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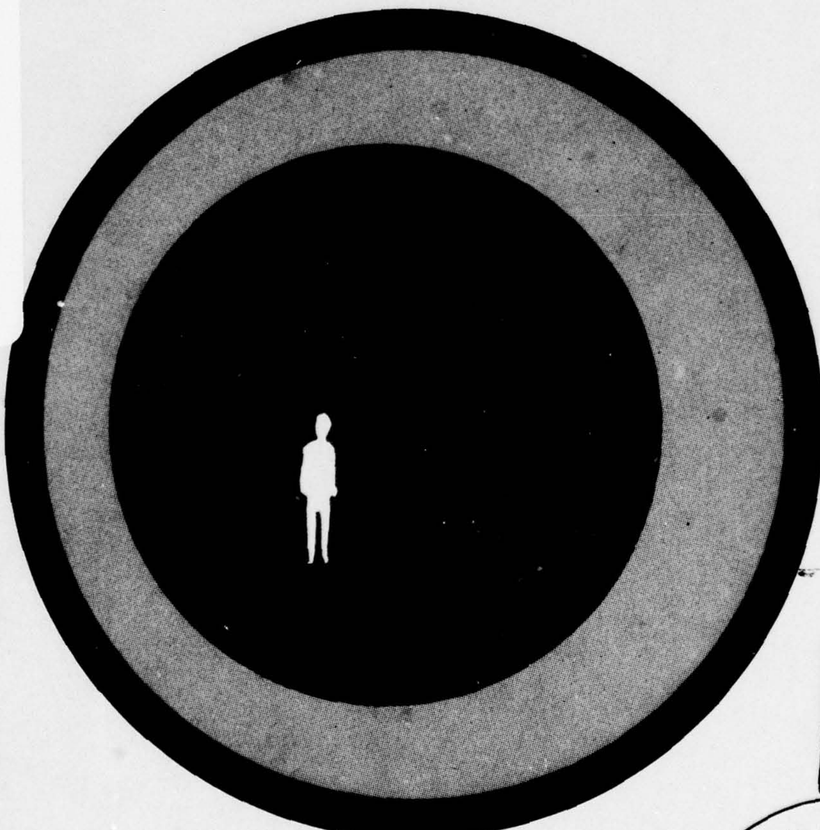
FLIGHT HOUR REDUCTIONS IN FLEET REPLACEMENT PILOT TRAINING THROUGH SIMULATION



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FLIGHT HOUR REDUCTIONS IN FLEET REPLACEMENT PILOT TRAINING THROUGH SIMULATION

Alfred F. Smode

Invited paper presented at Conference, "50 Years of Flight Simulation," sponsored by the Royal Aeronautical Society and the American Institute of Aeronautics and Astronautics, London, England, 23-25 April 1979.

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INTRODUCTION

It is only recently that the military has accepted training in the flight simulator as a substitute for training in the aircraft. A most compelling reason for this acceptance has been the fuel crisis. The emphasis on fuel economy as reflected in a United States Department of Defense planning goal, calling for a 25 percent reduction in hours flown by FY 1981, has intensified the interest in the cost savings associated with simulator substitution practices. However, this is not the whole story. Additionally, prominent reasons for this emphasis on substitution include the following:

- Substantive engineering advances in simulation technology are reflected in increasing design sophistication; e.g., fidelity of visual and motion systems, instructional control, and in the dynamics and control responsiveness of the simulators.

- Gains in the strategies of training have shaped new and impressive utilization concepts for flight simulators.

- While the cost differentials between simulator and aircraft construction, utilization, and amortization are subject to various interpretations, the evidence generally indicates significantly lower costs for training when the simulator is used efficiently in conjunction with the aircraft.

- Training considerations generally favor simulators. Foremost among these are mechanical reliability, availability of training time, compression of training sequences, and freedom from limiting factors in the flight environment; e.g., safety, weather, and airspace congestion.

Certainly, the role of the simulator in flight training has been and continues to be controversial. Debates on this issue have been with us for decades, covering topics ranging from direct comparisons of the simulator with the aircraft to intriguing interpretations and viewpoints on engineering design, fidelity of simulation, and transfer of training (see, for example, references 1, 2, 3, 4, and 5).

It is not the concern here to examine the expectations, accomplishments, and disappointments that have contributed to the current awareness of the values of flight simulators. The theme of this paper is that flight simulators can be employed to advantage in military flight training both in terms of efficiency and effectiveness. This is particularly so for pilot training in large multiengine, multipilot aircraft. New state-of-the-art flight simulators for these aircraft provide sufficient fidelity and capability to account for most training requirements. Also, safety is not compromised since transitioned pilots assume less than the aircraft commander role upon operational assignment. In this context, then, this paper addresses the training of first-tour aviators in the P-3 aircraft in the fleet replacement squadron (FRS). The P-3, "Orion," a four-engine turboprop aircraft, is a principal antisubmarine warfare land-based aircraft in use in the USA and in other countries.

BACKGROUND

The Training Analysis and Evaluation Group (TAEG) of the Chief of Naval Education and Training has been involved over a period of several years in a program concerned with the training of P-3 aircraft replacement pilots. The initiative for this overall program stemmed from a growing awareness that the potential of existing training resources in support of P-3 pilot training was not being fully realized. This, in concert with the anticipated acquisition of a new state-of-the-art flight simulator, indicated the need for detailed analyses and evaluations of the training situation.

Initial work (1972-1974) began with an analysis of pilot training practices and an assessment of training resources at the replacement squadron level. TAEG worked directly with Patrol Squadron THIRTY (VP-30) to improve the usage of existing training resources in producing pilots for fleet assignments. The early efforts demonstrated that in-flight training could be significantly reduced by the effective utilization of the existing synthetic training devices. One outcome was the reduction of flying time from 24.5 hours to 15 hours for first-tour pilots in the Familiarization/Instrument (FAM/INST) stage of training (references 6, 7, and 8).

