development
Gunsight
Carrier Trap System Simulation
Ball Control on FLOLS
Visual Cockpit Maintenance

Upon arrival at CNATRA, NAS Corpus Christi, Texas, 16 Jan 1978, Seville Research Corporation outlined the major problem areas they felt would overall affect the Transfer of Training Effectiveness Evaluation (TTEE). There were three areas of major concern to Seville Research Corporation: (1) Gunsight does not function properly; (2) During landing approaches the ball on the Fresnel Lens Optical Landing System (FLOLS) could not be tracked properly to the runway touchdown point; (3) Trap simulation on the carrier does not function properly.

Jim Burns, NTEC, and writer were asked by CNATRA to (1) Determine if the problem areas identified by Seville were real; (2) Define the 2B35 problem areas from an engineering viewpoint giving quantitative data; (3) Solve any problem areas with time remaining; (4) Brief results obtained at Conference on 19 January 1978.

Major Topics Discussed

Logistics Support

The only major problem area in Logistics Support that will probably affect the TTEE is the procurement of the light valves for the projector assembly. It presently takes 90-120 days to obtain a new light valve from the Federal Stock System. Messages from NTEC, ATSU-3 NAS Chase Field, and CNATRA have been generated to ASO to alleviate the problem with no apparent results.

Data Base Development

Data Base Development around the NAS Chase Field appeared to be satisfactory, although minor improvements could be made. The main concern was the data base development for the carrier. The instructor pilots stated there were not enough 3-D objects on the desk for proper visual cues. Also the carrier wake and drop line need improvement

<u>Gunsight</u>

Upon inspection of the gunsight it was found that (1) a setscrew was loose causing the gunsight barrel to move; (2) Rubber mount missing causing incorrect sighting of the pipper; (3) Full travel on the pipper was not possible due to misadjustment of the screw holding the sight mount; (4) After the above three problems were solved, it was found that the center of the pipper did not align with the center of the target at 125 mils. The glareshield was elevated to correct this problem.

It was noted that presently there is no PM schedule for the gunsight. A check of the gunsight should probably be made daily to ensure proper alignment, light is working properly, etc.

<u>Trap System Simulation</u>

Trap simulation for the visual system does not function properly. The software was initially programmed for the ADM at NAS Kingsville carrier data base which was modeled on a 1.5 to 1 basis. The trap coordinates were defined as being 1.5 times larger than the actual trap coordinates. Since the NAS Chase Field carrier was modeled on a 1 to 1 basis, problems developed in defining the data and instructions needed to compute the landing zone matrix. At present, it is not known whether the software problems can be easily corrected since there are no known flaws on the Sigma 5 visual programs originally developed by General Electric on the ADM at NAS Kingsville.

Ball Control on FLOLS

In a landing configuration, the ball is used on the Fresnel Lens Optical Landing System (FLOLS) to remain on glideslope. It was found it was difficult to land properly with the use of the FLOLS. It was found that the ball extinguished approximately 200 feet from touchdown on the runway. A programming error was found in the real-time program of the PDP 11/50 software and corrected. Although the programming effort improved the FLOLS, there still remains programming effort in this area.

Visual Cockpit Maintenance

Questions were asked concerning the preventive maintenance on the visual cockpit 504. It was emphasized that the control forces, gunsight, and daily readiness must be performed to ensure valid results of the TTEE by Seville Research Corporation. The IRAN program was discussed and the possibility of inspecting and performing repair as necessary on the visual cockpit before student pilots begin input into the program.

Summary

1. CNATRA will follow-up message to ASO concerning light valve shortage and it's overall effect on simulator training.

2. Carrier data base needs further development for proper visual cues on landing.

3. Gunsight problems were defined and corrected. No further action should be necessary except for periodic preventive maintenance.

4. The carrier trap program which is part of the 2F90 operational flight program does not function properly due to the incorrect trap coordinates being assigned. The problem can be corrected within a reasonable amount of time.

5. The problem with landing with the FLOLS has been partially corrected but still needs improvement.

6. Maintenance on the visual cockpit was emphasized for correct and consistent data to be obtained by Seville Research Corporation.

Seville Research Corporation quoted 25 April 1978 as a deadline for correcting the 2B35/2F90 problems. If the problems are not corrected by this date, Seville will adjust evaluation criteria to compensate for those areas. For example, if the FLOLS and Trap problems are not corrected, these areas will be eliminated from the evaluation criteria. This may impact the 2B35 syllabus.

Student pilots will be initiated into the evaluation 1 May 1978 and continue till 1 November 1978. Data Analysis and Preliminary Report will be drafted during Nov-Dec 1978 with Navy review January 1979. Final Report is due 1 March 1979.

FER NAS Meridian

Donald R. Mathis

EXHIBIT A-2

ETL21:DRM
DV 2B35
21 February 1978

MEMORANDUM

From: Donald R. Mathis
FER NAS Meridian
To: ETL
SFER Pensacola, Don Brassfield

Subj: Status of 2B35 Software Problems

Encl: (1) Coding for 2F-90 Software Changes and Additions
(2) Example TTY Printout

1. Below are comments on the present status of the 2B35 visual system software problems. Enclosure (1) contains the software changes and additions to the 2F-90 visual routines. The locations assigned in Flight, Systems, and Common memory are temporary locations. Coordination with Fred Haas, 2F-90 Digital Specialist, will be necessary for final locations.

2. The 2F-90 trap routine was written for a NAS Kingsville carrier data base modeled 1½ times the carriers' actual size. Since NAS Chase Field and NAS Meridian have a carrier data base modeled the actual size of the carrier, the coordinates that define the landing zone, wire zones, and bolter zone are incorrect. To correct the trap routine problems, changes were made to the Systems software routine, GEMOD.

3. The catapult zone limits are incorrectly defined due to the same problem mentioned in Item 2. For correction the GEMOD software program was changed.

4. It was determined that the carrier moves in a straight line at a speed of 15 knots on a heading of 144 degrees. Since the software position data is scaled to bit 20, there is a limit to the number of feet the carrier can travel without an arithmetic trap, approximately 1,050,000 feet. A software routine was written to limit the X,Y position of the carrier to 1,000,00 feet. The routine was programmed in Common memory, branching from the GEMOD routine.

5. It was requested by Seville Research Corporation and Trawing 3 to include on the TTY printout, distances off center-line when landing on the carrier and the airfield. A software routine was written to accomplish the results needed. The carrier landing printout routine gives distances left or right of center-line upon landing. The airfield

landing printout routine gives distances left and right, long and short, in relation to an optimum touchdown point on the runway. The LNDPRT in the flight programs and GEMOD was changed.

6. The 2F-90 software programs are written for a fixed wind speed, 15 knots. Trawing 3 feels that a fixed wind speed is unsatisfactory since it does not give the flexibility for changing wind by use of the 2F-90 instructor console. For correction the GEMOD software program was changed.

7. The Fresnel Lens Optical Landing System (FLOLS) does not function correctly for a proper landing on the carrier or airfield. The following changes were made to the PDP 11/50 CGI Realtime program to correct the problem:
a. The focal point of the lens was arithmetically changed in the equations
b. Equations were changed to extinguish the red ball so it did not blend with the ground during a low ball
c. The glideslope was changed from 3.54 to 3 degrees

8. Trawing 3 states that the present sound simulation of the 2F-90 is not an accurate presentation. Investigation is currently being performed to determine if a problem exists in this area.

