Transfer of Training Effectiveness of a Flight Training Device (FTD)

Semi-Annual Interim Report

FAA Cooperative Agreement 2002-G-033

From August 27, 2003 to February 27, 2004

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April 2, 2004

Executive Summary

This report covers the third six months of a three - year effort to investigate the incremental transfer effectiveness of the Frasca 141 with an approved school FAR 141 program. An experimental instrument course has been developed using the Frasca 141 and Piper Archers in the course. To determine incremental transfer (amount of training), four experimental groups received 5, 10, 15 and 20 hours of Frasca training during the instrument curriculum. In this design, the FTD 5 and FTD 10 groups provides a systematic replication for the PCATD 5 and PCATD 10 groups in the study by Taylor et al. (2002b) and these groups will be compared in the current study. The PCATD 5 group provides a direct replication of the PCATD 5 group in the Taylor et al. (2002b), study. The FTD 5 group in the current study provides a reference point for comparing the PCATD 10 and 15 groups in the Taylor et al. 2002b with the FTD 10 and 15 groups in the current study using a meta analysis. A control group will receive all of their training in the airplane. Transfer effectiveness ratios and incremental transfer effectiveness ratios will be computed comparing each experimental group with the control group. During the six-month period covered by the report, we have:

- Successfully completed 30 AVI 130, Basic Instruments students in the project in the fall semester, 2003.
- The total number of AVI 130 students to successfully complete the project to date is 101 students.
- Successfully completed 24 students in AVI 140, Advanced Instruments for the fall semester, 2003.
- The total number of AVI 140 students to successfully complete the instrument course and the project is 60.
- Started 27 AVI 130, Basic Instruments students in the project in the spring semester, 2004 and 25 are making satisfactory progress.
- Continued in AVI 140, Advanced Instruments for the spring semester, 2004, 28 students who have completed AVI 130.
- Papers and abstracts

Presented a paper, *Incremental Transfer of Training Effectiveness of a Flight Training Device (FTD)* at the Research Roundtable, University Aviation Association Fall Education Conference, October 24. 2003, Dayton. OH.

Presented a paper, *Incremental Transfer of Training Effectiveness of a Flight Training Device (FTD)*, at the, Technology Enhancements for Aviation Classrooms Seminar, University Aviation Association Fall Education Conference, October 22, 2003, Dayton. OH.

An abstract, *The Effectiveness of Personal Computers(PCATDs) and Flight Training Devices (FTDs) on Instrument Training for Pilots*, has been accepted for presentation at the Aerospace Medical Association 75th Annual Scientific Program Meeting, May 2004.

An abstract, *Incremental Effectiveness of Personal Computer Aviation Training Devices (PCATDs) and a Flight Training Device (FTD), ,* has been accepted for presentation at the annual meeting of the American Psychological Association, July 2004.

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Introduction

To evaluate transfer of training effectiveness of a flight training device (FTD), the performance of subjects trained on instrument tasks in an FTD and later trained to criterion in an airplane must be compared to the performance of subjects trained to criterion only in the airplane. The incremental transfer effectiveness ratio (ITER) can be used to determine the transfer effectiveness of successive amounts of prior training in the ground trainer (Flexman, Roscoe, Williams, & Williges, 1972). Roscoe (1971) and Povenmire and Roscoe (1973) demonstrated that the TER and the ITER are negatively decelerated functions. Successive increments of training in a FTD are predicted to decrease the average TER and the ITER. Incremental transfer functions need to be determined in order to measure the effectiveness of a FTD and to determine the point at which additional training in a FTD is no longer effective. Taylor, Talleur, Emanuel, Rantanen, Bradshaw, and Phillips (2002a, 2002b) investigated the incremental transfer of training effectiveness of Personal Computer Aviation training Devices (PCATDs) for instrument training. Three groups of students at the Institute of Aviation, University of Illinois, received 5, 10, or 15 hours of prior training on selected instrument tasks required for the instrument rating. The instrument tasks investigated were the following basic instrument tasks: steep turns, holds, and approach procedures, and the following advanced instrument procedures: NDB holds and approaches and partial panel procedures. After training on each instrument task, the subjects were evaluated in the airplane using completion standards for each task and these results were compared to a control group trained only in the airplane. The results indicated that the PCATD was effective in teaching basic and advanced instrument tasks to private pilots. As a result of prior training in a PCATD, trials on selected instrument tasks, time to complete the flight lesson and time to a successful evaluation flight were less when compared to an airplane Control group. Overall, the greatest effect was found for the PCATD 5 group, which was predicted by the incremental transfer of training theory of Roscoe (1971). Indeed, very little incremental transfer effectiveness was found for the PCATD 10 and PCATD 15 groups.