Concomitantly, assistance in the development of the specifications for the new 2F87F Operational Flight Trainer (OFT) was provided by TAEG in selecting the visual simulation system and the design for instructional control, including the recommendation for a synthetic voice generation system.

In March 1976, the 2F87F OFT came on line; TAEG was requested to assess the training potential of this new state-of-the-art simulator in the ongoing P-3 training program and to provide inputs to the development of a curriculum that would capitalize on its unique capabilities. This paper presents an account of the major facet of the TAEG program, dealing with the receipt and integration of the 2F87F flight simulator into the ongoing FRS training.

PURPOSE OF THE STUDY

The effort reported here was undertaken to integrate the 2F87F OFT into the program for training replacement patrol plane pilots. The intent was to determine the potential of the simulator as a substitute environment for learning aircraft tasks and to effectively utilize the simulator in pilot training. This was in consonance with the immediate requirement of VP-30 to reduce in-flight training time in qualifying pilots for assignment to operational P-3 squadrons.

PERSPECTIVE

At the outset, it is important to recognize certain noteworthy features of the TAEG studies. Perhaps the most significant is the opportunity that emerged for assessing, through transfer studies, the contribution of a "brand new" on-line, high fidelity simulator in producing qualified aviators for the fleet. A study program was tailored to adapt a specific simulator to a specific real-world training situation. The goal was straightforward--to efficiently integrate the new 2F87F simulator into the ongoing VP-30 training system without interrupting or delaying the pilot production commitments. Evaluating the potential of a state-of-the-art flight simulator concurrent with its acceptance by the Navy and in an operational setting was a rare opportunity.

Another feature of importance was the opportunity to assess systematically the performance of a group of students trained in the aircraft without simulation training. This initiative is seldom exercised in studies conducted in the operational environment. Training such a group contributes powerfully to the understanding of the value of simulator training, in that baseline data are provided for assessing simulator contributions under various conditions.

Certain accommodations had to be made in the design and conduct of the study due primarily to the recency of the device coming on-line and to the constraints associated with gathering data during the normal operations of the squadron. Beginning the study immediately after Device 2F87F acceptance limited the number of training periods available, since maintenance training and maintenance periods competed for simulator time. Also, instructor inexperience with the new OFT, substantial instructor pilot rotation, and the biases associated with utilizing many instructor pilots in evaluating student performance posed additional problems. However, problems were anticipated and minimized by having TAEG personnel monitor and assist in the data collection, provide detailed briefings and information to the instructor pilots, and standardize the scoring procedures employed. Team members also rode in the simulator and flew on student training flights. All told, this "in situ" approach contributed to the assurance of highly relevant evaluations within a tolerable range of experimental control.

STUDY PROGRAM OVERVIEW

A series of experimental studies was accomplished between 1976 and 1978. These studies were conducted in three phases in a relatively constant training environment in the VP-30 FRS. VP-30 has, as part of its mission, the responsibility for transitioning pilots to the P-3 aircraft. The squadron trains approximately 200 pilots per year distributed over 10 classes. Most are newly designated first-tour Naval aviators. As a prelude to discussing the specific objectives, procedures, and the resultant findings of each of the three study phases, it is worthwhile to describe at this point features of the training context common to the overall effort.

FAMILIARIZATION/INSTRUMENT PHASE. The studies were conducted in the FAM/INST phase of instruction. This 8-week training phase is designed to transition recent undergraduate pilot training (UPT) graduates into the P-3 aircraft.

TRAINING TASKS. The FAM/INST phase included instruction and practice in transition training tasks such as take-offs and landings, instrument flying, airways navigation, and in-flight malfunctions and emergencies. The FAM/INST phase provides training for 45 tasks. These are shown on the Universal Grade Sheet (UGS) (figure 1). Twenty tasks serve as the basis for the check flight in the aircraft. These selected tasks are circled in figure 1.

TRAINING DEVICES. Three classes of training devices were employed. Descriptions of these follow.

TRAINEE: TRAINING SESSION:

INSTRUCTOR FLIGHT TIME:

DATE: FIRST PILOT TIME:

COPILOT TIME:

Flight was: Satisfactory Unsatisfactory Incomplete Remarks on Back

	P	AA	A	BA	U		P	AA	A	BA	U
01 PREFLIGHT						26 FIRE OF UNK ORIG. (CPT)					
02 USE OF CHECKLISTS (CPT)						27 SMOKE REMOVAL (CPT)					
03 ENGINE STARTS						28 REST. ELECT PWR (CPT)					
04 START MALFUNCTION (CPT)						29 BAILOUT DRILL (SIM)					
05 TAXI						30 EMERGENCY DESCENT (SIM)					
06 INSTRUMENT PROCEDURES						31 DITCHING DRILL (SIM)					
07 ANTI-ICE/DE-ICE (CPT)						32 HOLDING					
08 BRAKE FIRE						33 NON PREC APPR's NO.					
09 TAKEOFF						34 PREC APPR's NO.					
10 ABORT FOUR ENGINE NO.						35 CIRCLING APPROACH					
11 ABORT THREE ENGINE NO.						36 MISSED APP					
12 EFAR						37 LDG PTRN AIRWORK					
13 DEPARTURE						38 NORMAL/APP FLAP LDGS NO.					
14 NTS						39 CROSSWIND LDGS					
15 GOVERNOR INDEXING						40 WAVEOFF					
16 BASIC AIRWORK						41 THREE ENG LANDINGS NO.					
17 LOITER SHUTDOWN (CPT)						42 TWO ENG LANDINGS (NO P)					
18 PROP MALF (CPT)						43 NO FLAP LANDINGS NO.					
19 EMERG SHUTDOWN (CPT)						44 KNOWLEDGE OF PROCEDS					
20 ENGINE RESTART (CPT)						45 CO-PILOT RESP					
21 AIRCOND/PRESS OP (CPT)						46					
22 HYD SYS OP/MALF (CPT)						47					
23 FUEL SYS OP/MALF (CPT)						48					
24 NAV FLT INST MALF						49					
25 ELECT SYS OP/MALF (CPT)											

Check flight tasks are circled.