9. Enclosure (2) contains an example of the TTY printout.

FER NAS Meridian

Donald R. Mathis

EXHIBIT A-3

Informal Memo

From: Don Mathis, FER NAS Meridian
To: TDC Garrett Via: SFER Corpus Christi
Subject: T^2E^2 Changes

The following are problem areas, solutions, and documentary information on T^2E^2 changes.

1. Gunsight: Problem - a. Mechanical parts missing; b. Full travel on pipper not possible; c. Pipper not aligned at 125 mils with center of screen target. Solution - Gunsight mechanically repaired, full travel was made possible by aligning sight mount, and glareshield was elevated to align gunsight at 125 mils with center of gunsight pipper and screen target center. PMS was submitted and forwarded to NTEC for proper documentation.

2. Trap Simulation on Carrier: Problem - Trap system of obtaining wire upon touchdown on carrier did not function properly. Solution - Problem was a result of software within 2F90 program being incorrect. Carrier data for NAS Chase was different from NAS Kingsville, where the 2F90 software was originally developed to function for a carrier data base modeled to a 1:1 basis. The trap coordinates were re-defined for a NAS Chase carrier modeled on a 1:1 vs. 1.5:1 basis. Documentation: 2F90 TECD 75.

3. Arithmetic Trap Problem: Trap would occur periodically, causing the computer to halt computations due to carrier and aircraft exceeding program arithmetic limits. Solution - 2F90 was programmed to limit carrier and eyepoint from exceeding 1,000,000 feet. Documentation: 2F90 TECD 75.

4. Catapult Zone Limits: Problem - Incorrect zone limits due to NAS Kingsville modeled to a 1.5:1 vs. NAS Chase 1:1 basis. Solution - 2F90 program was changed to allow proper catapult operation. Documentation: 2F90 TECD 75.

5. Wind Speed: Problem - Wind speed changes could not be entered around carrier. Solution - 2F90 software was changed to allow any wind speed from 2F90 instructor's console. Documentation: TECD 75.

6. Visual Cues: Problem - Insufficient visual cues upon landing on carrier, airfield, and when performing bombing runs. Solution: Extensive changes were made to the TEXA day scene and LEXT carrier data base to incorporate changes as a result of direct interface with using TRAWINGs. Documentation: 2B35 TECD 4.

7. Ball Control of FLOLS: Problem - Upon landing, ball control with FLOLS was difficult, if not impossible. Solution: 2B35 program was corrected for proper ball operation. Documentation: TECD 5.

8. It was requested by Seville Research to add a TTY printout of distances off center-line when landing on the carrier and the airfield. This was accomplished by developing 2F90 software programs. Documentation: 2F90 TECD 75.

9. Sound Simulation: Problem - Sound did not accurately simulate aircrafts'. Solution: Part of problem was a defective module creating incorrect noise.

10. Power Response: Problem - 2F90 visual cockpit did not simulate the proper power response upon landing. Solution: 2F90 software was modified for proper power response incorporating the TRAWING's comments. Documentation: 2F90 TECD 65.

APPENDIX B

PERFORMANCE MEASUREMENT INSTRUMENTS FOR FAM, NF, WEP AND SAMPLE FCLP/CQ LANDING TREND ANALYSIS FORM (OPNAV FORM 3760/71. REV 7/71)

PERFORMANCE RECORDING BOOKLETS

Appendix B provides copies of the performance recording materials used for FAM, NF, WEP, and FCLP/CQ. Instructions for the use of these materials were provided in the Instructor Briefing Guides found in Appendix C.

Exhibits B-1, B-2, and B-3 for FAM, NF and WEP, respectively, show the formats used for maneuver data collection. The actual booklets used were made up by combining, as appropriate, the student stage identifying header with the particular data sheets to be used for the flight being flown.

For example, in the FAM-1 booklet, the first page was for recording Takeoff performance, the next two pages were for Barrel Roll (2 trials), the next one for the Straight In Precautionary approach and the last four pages were to record the Full Flap Landing (two trials).

When assembled, the booklets were arranged so that the header was visible at all times and could be clipped to the IP kneeboard without interference with page turning during flight. The stage booklet headers were color coded - yellow for FAM, white for NF, and blue for WEP. The headers were also printed on heavier stock than were the recording sheets.

The assembled sheets were stapled on the upper right corner so that the IP could conveniently turn the pages. The top recording sheet also was marked as appropriate for the stage involved. This is illustrated by the block letters on the FAM and WEP pages.

Pagination of the booklets followed the sequencing appropriate for the events to be covered. It also provided for multiple maneuver recording, as required.

Exhibit B-4 shows a Landing Trend Analysis sheet with sample LSO notations for a hypothetical FCLP/CQ flight.

EXHIBIT B-1

FAM PERFORMANCE MEASURES
(HEADER AND DATA PAGES)

STUDENT__________ SSN__________

CLASS__________ IP __________

FLT__________ DATE__________

WX__________ WIND__________

(staple)

This space was covered by assembled pages from the remainder of this exhibit to provide the desired booklets.

INTENTIONALLY BLANK

(Yellow card stock was used)

FAM

TAKEOFF

T/O ROLL

TRKG — Drift L or R | Straight | Erratic

ROTATION

A/S — -10 | -5 | ON SPD | +5 | +10

ATT — 8° | 10° | 12° | 14°

RATE — U/C | O/C

AIRBORNE

TRKG — Left | CL | Right

A/S — 230 | 240 | 250 | 260 | 270

GRADE

U	BA		AVG		AA	
	-	+	-	+	-	+

BARREL ROLL

INITIAL ENTRY

HDG

A/S — 330 — 340 — 350 — 360 — 370

90° POSITION

HDG — -20° — -10° — 90 — +10° — +20°

BANK — -20° — -10° — INV — +10° — +20°

EXIT

ORIG. HDG — -20° — -10° — +10° — +20°

A/S — 330 — 340 — 350 — 360 — 370

OVERALL

PITCH RATE — Slow — Erratic — Fast

ROLL RATE — Slow — Erratic — Fast

GRADE

U	BA		AVG		AA	
	-	+	-	+	-	+

STRAIGHT-IN PA

INITIAL POINT

A/S	160	180	△	200	220
ALT (Chase-MSL)	3000	3100	△ 3200	3300	3400
DIST	Close		△ 4.5		Long