The use of the PCATD has been thoroughly investigated and its effectiveness has been shown for instrument training and recency of experience training. Similar studies have shown that FTDs can be used effectively for pilot training. However, flight instruction techniques, instructional requirements, and FTDs have evolved significantly since the Povenmire and Roscoe (1973) study was completed. Therefore, it is important to determine the effectiveness of FTDs within the current training environment. The purpose of the proposed study is to investigate the incremental transfer effectiveness of the Frasca 141 within an approved school FAR 141 program.

REQUIREMENTS FOR THE EXPERIMENT

In order to conduct the study, four essential elements are required: the experimental team, subjects, equipment, and procedures. We use this framework to describe our progress to date.

Experimental Team

Henry L. Taylor, Tom W. Emanuel, Jr., Esa M. Rantanen and Donald A. Talleur are serve as co-principal investigators on the project. The experimental team meets once each week by

conference call. An agenda is prepared and circulated in advanced and minutes of the meeting are prepared and circulated.

Subjects

A total of 120 University of Illinois, Institute of Aviation private pilot students will be participating in the study (20 subjects in each group). Originally a total of 180 University of students were to participate in the study (30 subjects in each group), but due to a reduction in funding for the project the number of subjects was reduced. These students will be enrolled in the instrument program of the Institute. All students in AVI 130 and 140 will be involved in the study. Additional time will be provided for those who fail to complete the stage check on AVI 130 or the instrument rating certification flight check in AVI 140 within the paid course time.

Equipment

Training in the FTD is being conducted in four Frasca 141 FTDs with a generic single-engine, fixed-gear, and fixed-pitch propeller performance model. The Institute has 6 Frasca 141s at the Institute. The PCATD training is being conducted using FAA approved PCATDs from Aviation Teachware Technologies (ELITE) v 6.0.2, and flight controls by Precision Flight Controls. These PCATDs simulate the flight characteristics of the Piper Archer III. Airplane training is being carried out in the Piper Archer III aircraft which is a single engine, fixed pitch propeller, fixed under carriage aircraft.

Procedures

The study is investigating instrument tasks in both AVI 130 Basic Instruments, and AVI 140 Advanced Instruments courses. An experimental instrument course has been developed using the Frasca 141 and Piper Archers in the course. To determine incremental transfer (amount of training), four experimental groups are receiving 5, 10, 15 and 20 hours of prior Frasca training during the instrument curriculum. In this design, the FTD 5 and FTD 10 groups provides a systematic replication for the PCATD 5 and PCATD 10 groups in the study by Taylor et al. (2002b). The PCATD 5 group provides a direct replication for The PCATD5 group in the Taylor et al. (2002b), study. The FTD 5 group in the current study provides a reference point for comparing the PCATD 10 and 15 groups (Taylor et al. 2002b) with the FTD 10 and 15 groups in a meta analysis. A Control group is receiving all of their training in the airplane. Transfer effectiveness ratios and incremental transfer effectiveness ratios will be computed comparing each experimental group with the Control group. We will compare the training trials, time saved for each flight lesson in which there is prior FTD training, and time to completion between the experimental groups and the control group Table 1 shows the hours of prior training in the FTD for each experimental group. The PCATD 5 and the FTD 5 and 10 groups will be used to examine the effectiveness of prior training on specific instrument tasks compared with the Control group. A comparison between the PCATD 5 and the FTD 5 will examine the relative effectiveness of the two training devices. Since little incremental transfer effectiveness for instrument tasks was found by Taylor et al. (2002b) for the PCATD 10 and PCATD 15 groups, the current study will investigate the effectiveness of 5 and 10 hours of IFR cross-country training in the FTD for the FTD 15 and 20 groups respectfully. Cross-country training requires that the pilot integrate selected instrument tasks into a meaningful whole. Thus, the FTD 15 and