Figure 1. Universal Grade Sheet

Operational Flight Trainer (OFT), Device 2F87F. The recently accepted Device 2F87F simulates the flight stations (pilot, copilot, and flight engineer) of the P-3C aircraft. The high fidelity digital device is equipped with a six degrees of freedom motion system and a narrow angle (50° horizontal by 38° vertical) television model board visual system. A broad range of environmental conditions varying from full daylight color to darkness with variable visibility, ceilings, and wind conditions can be simulated. The model board simulates an area of approximately 15 by 5 nautical miles on a scale of 2,000 to 1 for the low altitude maneuvers associated with take-off, landing, and instrument approaches. Low altitude on-top conditions are simulated electronically, and high altitude simulation is provided through the use of a high altitude model board (figures 2, 3, 4, and 5).

Operational Flight Trainer (OFT), Device 2F69D. This device is a trailerized, older OFT configured to the earlier P-3A/B models. The solid state analog device, which was the principal simulator used before delivery of the 2F87F, came into the inventory late in 1966 and provides crew or individual training for the pilot, copilot, and flight engineer. The 2F69D simulates the flight dynamics, systems, navigation, and communications functions of the P-3 aircraft and provides limited motion (three degrees of freedom) and environmental cues. No visual simulation is provided.

Cockpit Procedures Trainer (CPT), Device 2C45. The CPT was developed from a modification of an obsolete P-3 OFT. The motion simulation, most of the flight dynamics, and unneeded systems were removed or disabled. It provides training in power plant management and systems procedures.

Cockpit Familiarization Trainer (CFT), Device 2C23A. The CFT provides a static simulation of the pilot, copilot, and flight engineer positions. It is used to facilitate the learning of the nomenclature, location, and function of the various controls, instruments, switches, and annunciator lights. The device is well suited to the learning of repetitive tasks such as the sequence of steps in normal and emergency procedures.

Features common to the three phases of the study program are described next.

STUDENTS. These were recent graduates of the Navy undergraduate pilot training (UPT) program. All completed training in light multiengine aircraft and all had instrument ratings. Flight time ranged from 160 to 250 hours in UPT. Experimental and control groups were equated on the basis of UPT scores (the average of basic and advanced flight grades).

INSTRUCTORS. All training in the simulator and in the aircraft was provided by the instructor pilots in VP-30. All received instruction in the operation of the new flight simulator (Device 2F87F). Each instructor pilot had a minimum of one tour in an operational VP squadron.

PROCEDURE. Training was accomplished in the fleet replacement squadron setting using squadron resources and simulator and flight syllabi. All students in the study program received common training in academics, CFT, and the CPT. Beyond this point, students received training in either the old 2F69D simulator and the P-3 aircraft, the new 2F87F simulator and the P-3 aircraft, or the P-3 aircraft only.