GLIDE SLOPE CONT. U/C △ O/C

FINAL X-POINT

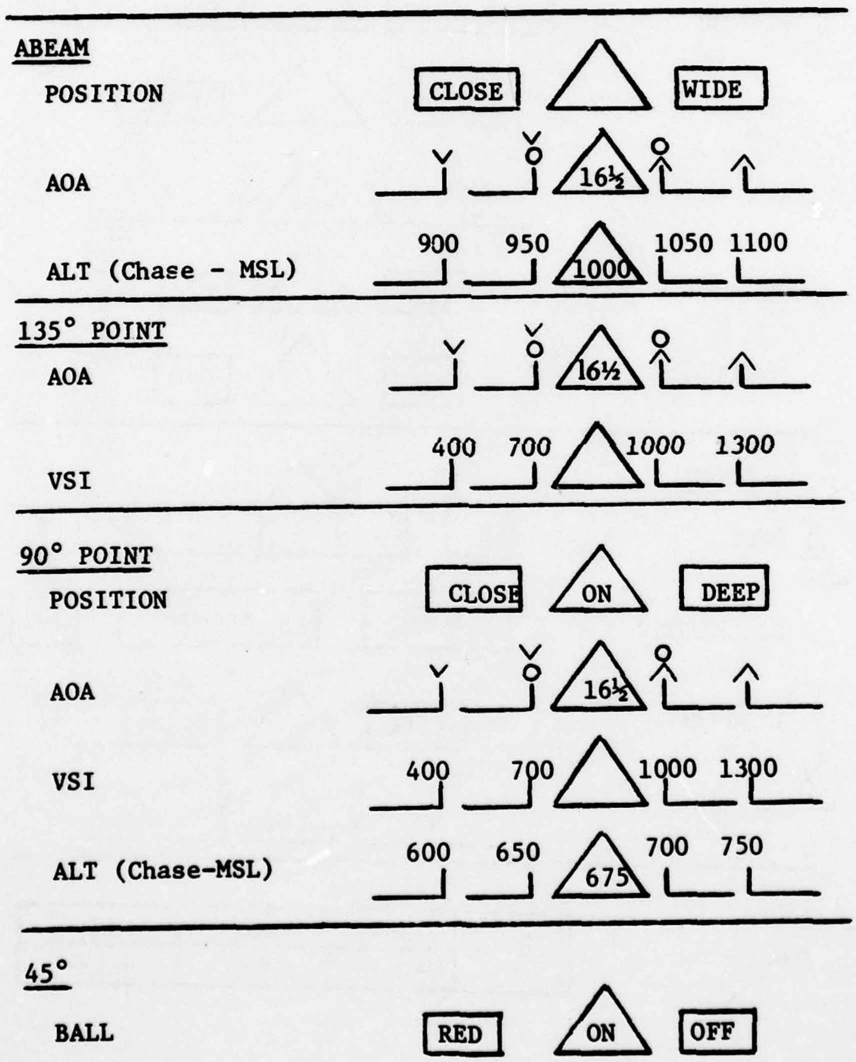
A/S	160	180	△	200	220
ALT (Chase-MSL)	300	350	△ 400	450	500
VSI	1300	1500	△	1800	2000
LINE-UP	Left		△ C/L		Right

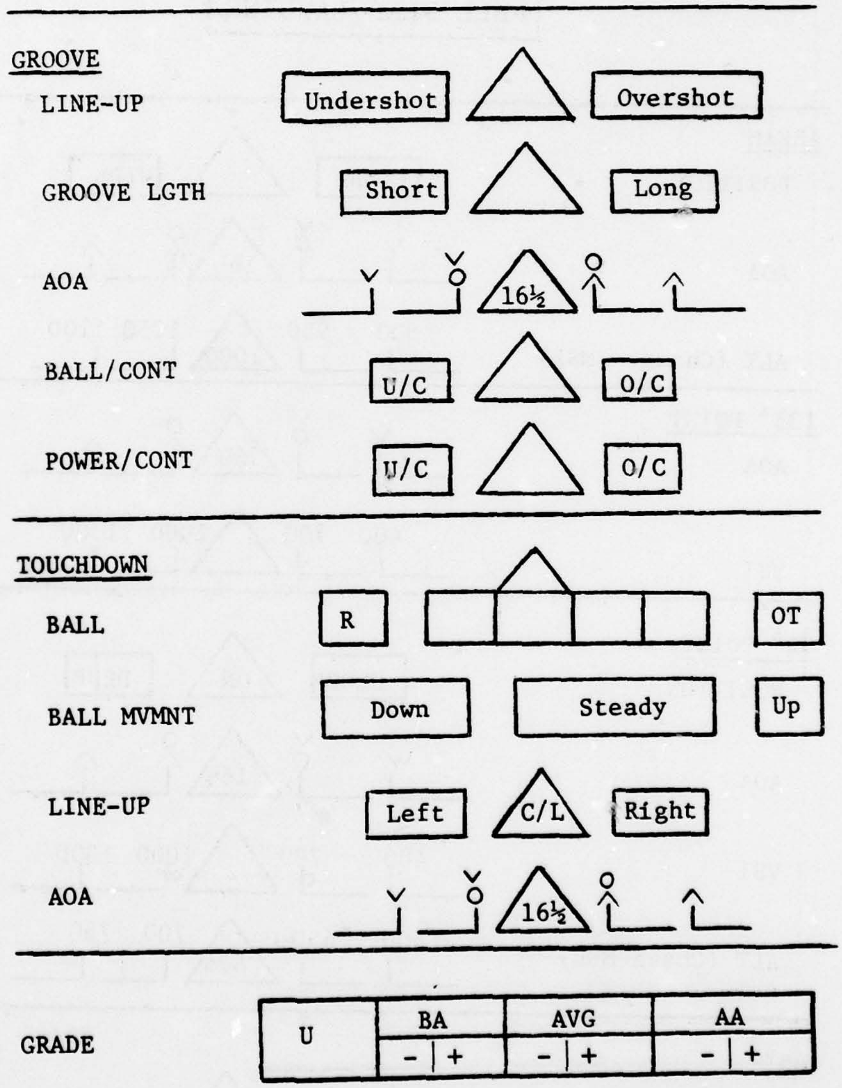
FLARE RATE U/C △ O/C

TOUCHDOWN ATT Low △ Float

GRADE	U	BA		AVG		AA	
		-	+	-	+	-	+

FULL FLAP LANDING

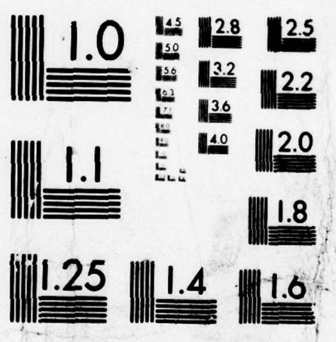



GROOVE
LINE-UP
Undershot
Overshot
GROOVE LGTH
Short
Long
AOA
16½
BALL/CONT
U/C
O/C
POWER/CONT
U/C
O/C
TOUCHDOWN
BALL
R
OT
BALL MVMNT
Down
Steady
Up
LINE-UP
Left
C/L
Right
AOA
16½
GRADE
U
BA
AVG
AA
- | +
- | +
- | +

AD-A073 669 SEVILLE RESEARCH CORP PENSACOLA FL F/G 5/9
TRANSFER OF TRAINING EFFECTIVENESS EVALUATION (T2E2): U.S. NAVY--ETC(U)
JUL 79 W V HAGIN, E P DURALL, W W PROPHET N61339-77-C-0164
UNCLASSIFIED SEVILLE-TR-79-06 NL

2 OF 2
AD A073669

END
DATE
FILMED
10-79
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

EXHIBIT B-2

NF PERFORMANCE MEASURES
(HEADER AND DATA PAGES)

STUDENT____________________ SSN________________

CLASS____________________ IP ________________

FLT____________________ DATE________________

WX____________________ WIND________________

(staple)

This space was covered by assembled pages from the remainder of this exhibit to provide the desired booklets.