20 will examine the effectiveness of 10 hours of prior training on specific instrument tasks, but also examine the effectiveness of 5 and 10 hours of IFR cross-country training by these groups respectively.

Table 1: Time (hours) in FTD by group and by flight lesson in the AVI 130 and AVI 140 courses

Flight Lesson	PCATD 5 and FTD 5	FTD 10	FTD 15	FTD 20
AVI 130				
34/35: Steep Turns	0.5	1.0	1.0	1.0
36: Holds	0.7	1.3	1.3	1.3
37: Approaches	0.7	1.3	1.3	1.3
38: Approaches	0.7	1.3	1.3	1.3
39: IFR X-country	NA	NA	2.0	2.0
42: IFR X-Country	NA	NA	NA	2.0
AVI 140				
48: Review Approaches	0.7	1.3	1.3	1.3
49: NDB Holds and App.	0.5	1.0	1.0	1.0
50: NDB Holds and App.	0.7	1.3	1.3	1.3
52: Holds/Approaches	0.7	1.3	1.3	1.3
53: IFR X-country	NA	NA	2.0	2.0
54: IFR X-country	NA	NA	1.0	2.0
55: IFR X-country	NA	NA	NA	2.0

After training on each instrument task the subjects will be compared with the Control group trained only in the airplane. The effectiveness of the IFR cross-country training will be evaluated by comparing the time to completion of the FTD 15 and 20 groups with both the Control and the FTD 10 groups.

One half of the prior training time on instrument tasks in the FTD and PCATD are in AVI 130 and one half in AVI 140. All students will be trained to a proficiency standard for each instrument task, for each flight lesson in which there is FTD training, and for the stage check in AVI 130 and the instrument rating check flight in AVI 140. The IFR cross country in the FTD is divided between AVI 130 and AVI 140 as follows: 2 hours and 3 hours for AVI 130 and 140 respectively for the FTD 15 group and 2 and 6 hours for the FTD 20 group. A limited number of standardized assistant chief flight instructors from the Institute of Aviation are performing the check flight.

An incremental transfer of training research design will be used to measure the effectiveness of FTDs and to determine the point at which additional training in an FTD will no longer be effective. The dependent measures will be trials to specific completion standards for instrument tasks, time to complete a flight lesson and time to a stage check in AVI 130 and time to the instrument proficiency check in AVI 140. Mean trials to reach criterion on the airplane for selected instrument tasks and mean time to complete the flight lesson will be computed for all groups for both courses. Percent transfer, transfer effectiveness ratios, and incremental transfer effectiveness ratios will be computed.

Percent transfer, transfer effectiveness ratios (TER) and incremental transfer effectiveness ratios (ITER) will be computed for each instrument task and for the time to complete a flight lesson. Mean trials to reach criterion on the airplane for selected instrument tasks and mean time to complete the flight lesson will be computed for all groups for both courses (AVI 130 and AVI 140). Separate ANOVAS will be performed to analyze the difference between the five groups (four FTD groups and the airplane group) on the three dependent measures for both AVI 130 and 140. ANOVAs will be computed to determine the significance of the trial variable, flight lesson completion time and time to complete the course as a function of experimental treatment for both AVI 130 and AVI 140. Finally, ANOVAs will be used to explore variability in the time to a successful evaluation flight for the AVI 130 and AVI 140 courses as a function of the experimental treatment. To further identify the locus of any significant effects, post-hoc Tukey's tests of significance will be employed to make specific pairwise comparisons. An ANOVA will be computed between the Frasca 5-hour group and the PCATD 5-hour group to determine if there are differences between prior training in the Frasca and the PCATD.