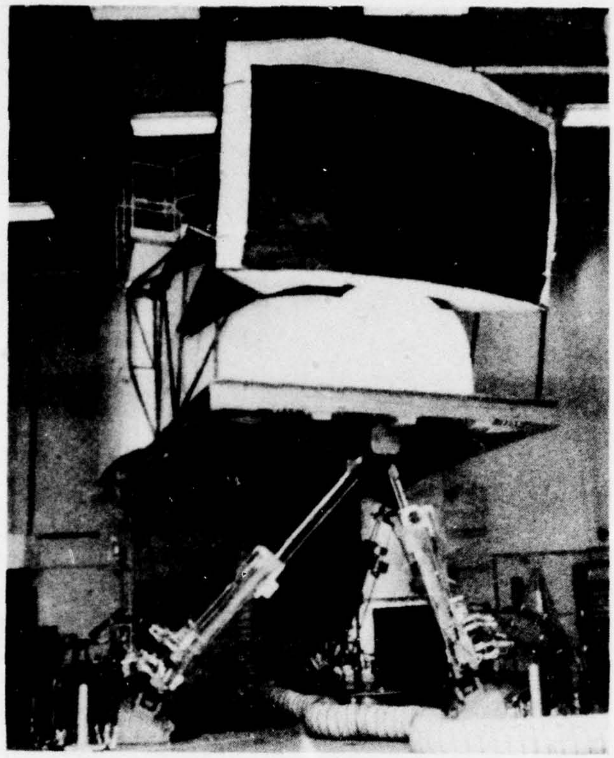

Figure 2. Device 2F87F Operational Flight Trainer

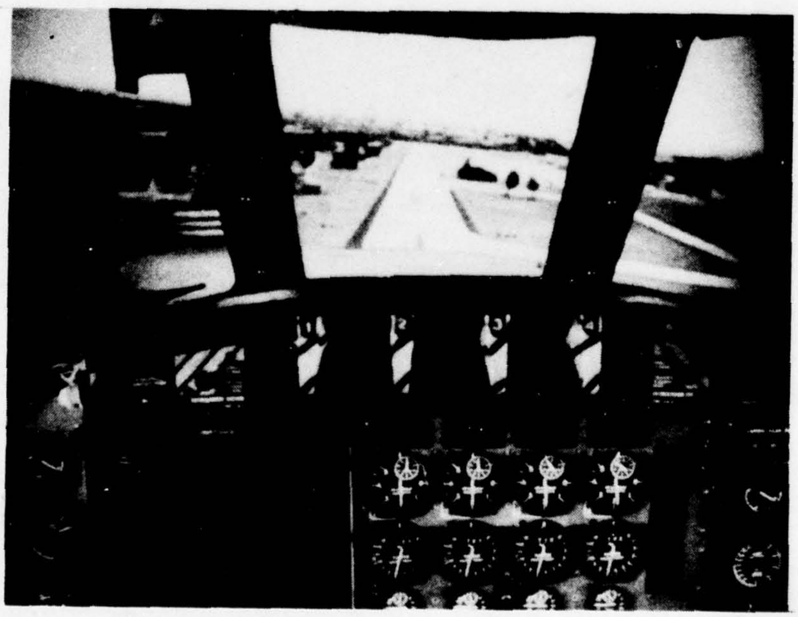

Figure 3. Visual Scene Final Approach from Device 2F87F Cockpit

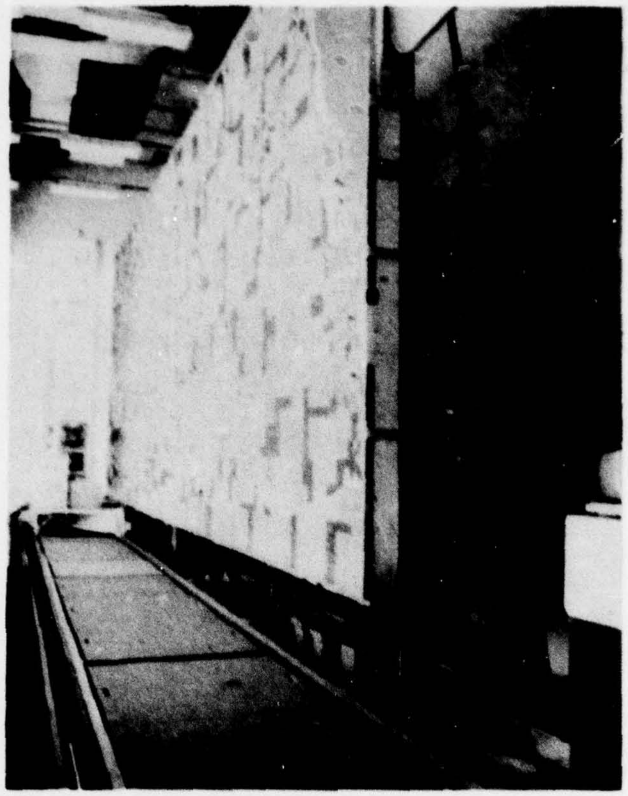

Figure 4. Closed Circuit TV Model Board, Device 2F87F

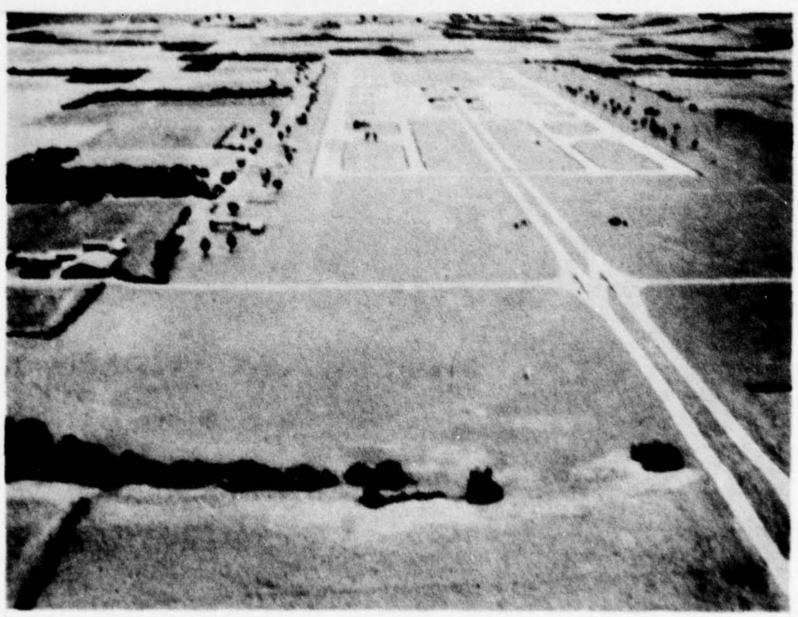

Figure 5. Photo of Model Board Detail Showing Runways and Terrain Features

The study program was accomplished while VP-30 conducted its business as usual. Effective experimental control and standardized data collection were maintained by having a team member(s) on site at VP-30. This enabled TAEG to provide necessary guidance and support to the instructors conducting the student performance evaluations.

GRADING. Student performance was assessed by two methods for both simulator and flight training. The conventional grading method used in Navy pilot training is referred to as the "UBAA" system, where U denotes unsatisfactory performance, BA below average, A average, and AA above average. Corresponding numerical grades are 0, 2.5, 3.0, and 3.5. This system was used to meet squadron requirements. A proficiency (P) scoring system was also used. A grade of "P" was assigned when performance was estimated to be equivalent to that required to demonstrate competence on the conventional flight check.

THE STUDY PROGRAM

The details of the three-phase evaluation of the 2F87F simulator are presented next. Each of the phases is described in terms of the objectives, technical approach, and the results obtained. The emphasis in each centers on the major outcomes consistent with the purpose of the simulator integration study program. A number of other issues and problems were also addressed in the study program but are not reported here. The interested reader is referred to the specific TAEG publications for these details.