INTENTIONALLY BLANK

(White card stock was used)

NF

TAKEOFF

T/O ROLL

TRKG — Drift L or R | Straight | Erratic

ROTATION

A/S — -10 | -5 | ON SPD | +5 | +10

ATT — 8° | 10° | (△) | 12° | 14°

RATE — U/C | (△) | O/C

AIRBORNE

TRKG — Left | CL | Right

A/S — 230 | 240 | 250 | 260 | 270

GRADE

U	BA		AVG		AA	
	-	+	-	+	-	+

FULL FLAP LANDING

ABEAM

POSITION	CLOSE		△		WIDE
AOA			16½		
ALT (Chase - MSL)	900	950	1000	1050	1100

135° POINT

AOA			16½		
VSI	400	700	△	1000	1300

90° POINT

POSITION	CLOSE		ON		DEEP
AOA			16½		
VSI	400	700	△	1000	1300
ALT (Chase-MSL)	600	650	675	700	750

45°

BALL	RED	ON	OFF

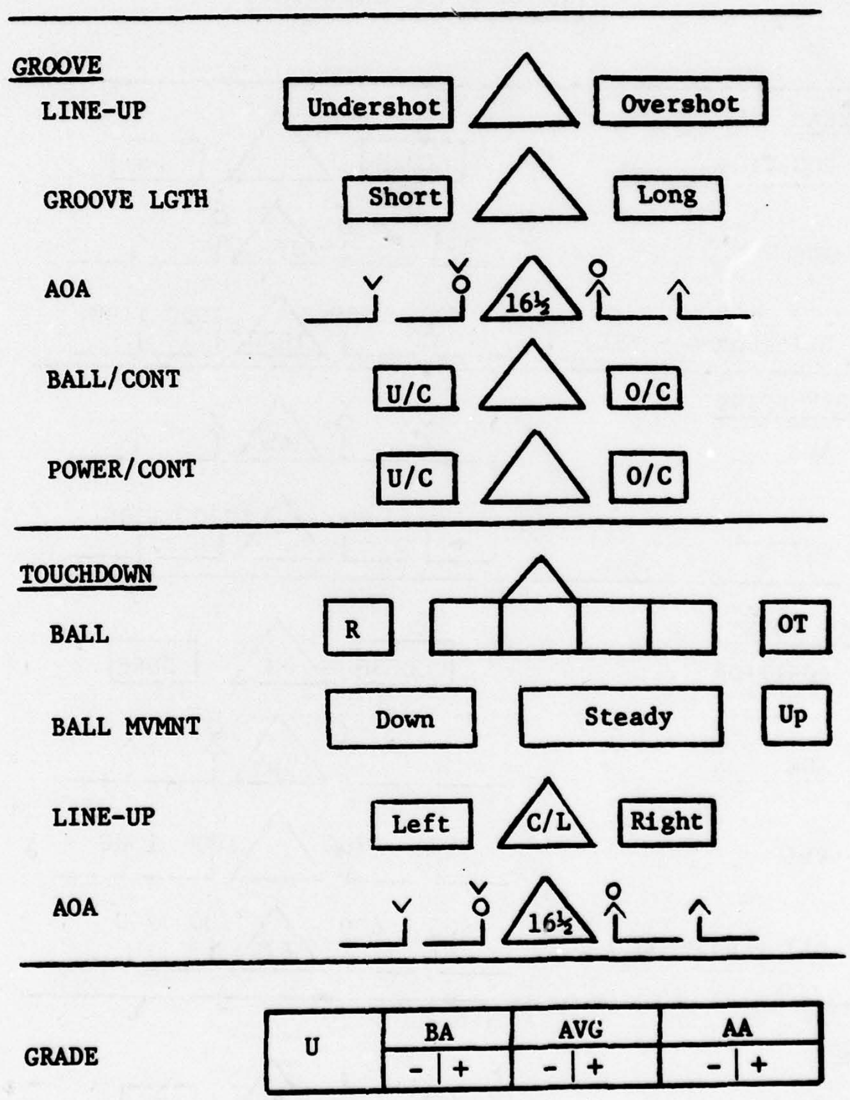

GROOVE
LINE-UP
Undershot
Overshot
GROOVE LGTH
Short
Long
AOA
16½
BALL/CONT
U/C
O/C
POWER/CONT
U/C
O/C
TOUCHDOWN
BALL
R
OT
BALL MVMNT
Down
Steady
Up
LINE-UP
Left
C/L
Right
AOA
16½
GRADE
U
BA
AVG
AA
- | +
- | +
- | +

EXHIBIT B-3

WEP PERFORMANCE MEASURES

(HEADER AND DATA PAGES)

STUDENT__________ SSN__________

CLASS__________ IP__________

FLT__________ DATE__________

WX__________ WIND__________

FULL DATA			
1 DIST / CLOCK	2 DIST / CLOCK	3 DIST / CLOCK	4 DIST / CLOCK
	FULL DATA		
5 DIST / CLOCK	6 DIST / CLOCK	7 DIST / CLOCK	8 DIST / CLOCK
9 DIST / CLOCK	10 DIST / CLOCK	11 DIST / CLOCK	12 DIST / CLOCK
13 DIST / CLOCK	14 DIST / CLOCK	15 DIST / CLOCK	16 DIST / CLOCK
17 DIST / CLOCK	18 DIST / CLOCK	19 DIST / CLOCK	20 DIST / CLOCK
21 DIST / CLOCK	22 DIST / CLOCK	23 DIST / CLOCK	24 DIST / CLOCK

WEP

30^{0} BOMBING

ABEAM

POSITION	Close		△		Wide
A/S	220	240	250	260	270
ALT (MSL)	7900	8100	8300	8500	8700

ROLL-IN

ENTRY POS		Close	△	Deep	
A/S	230	240	250	260	270
POWER		Low	ON	High	
ALT (MSL)	7900	8100	8300	8500	8700
NOSE ATT		Drop	Lvl	Climb	

DIVE

ANGLE (WING LVL)	26°	28°	30°	32°	34°

RELEASE

WIND COR		NO	YES	N/W	
WING ATT		LWD	LVL	RWD	
RLS ALT (MSL)		Low	O/A	HI	
RLS MACH	-.02	-.01	△	+.01	+.02

RECOVERY

PROPER REC	NO	YES

SCORE DIST ☐ CLOCK ☐

GRADE	U	BA		AVB		AA	
		-	+	-	+	-	+

EXHIBIT B-4

FCLP/CQ LANDING TREND ANALYSIS

PILOT ________________ LSO ________________ YEAR ___ ACFT ____ SQUADRON ____ SHIP______

DATE/ FLT	D or N	GR	GLIDESLOPE & SPEED ERRORS						CONTROL ERRORS		LINEUP & WINGS	REMARKS (Note Wire No. on CQ 14)
			AW	OT	X	IM	IC	AR	POWER	ATT		
7 Sep	D	—			LO	S			AFU	DECIM	OSX	
	↓	B	H					SLO		NOTL		
		(OK)	(LO)			NERD			NEP	NEATT		
		WO			H	H			NP			NESA
		—			HF	→	SBDOLWIC-AR				LURAW	
		(OK)			US				(NEPOLWAR)			(HSLOAW)
		(OK)						H	TMPAR	CD		(SLOCWIM)
		B	H						TMP	FNDAW		LIG

APPENDIX C

TRAINING TREATMENTS

The supplementary 2B35 briefing guides developed to support T^2E^2 minimized innovation and focused on only those procedures which assured a desired minimum number of trials on critical tasks and IP adherence to prescribed sequences, both at the trainer and in the air. The principal emphasis was on ensuring that students received enough practice in the device on the key T^2E^2 tasks and maneuvers for meaningful learning to occur, thus allowing the possible demonstration of transfer. The supplements for the 2B35 FAM, NF, WEP and CQ flights briefing guides provided in this Appendix were the instructional scenarios employed by the instructors for all visual 2B35 training and for the nonvisual control group's aircraft training.

It should be noted that both A and B treatment groups received the FAM 1V and 2V programs. FAM 3V and 4V treatment was given only to the A group. Similarly, the A and B groups both received the same NF 1V; only the A group was given NF 2V.