RESULTS TO DATE

AVI 130

A total of 30 students completed the AVI 130 Basic Instrument course for the fall semester and took the final check ride for the course. The following table shows the results of the check ride. A total of 16 students passed the check ride on the first attempt and 14 on the second attempt. Two students failed to complete the course requirements and were recommended for AVI 102, the remedial course.

Table 1. Lesson 45 Statistics (Fall, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	5	6	4	5	5	5
% First Flight Pass Rate	60.00 (N=3)	50.00 (N=3)	25.00 (N=1)	80.00 (N=4)	80.00 (N=4)	20.00 (N=1)
% Second Flight Pass Rate	100.00 (N=2)	100.00 (N=3)	100.00 (N=3)	100.00 (N=1)	100.00 (N=1)	100.00 (N=4)
Students Recommended 102	1	0	0	0	1	0
Total Dual to Completion	22.16 (N=5)	21.30 (N=6)	19.70 (N=4)	25.64 (N=5)	20.66 (N=5)	20.43 (N=5)
Variance Total Dual to Completion	5.15	5.05	32.68	2.30	13.91	5.18

Note: This lesson is the final check ride.

A combined total of 101 students completed the AVI 130 Basic Instrument course for the fall 2002, spring 2003, summer 2003 and fall 2003 semesters and took the final check ride for the course. Table 2 shows the results of the stage check. A total of 61 students passed the check ride on the first attempt and 38 on the second attempt. One student failed the check ride on the second attempt and was recommended for a remedial course, AVI 102. Seven other students failed to complete the course and were recommended for AVI 102. These failures to successfully complete the course are consistent with expectations. It should noted that the variance in time to complete the course is substantial which indicates that additional subjects must be completed to provide the power needed to determine the statistical differences between groups.
Note: This lesson is the check ride

Table 2. Aviation 130 Combined Statistics
Lesson 45 Statistics (Fall, 2002; Spring, Summer and Fall, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	18	18	15	18	16	16
% First Flight Pass Rate	50.00 (N=9)	66.67 (N=12)	53.33 (N=8)	72.22 (N=13)	81.25 (N=13)	37.50 (N=6)
% Second Flight Pass Rate	100.00 (N=9)	100.00 (N=6)	100.00 (N=7)	100.00 (N=4)	66.67 (N=2)	100.00 (N=10)
Students Recommended 102	1	0	1	1	3	2
Total Dual to Completion	22.69 (N=18)	20.19 (N=18)	19.55 (N=15)	21.35 (N=17)	19.38 (N=15)	18.31 (N=16)
Variance Total Dual to Completion	8.88	7.09	12.19	14.20	8.49	11.15

Note: This lesson is the final check ride.

AVI 140

A total of 24 students completed the AVI 140 Advanced Instrument course for the fall semester and took the final check ride for the course. The following table shows the results of the check ride. A total of 9 students passed the check ride on the first attempt and 11 on the second attempt. Four students failed to pass the check ride on the second attempt and were recommended for AVI 102, the remedial course. Two other students failed to complete the course and were recommended for AVI 102.

Table 3. Lesson 60 Statistics (Fall, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	3	4	4	6	2	5
% First Flight Pass Rate	0.00 (N=0)	25.00 (N=1)	50.00 (N=2)	50.00 (N=3)	0.00 (N=0)	60.00 (N=3)
% Second Flight Pass Rate	100.00 (N=3)	66.67 (N=2)	100.00 (N=1)	66.67 (N=2)	100.00 (N=2)	50.00 (N=1)
Students Recommended 102	1	1	1	1	1	1
Total Dual to Completion	26.73 (N=3)	24.37 (N=3)	23.63 (N=3)	24.98 (N=5)	28.40 (N=3)	19.70 (N=4)
Variance Total Dual to Completion	34.74	.34	4.85	15.13	3.38	9.85

Note: Lesson 60 is the final check ride.