PHASE I

The initial phase was concerned with determining the training effectiveness and cost savings potential of the 2F87F simulator in combination with the P-3 aircraft as a substitute for the then-in-use-2F69D simulator in combination with the P-3 (reference 9). With the advent of the new 2F87F simulator, it was expected that the number of training flights and training hours per student would be reduced in the FAM/INST phase. A reduction in the number of training aircraft was also anticipated. TAEG was requested by VP-30 to evaluate a new four-flight (8-hour) syllabus used in combination with the 2F87F simulator against the current six-flight (15-hour) syllabus used in combination with the older 2F69D simulator.

STUDY DESIGN. The phase I study plan is shown in table 1.

TABLE 1. STUDY PLAN - PHASE I

Control Group (N=58)	Experimental Group (N=27)
4 periods CFT	4 periods CFT
6 periods CPT	6 periods CPT
3 OFT (2F69D)	6 OFT (2F87F)
6 P-3 flights	4 P-3 flights

Subjects. The control (C) group sample was 58 students trained in 4 classes immediately preceding the phase I initiation. These data were obtained from squadron records. The experimental group (E) sample was 27 students trained in 3 classes. Experimental and control groups were equated on the basis of average UPT basic and advanced flight grades.

Training Tasks. The 20 training (check flight) tasks circled on the UGS (figure 1) were evaluated. A block syllabus presentation was utilized for the E group (i.e., all simulator training followed by all air training). Each simulator flight was 4 hours during which the trainee time was split between the left and right seats. In the aircraft, the C group students were scheduled for approximately 15 hours each in the left seat, since squadron experience indicated this was required to complete the in-flight syllabus. The E group students were scheduled for 8 hours each. This lesser amount was based on the assumption that simulator training would substitute for flight time.

Instructors. Squadron instructor pilots (IP) provided all training in the simulators and in the aircraft.

Grading. Both conventional (UBAA) and proficiency (P) scoring were employed in the simulator and in aircraft flights for the E group. In the proficiency scoring system, students were assigned a "P" for each task when it was performed to proficiency in the simulator and again when it was performed to proficiency in the aircraft.

RESULTS. Table 2 summarizes specific findings of phase I.

TABLE 2. COMPARISON OF PILOT FLIGHT PERFORMANCE IN THE NEW AND THE CONVENTIONAL PROGRAMS

	Control Group (2F69D and P-3) (N=58)	Experimental Group (2F87F and P-3) (N=27)
Average flight hours per student	15.1	8.6
Average flight hours per student to proficiency	*	6.2
Average landings received per student	*	36
Average landings to proficiency per student	*	17
Average flight grades	3.02	3.03

*Data not available.

With the new simulator, flying hours per student were reduced from 15.1 to 8.6 hours. The quality of student performance as determined by squadron IPs using the conventional grading system was essentially the same. Accurate records of landings were not kept for the control group, but the IPs stated that each student uniformly received an average of 60 landings in the aircraft to complete the syllabus. The E group received only 36 landings.

Based on proficiency (P) grading criteria, the E group required only 6.2 flight hours to complete the FAM/INST phase. However, training was continued beyond this to accomplish the four flights scheduled per student. Similarly, only 17 landings were required to demonstrate proficiency. Again, it was the squadron decision to continue landing practice over the four flights; hence, an average of 36 landings was received per student.

Despite the instructions to the IPs that students were to be trained to "P" in all check tasks in the 2F87F simulator prior to aircraft training, this requirement was not always met. This shortcoming was turned to advantage in that it enabled check tasks to be evaluated in the aircraft as a function of whether they had been trained to proficiency in the 2F87F simulator. Table 3 presents these data. A higher cumulative proportion of tasks trained to "P" in the simulator was judged proficient in the aircraft on Fly 1 (.76) than the same tasks not trained to "P" in the simulator (.46). This relationship held across the flights. It is clear that the training of tasks to proficiency in the simulator prior to flight reduces the time for these tasks to be judged proficient in the aircraft.

TABLE 3. CUMULATIVE PROPORTION OF CHECK TASKS ON WHICH EXPERIMENTAL GROUP TRAINEES WERE JUDGED PROFICIENT IN THE AIRCRAFT

	FLY 1	FLY 2	FLY 3	FLY 4
Tasks trained to proficiency in Device 2F87F	.76	.87	.94	.99
Tasks practiced in Device 2F87F but not trained to proficiency	.46	.60	.75	.96

PHASE II

The investigation of the training effectiveness of the 2F87F simulator continued with an examination of additional factors influencing device utilization (reference 10). Baseline data were obtained for a precise determination of the contribution of the simulator to the FAM/INST phase of training. A group trained in the aircraft without previous simulator training (flight-only group) was compared with an equivalent group trained in the simulator and in the aircraft.

STUDY DESIGN. The phase II study plan is shown in table 4.

Subjects. The control group (C) sample was 10 students trained in 1 class; the experimental group (E) was the experimental group of 27 subjects tested in phase I.

TABLE 4. STUDY PLAN - PHASE II

Control Group (C) (Flight Only) N=10	Experimental Group (E) (Phase I) N=27
4 periods CFT	4 periods CFT
6 periods CPT	6 periods CPT
No OFT	6 OFT (2F87F)
6 P-3 flights (minimum)	4 P-3 flights

Training Tasks. Same as phase I study.

Instructors. Same as phase I study.

Grading. Same as phase I study.

RESULTS. Table 5 summarizes the findings of the phase II study.