The briefing guides for 2B35 training were complete, 'stand-alone' documents always available at the instructor's console. They provided all the information needed to set up the trainer for each flight, gave guidance concerning recommended use of special instructional features, and specified the scenario of required instructional events.

The guides for the aircraft training and data gathering flights were prepared as supplements to the flight line briefing guides for the aircraft flights of interest. These were appended to the appropriate pages in the squadron documentation on the flight line.

The general procedures for trainer setup are presented in Exhibit C-1; the FAM materials are to be found in Exhibit C-2; NF in Exhibit C-3; WEP in Exhibit C-4; and the CQ instructions in Exhibit C-5.

EXHIBIT C-1

2B35 TRAINING DATA SET-UP CHECKLIST

A. PROBLEM WORLD'S DATA identities:

(1) Chase Field and weapons range - TEXA

(2) Chase Field Night - NTTX

(3) Lexington - 2LEX

B. TO CALL-UP DESIRED PROBLEM WORLD'S DATA with input teletype:

(1) Type SE and RETURN key (Teletype will print $ (R)ESTORE or (L)IST?).

(2) Type R and RETURN key (Teletype will prompt with $ NAME?).

(3) Type TEXA or NTTX or 2LEX and RETURN (name of data base desired) (When the data base is loaded, the 3 TV monitors will show the PROBLEM WORLD and the teletype will prompt with $ # ?).

C. TO Assign FLOLS to desired location with input teletype: Type FL, SPACE BAR and the following number:

(a) 0 and RETURN (Carrier)

(b) 1 and RETURN (Chase Field RW 13L)

(c) 2 and RETURN (Chase Field RW 13R

(d) 3 and RETURN (Chase Field 31L)

(e) 4 and RETURN (Chase Field RW 31R)

D. No fog or visibility restriction are desired for this training:

(1) Type FG space 1 space 2 and RETURN (to remove any fog).

(2) Type VS space 999999 space 999999 space 999999 space RETURN (to remove visibility restrictions).

E. To delete teletyping errors:

(1) Type RUBOUT (needed to backspace and clear each typo).

(2) Type CONTROL and U (to start over).

SPECIAL INITIAL CONDITIONS (SIC) and SET-UP CHECK LIST

A. RESET - On Deck, Short of RW 13L - FOR START

No. 1 - 1000' ABEAM RW 13L, HEADING 315°, ALT 1050 MSL

No. 2 - 1/2 MILE TURNING DOWNWIND ON RW 13R, ALT 650 MSL

No. 3 - ON DECK, RW 13L CENTER-LINE, ENGINE STARTED

No. 4 - 10 MILES DOWNWIND RW 13R, ALT 3000

No. 5 - NOSE DOWN ON BOMBING PATTERN (30° DIVE, ALT 3325)

B. SET-UP PROCEDURES:

1. Depress "FREEZE" button
2. Depress "PROBLEM MODE"
3. Push the "SELECT" button below SPECIAL INITIAL CONDITION display window
4. Enter desired SIC number via keyboard
   (a) Press CLEAR
   (b) Enter SIC number
   (c) Press ENTER
5. Depress OPERATE button which flashes approximately 30 seconds while SIC is being initialized, then trainer will revert to FREEZE.

C. WEP SET-UP PROCEDURES:

1. Enter SIC #5 as per "B" above.
2. Field Elevation entry:
   (a) Depress SELECT button below NORMAL display window
   (b) Depress ENVIRONMENT control button
   (c) Depress SELECT button below FIELD ELEVATION display window
   (d) Enter 300 feet via keyboard
3. Bomb load entry:
   (a) Depress STORES control button
   (b) Depress SELECT button below STATION #3 display window
   (c) Enter 13 via keyboard (loads 10 MK76 bombs; repeat as necessary)

EXHIBIT C-2

T^2E^2 SUPPLEMENT TO BRIEFING GUIDE

FAM-1V

Group/Period
FAM-A1V & B1V

2B35/2F90
Flight Instructor

2 Hrs. Block Time
1.5 Hrs. Min. Cockpit Time

Trainer Conditions:

1. Call up TEXA data base & FLOLS to Rwy. 13L.
2. SICs
   a. Start - RESET or #3
   b. 2nd and 3rd takeoff-RESET & #3
   c. PAs - #4
3. Motion - ON
4. Sound - ON
5. Wind - None until PAs, then 130° @ 25 KTS.

General Training Instructions

1. Comply with all Squadron operating procedures, checklists, voice procedures, and course rules throughout flight as appropriate.
2. a. IPs should use FREEZE for instructions other than brief comments.
   b. FREEZE and use SIC to reposition student to other locations for more effective use of training time, e.g., (1) after 1st & 2nd takeoff FREEZE & enter SIC #3 (on runway ready for another practice takeoff), then student completes 3rd takeoff & climb to altitude; (2) after 1st & 2nd PA, FREEZE during waveoff or touch & go & enter SIC #4 (10 miles out straight-in) rather than flying entire pattern if student doesn't need that kind of practice.
   c. IPs are encouraged to use 2B35/2F90 training enhancement features such as FREEZE, SICs, visual cues, etc. to aid student's learning
3. Record student's performance on Trials #1 & 3# for selected maneuvers as per data forms. Write student's name on teletype landing sheet and staple to back of data booklet.

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. Start and ground procedures	
b. Taxi	
c. Takeoff	(3)
d. Rotation to takeoff attitude	(3)
e. Transition to climb schedule	(1)
f. Stall series	(1)
g. Turn pattern	(1)
h. Steep turn to buffet	(1)
i. Aileron roll	(1)
j. Wingover	(1)
k. Barrel roll	(3)
l.*Loop	(1)
m.*Half Cuban eight	(1)
n.*Immelman	(1)
o.*Split S	(1)
p. Straight-in PA to touch & go	(3)
q. Reenter break	(1)
r. Touch & go full flap landings	(5)
s. Abeam PA	(1)
t. Full flap final landing	(1)
PRACTICE	
a. Pilot controlled start	
b. Poststart checks	
c. Emergencies	

* May be done as a Squirrel Cage.

Performance

T^2E^2 SUPPLEMENT TO BRIEFING GUIDE

FAM-2V

Group/Period
FAM-A2V & B2V

2B35/2F90
Flight Instructor

2 Hrs. Block Time
1.5 Hrs. Min. Cockpit Time

Trainer Conditions:

1. Call up TEXA data base and FLOLS to Rwy. 13L
2. SICs
   a. Start - RESET or #3
   b. 2nd & 3rd takeoff -RESET & #3
   c. PAs #4
3. Motion - ON 4. Sound - ON
5. Winds - none initially, then:
   a. 3 PAs - 130° @ 15 Kts
   b. 3 Full Flaps Landing - 130° @ 15 Kts
   c. 2X-Wind Landing-085° @ 15 Kts
   d. 2X-Wind Landing-175° @ 15 Kts
   e. As desired

General Training Instructions
Same as noted for FAM 1V

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. High altitude flameout and successful air start	(1)
b. Vertical recoveries (high & low)	(2)
c. No flap landing	(1)
2. PRACTICE	
a. *Start, ground procedures, and taxi	
b. Takeoff	(3)
c. Rotation to takeoff attitude	(3)
d. Transition to climb schedule	(1)
e. Stall series	(1)
f. Aileron roll	(1)
g. Wingover	(1)
h. Barrel roll	(3)
i. Overhead aerobatics (Squirrel Cage)	(1)
j. Straight-in PA	(3)
k. Reenter break	(1)
l. Full flap landings (include X-wind)	(5)
m. Abeam PA	(1)
n. Full Flap final landing	(1)
o. Emergencies	

*** - If required by students' FAM-1V Performance.**

T^2E^2 SUPPLEMENT TO BRIEFING GUIDE

FAM-3V and 4V

Group/Period
FAM-A 3V & 4V

2B35/2F90
Flight Instructor

2 Hrs. Block Time
1.5 Hrs. Min. Cockpit Time

Trainer Conditions:

1. Call up TEXA data base and FLOLS to Rwy. 13L
2. SICs
   a. Start-RESET or #3
   b. 2nd & 3rd Takeoff-RESET & #3
   c. PAs - #4
3. Motion - ON
4. Sound - ON
5. Winds
   a. 3 PAs - zero
   b. 3 Full Flap Landing-zero
      2 Full Flap Landings-130° @ 20 Kts
   c. As desired

General Training Instructions:

Same as noted for FAM 1V

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. *No flap, no speed brake, no spoiler final landing	
2. PRACTICE	
a. *Start, ground procedures and taxi	
b. Takeoff	(3)
c. Rotation to takeoff attitude	(3)
d. Transition to climb schedule	(1)
e. Stall series	(1)
f. Aileron roll	(1)
g. Wingover	(1)
h. Barrel roll	(3)
i. Overhead aerobatics (Squirrel Cage)	(1)
j. Vertical recoveries	(1)
k. Straight-in PA	(3)
l. Full flap landings	(5)
m. No flap landings	(1)
n. Abeam PA	(1)
o. Full flap final landing	(1)
3. REVIEW	
a. Start and poststart checks	
b. Airborne procedures	
c. Emergencies	

* - If required by students' previous performance.

T^2E^2 SUPPLEMENT TO FAM 4, 5, 6, 7 and 8X BRIEFING GUIDES

FAM 4

1. CONDUCT OF FLIGHT Paragraph, add:
   a. Barrel Roll - Introduce and practice a minimum of three.
   b. Full Flap Landing - Introduce and practice a minimum of three.
2. PERFORMANCE MEASUREMENT Requirements:
   Record the student's performance on his first and third trials for the Barrel Roll and Full Flap Landing, and on the first for the Takeoff as per the PERFORMANCE DATA FORM.

FAM 5

1. CONDUCT OF FLIGHT paragraph, add:
   Straight-in PA - Introduce and practice a minimum of one.
2. PERFORMANCE MEASUREMENT Requirements:
   Record the student's performance on his first and third trials for the Barrel Roll and Full Flap Landing, and on the first for the Takeoff and the Straight-in PA as per the PERFORMANCE DATA FORM.

FAM 6, 7, and 8X

1. PERFORMANCE MEASUREMENT Requirements: Same as FAM 5.

T^2E^2 SUPPLEMENT TO FAM 1NV, 2NV, 3-7XNV BRIEFING GUIDES

FAM 1NV

1, CONDUCT OF FLIGHT Paragraph, add:

a. Barrel Roll - Introduce and practice a minimum of three.

b. Full Flap Landing - Introduce and practice a minimum of three.

2. PERFORMANCE MEASUREMENT Requirements:

Record the student's performance on his first and third trials for the Barrel Roll and Full Flap Landing, and on the first for the Takeoff, as per the PERFORMANCE DATA FORM.

FAM 2 NV

1. CONDUCT OF FLIGHT paragraph, add:

Straight-in PA - Introduce and practice a minimum of one.

2. PERFORMANCE MEASUREMENT Requirements:

Record the student's performance on his first and third trials for the Barrel Roll and Full Flap Landing and on the first for Takeoff and Straight-in PA as per the PERFORMANCE DATA FORM.

FAM 3-7X NV

1. PERFORMANCE MEASUREMENT Requirements: Same as FAM 2NV.

EXHIBIT C-3

T^2E^2 BRIEFING GUIDE

NF-1V and NF-2V

Group/Period
NF-A 1 & 2V & NF-B1V

2B35/2F90 Flight Instructor

2 Hrs. Block Time 1.5 Hrs. Min. Cockpit Time

Trainer Conditions:
1. Call up NTTX data base and FLOLS to Rwy. 13L 2. SICs a. Start - #3 b. 2nd & 3rd Takeoffs-RESET & #3 c. 2nd & 3rd GCA - #4 3. Motion - ON 4. Sound - ON 5. Wind a. GCAs: 1st 130° @ 25 Kts; 2nd 130° @ 15 Kts; and 3rd 130° zero Kts. b. Full Flaps Landing- 3 @ 15 Kts. and 3 with X-wind c. As desired

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. *Start, ground procedures & taxi	
b. Takeoff	(3)
c. Rotation to takeoff attitude	(3)
d. Transition to climb schedule	(1)
e. Penetration: GCA to touch & go	(3)
f. Depart and reenter break	(1)
g. Touch and go full flap landing	(6)
h. Roll and go	(1)
i. Full flap final landing	(1)
2. PRACTICE	
a. Pilot controlled start	
b. Poststart checks	
c. Emergencies	

* - If required by student's previous performance.

T^2E^2 SUPPLEMENT TO BRIEFING GUIDES
NF 1 and 2

1. CONDUCT OF FLIGHT paragraph, add:
   a. Full Flap Landing - practice a minimum of three.

2. PERFORMANCE MEASUREMENT Requirements:
   a. The IP will record the student's performance on the first Takeoff and first and third Full Flap Landing as per the PERFORMANCE DATA FORM.

EXHIBIT C-4

T^2E^2 SUPPLEMENT TO BRIEFING GUIDE

WEP-1V

Group/Period
WEP-1V

2B35/2F90
Flight Instructor

2 Hrs. Block Time
1.5 Hrs. Min. Cockpit Time

Trainer Conditions:

1. Call up TEXA data base
2. SIC #5
3. Motion - OFF
4. Sound - ON
5. No wind
6. Field elevation - 300 ft
7. Bombs - select as needed

General Training Instructions:

1. Record bomb runs #1 and #6 as per data forms, record distance and clock information for all runs (on boxes located on back page of WEPs booklet) and write student's name on the teletype bomb performance sheet and staple to back of data booklet.
2. General instructional comments same as FAM 1V.

Instructional Events

1. INTRODUCE
   - a. Gunsight and bomb switch checks
   - b. 30^o bomb pattern
   - c. Abeam position
   - d. Roll in position/technique
   - e. Tracking technique
   - f. Dive angle
   - g. Corrections during run
   - h. Release position
   - i. Dive recovery
   - j. Minimum of 18 drops
   - k. Emergency procedures

T^2E^2 SUPPLEMENT TO BRIEFING GUIDE
WEP, 2V, 3V, and 4V

Group/Period
WEP-2V, 3V, & 4V

2B35/2F90
Flight Instructor

2 Hrs. Block Time
1.5 Hrs. Min. Cockpit Time

Trainer Conditions:

1. Call up TEXA data base
2. SIC #5
3. *Motion - OFF*
4. Sound - ON
5. Winds
   a. 4 drops-Headwind @ 20 Kts.
   b. 4 drops-Left X-wind @ 20 Kts.
   c. 4 drops-Right X-wind @ 20 Kts.
   d. Vary velocity as needed for others; show effect of higher velocities, e.g., 30, 40 Kts.
6. Field elevation - 300 ft
7. Bombs - Select as needed