TABLE 5. COMPARISONS OF PILOT PERFORMANCE BETWEEN FLIGHT-ONLY GROUP AND A GROUP TRAINED IN THE 2F87F SIMULATOR AND AIRCRAFT

	Control Group (C) (Flight-Only) N=10	Experimental Group (E) (Phase I) N=27
Average flight hours per student	15.1	8.6
Average flight hours per student to proficiency	14.2	6.2
Average landings received per student	60	36
Average landings to proficiency per student	50	17
Average flight grades	3.01	3.03

The flight-only group (no 2F87F simulator training) received 15.1 hours to complete the syllabus, whereas 8.6 hours were required by the E group. This represents a 43 percent decrease in flight hours over the flight-only group. It is important to note that the E group required only 6.2 flight hours to achieve proficiency, whereas the flight-only group required 14.2 hours to achieve proficiency.

Great emphasis is placed on the landing task and more time is spent training this skill than any other task in the syllabus. Table 5 presents the average number of landings actually performed and the average number required to attain proficiency, for students in each group. Based on landings to proficiency, the experimental group required 33 fewer landings than the flight-only group.

The difference between the C and the E group is attributable to simulator training. The savings in time effected by 2F87F simulator training is substantial when one considers that a 1-hour reduction in P-3 flight time per student in the FRS program (two squadrons with approximately 400 student throughput per year) yields a savings in excess of $900,000 based on an operating cost of $2,284 per flight hour for the P-3C aircraft (reference 11).

The flight-only group hours to complete the syllabus is identical with that of the 2F69D simulator and aircraft trained group cited in phase I (15.1 hours). This suggests that the older 2F69D simulator, as then utilized, was not contributing to a reduction in flight hours.

As found in the phase I study, those tasks trained to "P" in the simulator had a higher probability of being judged "P" earlier in the aircraft than tasks not trained to "P" in the simulator.

Every check task trained in the 2F87F simulator transferred positively to the P-3 aircraft. Perhaps the most significant finding is that the simulator was highly effective for training landings.

In this phase of study, measures of performance were also obtained on a substantial number of students trained by the squadron without any TAEG involvement (representing, in effect, a shakedown cruise by the squadron). This was made possible by the receipt of a second 2F87F simulator in VP-30. With this second device on-line, the squadron was now able to provide 2F87F training for all students (both first and second tour).

Implementation of the syllabus required an integration of 2F87F simulator training with aircraft availability to avert queues for aircraft flights. Data were collected independently by VP-30 IPs. TAEG performed the data analyses.

Table 6 summarizes the results obtained from the operational verification of the experimental syllabus. These are compared with the flight-only group and the experimental group.

The squadron trained group (operational group), comprised of 39 students in 3 classes, averaged 9.6 hours to complete the syllabus. It is noteworthy that under squadron operational conditions the operational group required 36 percent less in-flight training and 22 fewer landings than the flight-only group. The operational group results are less dramatic than the E group compared with the flight-only group (36 percent vs. 43 percent in-flight savings, 22 vs. 33 less landings). The differences may be due to a number of factors. These include:

- A change in student input quality (increased variance in UPT scores),
- Degradation of simulator quality (maintenance problems),
- Instructor turnover,
- Change in training sequence (integrated vs. block training),
- Failure to consistently train to proficiency in the 2F87F simulator.

Unfortunately, the specific impact of each of these variables is not known.

Of significance was the finding that without the controls exercised during formal experiments, the syllabus was implementable by the squadron for full scale operation on a continuing basis.

TABLE 6. COMPARISONS OF PILOT PERFORMANCE AMONG FLIGHT-ONLY GROUP AND GROUPS TRAINED IN THE 2F87F SIMULATOR AND AIRCRAFT

	Control Group (Flight-Only) N=10	Experimental Group (Phase I) N=27	Operational Group (VP-30 Implementation) N=39
Average flight hours per student	15.1	8.6	9.6
Average flight hours per student to proficiency	14.2	6.2	*
Average landings received per student	60	36	45
Average landings to proficiency per student	50	17	28
Average flight grades	3.01	3.03	3.00

*Incomplete data.

PHASE III

Phases I and II demonstrated the positive benefits of landing practice in the 2F87F simulator. However, due to less than exact handling characteristics of the simulator during the final phase of landing, the VP-30 instructor pilots were still not convinced that much benefit could be gained by practicing the final phase in the simulator. In a message to the Commander, Patrol

Wings Atlantic (6 June 1977), VP-30 stated that, "training experience in the 2F87F has revealed optimum training transfer in all areas except for ground handling phase and final landing phase. The suspected lack of transfer in these phases is due to overly responsive aileron control, lack of peripheral vision, poor depth perception, and poor flight simulation when landing flaps are selected. The fact that some landing pattern training does transfer from the 2F87F to the aircraft is not in question. However, the amount of transfer and the reinforcement realized is neither documented nor substantiated at this time." The extent of pilot concern coupled with the importance of the issue led VP-30 to request that TAEG conduct a study of the final phase of landing.

STUDY DESIGN. The study was concerned with landing performance as a function of variations in landing training in the 2F87F simulator (reference 12). An experimental group (E) completed the simulator syllabus but received landing practice only to the "select landing flap position," on the final approach in the landing pattern. No flare or touchdown practice was provided. The simulator was "frozen" or a waveoff given at the select land flap position (approximately 300 ft. AGL). An integrated simulator and aircraft syllabus was employed. The performance of this group was compared with the performance of two previous groups who received simulator landing practice to touchdown and with the flight-only group who received no simulator training. The study plan is shown in table 7.

TABLE 7. STUDY PLAN - PHASE III

Control Groups			Experimental Group
C-1 (N=27)	C-2 (N=39)	C-3 (N=10)	E (N=19)
4 CFT	4 CFT	4 CFT	4 CFT
6 CPT	6 CPT	6 CPT	6 CPT
6 OFT (Device 2F87F)	6 OFT (Device 2F87F)	No OFT	*6 OFT (Device 2F87F)
4 P-3 flights	4 P-3 flights	6 P-3 flights	4 P-3 flights

*The trainer was frozen or a waveoff initiated at the Select Land Flap position on the final approach in the landing pattern.