General Training Instructions:

Same as noted for FAM 1V

Instructional Events

1. INTRODUCE
   a. Wind corrections and offset aimpoint
2. PRACTICE
   a. Gunsight and bomb switch checks
   b. 30^o bomb position
   c. Abeam position
   d. Roll in position/technique
   e. Tracking technique
   f. Dive angle
   g. Corrections during run
   h. Release position
   i. Dive recovery
   j. Student make 12 drops with known wind
   k. Student make 12 drops with unknown wind (leave wind constant to allow student sufficient opportunity for correction cues)
   l. Emergency procedures

T^2E^2 SUPPLEMENT TO BRIEFING GUIDES
WEP 5, 6, 7X and 11X

1. PERFORMANCE MEASUREMENT Requirements:

   a. WEP 5 (non-visual group): Record the student's performances (except the bomb scores) on bomb runs number one and number six.

   b. WEP dual aircraft flights loaded with MK 76 bombs: Record the student's performance for his first and sixth planned bomb drops. If student does not drop for any reason, IP will still record all other data and note reason for not dropping. Record distance and clock information for all six drops (boxes provided on back page of WEPs PERFORMANCE DATA booklet).

EXHIBIT C-5

FCLP/CQ SUPPLEMENT TO BRIEFING GUIDE

FCLP/CQ 1V (requires 2 students)

Set up trainer for day FCLP. Fly a minimum of 8 day passes with student 1 and 2.

Set up trainer for night FCLP. Again fly a minimum of eight night passes for students 1 and 2.

FCLP/CQ 2V (requires 2 students)

Set up trainer for night FCLP. Fly a minimum of eight night hops with each student. Repeat, so that each student makes a total of 16 passes.

Record performance, using NATOPS CQ notation. Attach to teletype printout showing each student's touchdown parameters.

FCLP/CQ 3V

Set up trainer for carrier landing practice. Fly a minimum of six Day Catapult Takeoffs and eight Approach/Landings for students 1 and 2.

FCLP/CQ

Record student performance in NATOPS LSO notation using Carrier Landing Trend Analysis Form

T^2E^2 INSTRUCTOR GUIDE

CQ-1 and 2V

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. Day FCLP	(8)
b. Night FCLP	(8)

Group Period

CQ-A1 & 2V & B1V

2B35/2F90
One LSO IP
Two Students

2 Hrs. Block Time
Each student:
.5 Hrs. Day FCLP &
.5 Hrs. Night FCLP

Trainer Conditions:

1. TD set-up Day & Night data normally
2. SIC - #3
3. Motion - ON
4. Sound - ON
5. Winds - 130^{o} @ 30 KTS for first 4 Day and Night approaches and 20 KTS for others

General Training Instructions

1. Comply with all squadron operating and FCLP/CQ procedures as appropriate
2. Training Scenario
   a. Day FCLP: Each student will fly a minimum of 8 approaches, i.e., one student will fly while the other observes at the Console; they will switch after 8 passes or .5 Hrs.
   b. Night FCLP (TD call up data): Each student will fly a minimum of 8 approaches using the routine described in 2a above
3. Data Recording: LSO will record each pass, using the NATOPS LSO procedures. Afterwards, each student will transcribe the LSO's comments to a FCLP/CQ LANDING TREND ANALYSIS form which will be certified by his LSO. This same procedure will be used for CQ 1 through CQ 14 in the aircraft.

T^2E^2 INSTRUCTOR GUIDES

CQ 3V

Group/Period
CQ-A3V

2B35/2F90
One LSO IP
Two Students

2 Hrs. Block Time
.8 per student

Instructional Events	Minimum Number of Trials
1. INTRODUCE	
a. Day Catapult Takeoff	(6)
b. Day CQ Approach/Landing	(8)
c. Bolter Procedures	

Trainer Conditions:

1. TD set up Day LEX data normally
2. SIC - #3
3. Motion - ON
4. Sound - ON
5. Wind - 127° @ 40 KTS for first 4 approaches and 30 KTS for others

General Training Instructions

1. Comply with all squadron operating and FCLP/CQ procedures as appropriate.
2. Training Scenario
   a. Student will start with a catapult takeoff and enter pattern
   b. Student will make approaches to arrested landing or bolter
   c. LSO should mix up the training to provide realism, i.e., if over 2-3 bolters occur without any arrested landing, then FREEZE problem and enter SIC #3 to ensure completing minimum number of "cat" shots.

LSO 2F90/2B35 OPERATIONS

T^2E^2 CQ 3V FLIGHT

1. LEX DATA BASE loaded (TD task)
2. Assign FLOLS to 2 LEX (TD task normally)
   a. Type FL, space, 0, and RETURN
3. Assign Carrier to Gulf of Mexico (TD task normally)
   a. Press RESET
   b. Press CAT LAUNCH
   c. Press OPERATE
4. Obtain Carrier Special Initial Condition #3 (2F90 Console)
   a. Press FREEZE
   b. Press PROBLEM MODE
   c. Press SELECT under SPECIAL INITIAL CONDITIONS
   d. Keyboard
      1. Press CLEAR
      2. Press 3
      3. Press ENTER
   e. Press OPERATE *(will flash initially)*
   f. While operate light is flashing:
      1. Press LOCATION/GC
      2. Press the fifth SELECT switch from left (may have to repeat twice to get engine to idle RPM)
   g. When trainer FREEZES:
      1. Press PROBLEM MODE
      2. Press SELECT under NORMAL
      3. Press OPERATE
   h. Press CAT LAUNCH when pilot ready for takeoff

APPENDIX D

INSTRUCTOR TRAINING MATERIALS

As discussed in the body of the report, the approach taken to instructor training was one of building upon existing instructor expertise and current instructional concepts and materials. This approach was taken principally to minimize the extra workload that would be imposed on the instructor pilots if substantial new materials or techniques were introduced. The instructional procedures and materials which resulted were prepared as supplements to the existing Squadron Briefing Guides for each trainer and aircraft flight of T^2E^2 concern.

Exhibit D-1 presents the schedule for instructor training and an outline of the content covered in that training. It should be noted that over 50% of the instructor training programmed was hands-on practice at the 2B35 or in the TA-4J.

It should be noted that the content of the instruction specific to T^2E^2 activities emphasized the use of the procedures for controlling training and evaluating performance which have been provided in the preceding Appendices B and C.

EXHIBIT D-1

T^2E^2 INSTRUCTOR TRAINING PROGRAM

The approach taken to instructor and student training materials development is one of building upon the existing instructor expertise and current instructional concepts and materials. This approach is taken principally to minimize the extra workload that would be imposed on instructor pilots if substantial new materials or techniques were introduced. The instructional procedures and materials to be used have been prepared as supplements to the existing Squadron Briefing Guides for each trainer and aircraft hop of T^2E^2 concern.

Instructor training activities and content outline are described in the following pages. It should be noted that over 50% of the instructor training programmed will be hands-on practice at the 2B35 or in the TA-4J. Instructor pilots will complete the workshop sessions(Summary of 2B35 T^2E^2 Study; Instructional Procedures; and Performance Measurement) before being scheduled for the 2B35 practice session. Then, airborne data recording (FAM and WEP in the TA-4J) practice will be necessary prior to instructing students in the T^2E^2 study.

Copies of the Briefing Guide supplements are enclosed. The supplements are intended to control the trainer set-up procedures and the minimum numbers of practice trials each student receives during a given lesson. As supplements to the existing squadron practices, they do not, however, unduly impact on the instructor's established approach to student training management. The principal effect will be systematize the number of practice trials students receive on key events and to standardize for T^2E^2 purposes the procedures for performance measurement.