Subjects. The experimental group (E) sample was composed of 19 students from 2 classes. The control groups were: C-1 (the E group from phase I), C-2 (the operational group from phase II), and C-3 (the flight-only group from phase II).

Training Tasks. Three tasks served as the basis for comparing the performance of the E and C groups. These were: (1) normal landings, (2) approach flap landings, and (3) three-engine landings.

Instructors. Same as phases I and II.

Grading. Same as phases I and II.

RESULTS

Table 8 presents the average number of simulator landings and the average number of aircraft landings required to attain proficiency for the groups compared.

The data indicate that students who received no flare or touchdown practice during landing trials in the simulator (E group) required significantly more aircraft landings to attain proficiency than did students who received full landing practice in the simulator (groups C-1 and C-2). But the E group required significantly fewer landings than students trained only in the aircraft (C-3 group).

The data in table 8 support the conclusion that practicing landing pattern airwork in the simulator transfers positively to landing performance in the P-3 aircraft even when actual touchdown is not made. These data also indicate that greater transfer occurs when the final phase of landing is included in the simulator practice. Thus, practice in the final phase of landing also transfers to the aircraft. This transfer occurs even though VP-30 instructor and student pilots universally agreed that the 2F87F does not "handle" exactly like the aircraft during the final phase of landing.

TABLE 8. AVERAGE SIMULATOR LANDINGS AND AIRCRAFT LANDINGS REQUIRED TO ATTAIN PROFICIENCY

Group	Simulator Landings	Aircraft Landings to Proficiency
C-1 (N=27)	28	17
C-2 (N=39)	28	28
C-3 (N=10)	0	50
E (N=19)	23*	37**

*Trainer frozen or waveoff initiated at Select Land Flap position in the landing pattern.
**E group is significantly different from the C-2 and C-3 groups ($p < .05$) and from the C-1 group ($p < .01$).

A major concern of pilots was the limited field of view of the rigid model board system. They felt this reduces the training value of landing practice in the simulator since visual cues in the periphery are absent. However, the belief that a wide angle visual capability is required for effective training is not supported by a number of research reports. For example, in one study a Varsity aircraft was configured such that the field of view of the pilot was limited to 50°. Landing performance in the aircraft was almost unaffected by loss of peripheral vision, even under poor visibility conditions (reference 13). In another study a Cessna T-50 (small twin engine trainer) was configured such that the windshield of the airplane was replaced by an aluminum sheet through which a periscope was installed. An image was projected from the periscope to an 8-inch screen with a field of view from the pilot's eye of a maximum of 30° horizontally and vertically. Both experienced and inexperienced pilots could make safe take-offs and landings by periscope using a variety of techniques and under a variety of conditions (reference 14). These aircraft data as well as the data from this study suggest the conclusion that a "wide" angle visual capability is not necessary for effective landing training.

COCKPIT MOTION AS A TRAINING VARIABLE. The 2F87F simulator aperiodically experienced some motion system problems. This was troublesome to squadron personnel and they voiced concern about simulator effectiveness without platform motion.

Accordingly, an inquiry was made to compare the performance of students trained in the simulator with and without platform motion. The visual system was used as specified in the 2F87F syllabus. This effort, however, was limited and the data are only suggestive. To begin with, the number of students in the experimental sample is small and all did not receive advanced UPT in the same aircraft type. Some were trained in the T-44 twin turboprop aircraft; others in the S-2 twin reciprocating engine aircraft. In addition, there was after the fact evidence of departure from the study design in that an undetermined number of E group students received some training trials with the motion system engaged when it should have been off. Nevertheless, the findings are considered to be of sufficient interest to multiengine pilot training communities to be reported here.

Table 9 shows the study plan.

TABLE 9. STUDY PLAN - EFFECTS OF PLATFORM MOTION

Control Group C (N=39)	Experimental Group E (N=11)
4 CFT	4 CFT
6 CPT	6 CPT
6 OFT	6 OFT*
4 P-3 flights	4 P-3 flights

*Cockpit motion system off.

The experimental group consisted of 11 students from 1 class. Six of these received the new UPT curriculum with advanced flight training in the T-44 aircraft. The control group was the Operational group in the phase II study. All C group students and five from the E group received advanced flying training in the S-2 aircraft. The E and C groups completed the same simulator and flight syllabus.

The limited data show no major effects in simulator or aircraft performance as a function of platform motion in the simulator. Trials to proficiency in the aircraft for (1) four-engine aborts, (2) three-engine aborts, (3) instrument tasks, (4) landings, and (5) engine failure after refusal were not significantly affected by previous simulator training without cockpit motion. One explanation for this is that for contact tasks motion cues provided by the visual scene were adequate for training. Use of the motion system, however, greatly increases acceptance of Device 2F87F by both instructors and students.

CONCLUSIONS

- The 2F87F simulator is an effective substitute for the P-3 aircraft in the transition training of pilots. Fleet replacement pilot training in-flight hours were reduced from 15.1 to 8.6 through effective employment of the simulator. Based on the findings over the period of the TAEG studies, VP-30 made adjustments to its program. Currently, the squadron employs a 9.5-hour flight syllabus for first-tour aviators in the FAM/INST phase. This translates to about a $5 million annual savings in training costs for the two FRSs.

- Performance in the 2F87F simulator is predictive of later performance in the aircraft.

- Training tasks to proficiency in the simulator prior to aircraft training significantly reduces the time required for students to become proficient in the aircraft.

- Landing training in the simulator dramatically reduced the landing practice required in the aircraft. This was most prominent when block simulator instruction was given prior to aircraft training.