Instructor pilots will use this material in addition to their current squadron operating procedures, including briefing guides, to conduct the scheduled student training activities as per the T^2E^2 CNATRA Advanced Jet Syllabus.

INSTRUCTOR TRAINING PROGRAM:
2B35 T^2E^2

1. List of Training Activities Workshops:

	Block Time
a. Summary of 2B35 training effectiveness transfer study	2 hrs
b. Instructional procedures	1 hr
c. Performance measurement	1 hr
d. Instructor FAM and WEP practice 2F90/2B35	4 hrs
e. Instructor FAM and WEP data recording practice in TA-4J	2 hrs
TOTAL	10 hrs

2. Content Outline of Instructor Training
   a. Summary of 2B35 training:
      (1) Explain purpose of evaluation, i.e., to identify what transfer occurs from 2B35/2F90 to the TA-4J aircraft, if any, for the Navy's present and future planning purpose.
      (2) Describe test plan, i.e., A, B, and C pipelines are necessary for performance comparison purposes.
      (3) Performance measurement importance
      (4) Flight safety aspects
      (5) Joint Navy/Seville effort
         (a) Team work necessary and essential
         (b) Seville's role and responsibilities
         (c) CNET, CNATRA and TRAWING's role and responsibilities
         (d) Training Squadrons 24 and 25's role and responsibilities
      (6) Program implementation plan
   b. Instructional Procedures Discussion:
      (1) Appropriate FAM day/night and WEP 2B35 and aircraft syllabi flight content will be reviewed. Only instructors currently qualified to instruct in FAM or WEP will receive this training (CQ LSOs/instructors later).
      (2) Each visual maneuver to be recorded will be discussed.
      (3) 2B35/2F90 console and teletype entry procedures for the problem world, initial conditions, and environmental conditions desired will be discussed.

(4) 2B35/2F90 console instructional features to be emphasized will be explained, e.g., FREEZE, INITIAL CONDITION SET-UP, MALFUNCTIONS, etc.

(5) Example student scenarios and instructional cues for each 2B35/2F90 flight will be discussed. These examples will include usages of the 2B35/2F90 instructional features. Example: On initial takeoff, if the student allows the takeoff track to drift right or left of accepted track criteria, the IP should "FREEZE" the problem to show the student how to prevent and/or correct the directional problem.

c. Performance measurement - data forms content and recording procedures:

(1) Distribute forms and discuss each maneuver and recording rules for all data points.

(2) Data recorded must represent specific student's performances. The middle triangle scale denotes acceptable end-of- phase performance standards. The instructor will record a deviation to either side of acceptable triangle based on student's performance.

(3) Normally, the first and third trials by the student will be recorded except the first and sixth bomb drop based on student's plans. The IP should avoid making instructional comments during these recording trials.

(4) The performance data should be recorded as soon afterwards as safely practical.

(5) IPs will carry appropriate maneuver data forms, complete them on each flight (both 2B35/2F90 and aircraft), and deposit them at a centrally located area afterwards (probably in the ATJ box).

(6) Complete data for each flight and maneuver is essential.

d. Instructor Practice Teaching Using the Test Syllabi and Data Forms

(1) Two instructors will team for a 2-hour device block. One will play the IP role at the console, i.e., set up the problem world and initial conditions; control the training content and sequence; and record the appropriate maneuver performance. The other IP will fly the cockpit and play the student role. The IP at the console should use the device's training features to help identify the student's problems and enhance the learning.

(2) The IP team will swap roles after the practice training flight, which will consist of the minimum number of practice trials per maneuver, and after the appropriate data have been recorded.

(3) This training serves two purposes:

(a) Even though the IPs have been instructing students in FAM and WEP previously, the test will involve some different aspects. For example, the IP will essentially set up and control the problem world and the trainer with limited or no assistance from a TD; the test program will emphasize training device features easily overlooked by IPs; and, of course, the data recording is new and extremely important.

e. Instructor Practice FAM and WEP Data Recording in the TA-4J:

(1) The maneuver data recording forms will require more of the IPs' attention. All the performance criteria used should be well known to theIPs, but the task of marking a simplified form in the aircraft while carrying out the traditional IP role will require some training.

(2) The IP's responsibility for maintaining a safe flight environment is recognized. The data points needed should be recorded as soon after the student's performance as practical. For some maneuvers, like the takeoff and landing, the IP will normally not be able to mark the data points when the aircraft is near or on the runway. However, for many of the maneuvers, the data can be recorded immediately.

(3) For the initial IP data recording training, it is desirable to have a qualified pilot performing the student role so that the IP can concentrate on data recording.

APPENDIX E

CNATRA SEQUENCING GUIDELINES

CNATRAINST 1542.20B
20 SEP 1976

SEQUENCING GUIDELINES

1. Objective. The objective of each block of instruction is to present the units of the flight, flight support and academic curriculums pertaining to a particular knowledge area or skill level in a mutually supportive manner.

2. Sequencing considerations and limitations. Each block of instruction shall be completed before progressing to the next block, thereby ensuring that flight support and academic instruction are chronologically supportive of the in-flight instruction.

FLIGHT/SIMULATOR	WHEN GIVEN
BI 1S-3S	After INTRO, AERO, INAV I, NAMTRADET, CO-5S and parallel flight support lectures
RI 1S, AN-10X	After BI stagé and completion of FR & R, INAV II, METRO
FAM-IV-4V, 4-8X or FAM-1V-2V, 4-8X or FAM-1NV-7X NV	After AN 10X and parallel flight support lectures; simulator and flights in sequence-no interrupting flights
FORM 1	After FAM-8X or FAM 7X
AN-12, 13	After NF-2
NF-1V or NF-1	After FORM-3; NF-1V through NF-2 in sequence

SEQUENCING GUIDELINES

FLIGHT/SIMULATOR	WHEN GIVEN
AN-14 through 18	After NF-5. AN-17, AN-18 within three weeks of curriculum completion
ON-1-4	Anytime after FORM-4
TACF-1-3	Anytime after FORM-4
WEPS-1V-15 or WEPS-5-15	Anytime after FORM-6. No flights in other stages between WEP-1V and WEP-7X or WEP-5 and WEP-7X
ON-5, ON-6	Anytime after WEP-3 (may be flown interchangeably)
ACM-1-11	Anytime after TACF-3. A minimum of 60 hours flight time in model prior to ACM-1
CQ-1V-13X or CQ-1-13X	A minimum of 85 hours flight time in model prior to CQ-1. CQ-7 through CQ-10 flown at night. CQ-1V through CQ-1 flown consecutively
CQ-14	After certification of field qualification
AN-6, 7, 8, 13 ON-2 ¢ 3X	If flown in combination on multi-legged cross countries, routes must be very thoroughly planned by both student and instructor and shall be reviewed in detail with the Operations Officer

FLIGHT SUPPORT, SIMULATOR SUPPORT

SUBJECT	WHEN GIVEN
ASI-1	Within three working days of check-in
EP-8, BIFP-1	Prior to BI-1S
FAFP-1, CO-7S	Prior to FAM-1V
CO-8S	Prior to FAM-7
ANFP-1	Prior to AN-1S
FFP-1	Prior to FORM-1
FAFP-2, ONFP-1	Prior to ONAV-1
TFFP-1	Prior to TACF-1