- The narrow field of view visual system provided adequate cues for training the landing task.

- Based on the limited evidence, platform motion did not appear to be essential for effective training in the 2F87F simulator. However, pilot acceptance of the device is enhanced by use of the motion system.

Undoubtedly, new state-of-the-art simulators will have a salutary effect on training programs. However, the specific contributions can only be determined through a systematic program integrating the simulator into the ongoing training. The effectiveness of a new simulator should be assessed in the specific training environment in which it is placed. To insure the effective integration of a new simulator into an ongoing training program, certain controls are required. These include: (a) effective employment of training assets that match media capabilities with training tasks, (b) standardization of instructional practices and grading criteria, (c) instructor training in the capabilities and use of synthetic trainers, and (d) continuity in the management of training.

FLEET FEEDBACK

To obtain feedback on the efficacy of the FRS training described in this paper, a 42-item questionnaire was submitted to operational P-3 squadrons requesting information on students who participated in the TAEG studies (both control and experimental groups). The squadrons indicated a general satisfaction with the VP-30 training program. They reported no differences in overall performance or in performance for instrument tasks and landings between students who received the conventional 15.1 flight hours and those who received 2F87F training and less flight hours in the FAM/INST phase.

POST NOTE

Within the theme of integrating the 2F87F into the replacement pilot training program, additional issues possibly influencing training outcomes were investigated. The findings are worthy of note.

HIGH RISK MANEUVERS. The TAEG analyses of existing P-3 FRS training (references 8 and 9) indicated a considerable emphasis on the training of emergencies and high risk maneuvers in the aircraft. The requirement for this type of training for first-tour aviators in the FAM/INST phase was examined in terms of relevance and safety. Analysis of the P-3 aircraft mishap data requested from the Naval Safety Center indicated that the incidence of some high risk tasks was infrequent in operational flying. The extensive data indicated that for certain tasks, mishaps occurring during training substantially exceeded the operational occurrences. This information, coupled with demonstrations that these tasks could be trained in the simulator, contributed to the decision to remove a number of them from the flight syllabus.

ADDITIONAL CORRELATES OF PERFORMANCE RELEVANT TO FRS PILOT PRODUCTION. Three classes of relationships were examined which presumably influenced the effectiveness of the FAM/INST phase of training. These were:

- Flight hours and flight grades in UPT and subsequent performance in FRS,
- Performance in the 2F87F simulator and subsequent performance in the air,
- Conflict of visual and motion cues.

Concern over earlier significant reductions in UPT flight hours, coupled with increased substitution of simulator time for flight time at the FRS, resulted in a VP-30 message to Commander, Patrol Wings Atlantic, suggesting that the optimum simulator/flight mix may require assessment. This prompted TAEG to examine the relationships between student performance in undergraduate pilot training and later performance in the fleet readiness squadron, and between UPT flight hours and UPT performance scores.

An inverse relationship was found between UPT flight grades and flight hours upon graduation--the greater the number of flight hours required to complete UPT, the lower the average flight grade. This relationship held for total UPT flight hours to graduate and subsequent performance in VP-30.

Table 10 presents data on 59 students comparing their performance in UPT with subsequent performance in VP-30 (reference 10). The results indicate that basic and advanced UPT flight scores are valid predictors of subsequent performance in VP-30.

TABLE 10. COMPARISONS OF UPT PERFORMANCE AND VP-30 PERFORMANCE FOR FIFTY-NINE FIRST-TOUR STUDENTS

UPT Flight Average	Average UPT Flight Hours	VP-30 Flight Grade Average
>59	197	3.05
50-59	203	3.04
<50	218	2.92**

	r_{xy}
UPT flight average vs. UPT flight hours	-.59*
UPT flight average vs. VP-30 flight average	.50**
UPT flight hours vs. VP-30 flight average	-.29*

* P = <.05
** P = < 01

The importance of attaining proficiency in the flight simulator on each task prior to training in the aircraft (see table 3) suggested the need to examine the correlations between performance in the simulator and later performance in the aircraft. A significant positive correlation was found between simulator performance and later performance in the aircraft, and between performance on specific instrument tasks and later performance in the aircraft (table 11). These findings suggest that student performance in the aircraft can be predicted with some certainty based on performance in the simulator. It is not an effective training strategy to take a student to the aircraft until he has attained proficiency in most or all tasks in the simulator. These findings augur well for the development of prescriptive training strategies. A course of instruction can be tailored to the student having trouble in the simulator that will enhance his ability to benefit from training in the aircraft.

The addition of visual simulation to high fidelity flight simulators has produced instances of physiological discomfort during and immediately after training in the device. This has presumably resulted from cue conflict when visual motion cues are present in the absence of cockpit motion cues. During the series of TAEG studies, several instances of nausea and general disorientation were reported when the visual system was operative while the cockpit motion system was off. Consequently, the issue of motion sickness relating to simulator training was examined (reference 12).

TABLE 11. CORRELATION OF SIMULATOR PERFORMANCE AND FLIGHT PERFORMANCE

	r_{xy}
VP-30 simulator average vs. flight average	.46*
Performance in the simulator on instrument tasks vs. performance in the P-3**	.65*

* $P \leq .05$

** Instrument tasks include holding, precision, and non-precision approaches and instrument procedures.

A motion sickness questionnaire developed by the Naval Aerospace Medical Research Laboratory (NAMRL) was employed. The questionnaire was administered to students and instructors of two classes: One class (N=26) received simulator training without cockpit motion; the other class (N=21) received simulator training with cockpit motion. Based on student and instructor responses on the motion sickness questionnaire, simulator training with and without cockpit motion produced little evidence of motion sickness either during or after simulator flights.

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