A combined total of 60 students completed the AVI 140 Advanced Instrument course for the spring 2003, summer 2003 and fall 2003 semesters and took the final check ride for the course. The following table shows the results of the check ride. A total of 33 students passed the check ride on the first attempt and 27 on the second attempt. Therefore 60 students out of a planned 120 students have completed the study. Five students failed to successfully pass the second check ride and were assigned to the remedial course AVI 102. Seven subjects failed complete the course requirements and were assigned to AVI 102. There is a significant amount of variance in the groups “total dual to completion. This indicated that the additionally planned students in the study need to be completed before there will be enough power to determine the statistical difference between groups.

Table 4. Lesson 60 Statistics (Spring, Summer, Fall, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	11	12	9	13	8	12
% First Flight Pass Rate	45.45 (N=5)	50.00 (N=6)	77.78 (N=7)	38.46 (N=5)	32.50 (N=3)	58.33 (N=7)
% Second Flight Pass Rate	100.00 (N=6)	83.33 (N=5)	100.00 (N=1)	85.71 (N=6)	100.00 (N=5)	80.00 (N=4)
Students Recommended 102	2	1	3	2	3	1
Total Dual to Completion	27.66 (N=11)	26.05 (N=11)	24.91 (N=8)	24.39 (N=11)	22.86 (N=8)	20.04 (N=11)
Variance Total Dual to Completion	13.99	4.62	5.60	8.93	15.10	9.62

Note: Lesson 60 is the final check ride.

PAPERS AND ABSTRACTS

During the six months the following papers have been presented and abstracts have been accepted for presentation.

Presented a paper, *Incremental Transfer of Training Effectiveness of a Flight Training Device (FTD)* at the Research Roundtable, University Aviation Association Fall Education Conference, October 24. 2003, Dayton. OH.

Presented a paper, *Incremental Transfer of Training Effectiveness of a Flight Training Device (FTD),* at the, Technology Enhancements for Aviation Classrooms Seminar, University Aviation Association Fall Education Conference, October 22, 2003, Dayton. OH.

An abstract, *The Effectiveness of Personal Computers(PCATDs) and Flight Training Devices (FTDs) on Instrument Training for Pilots,* has been accepted for presentation at the Aerospace Medical Association 75th Annual Scientific Program Meeting, May 2004.

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PROJECT MILESTONES

(Start date of August 28, 2002)

Task	Date	Completed
Begin subject testing	August, 2002	X
Interim Summary Report	February 27, 2003	X

Interim Summary Report	August 27, 2003	X
Interim Summary Report	February 29, 2004	X
Interim Summary Report	August 27, 2004	
Interim Summary Report	February 27, 2005	
Interim Summary Report	August 27, 2005	
Complete experimental testing	May 27,2005	
Prepare data file	June 30, 2005	
Complete Analysis	July 31, 2005	
Final Report	August 31, 2005	

PROBLEMS AND SOLUTIONS

Financial

Revised proposal Dated January 23,2004

The original approved proposal was for a total of 180 University of Illinois, Institute of Aviation private pilot students, who are enrolled in the Institute's instrument program, to participate in the study (30 subjects in each group). The revised proposal is for 120 subjects (20 subjects in each group). The reduction in the number of subjects was due to funding limitations for the 3rd and 4th funding periods. The work in FY 2004 will continue the previous work. Approximately 60 additional students will be evaluated during the 3rd and 4th periods. The budget request for FY 04 is $71,818 a reduction of $185,704 from the previously approved amount of $257,522. The request for FY 05 is $74,086 a reduction of $99,944 from the previously approved amount of $174,030.

Exemption

On march 1,2004, the FAA extended the termination date of Exemption No. 7921 to November 30,2006. The exemption permits the University of Illinois, Institute of Aviation to hold examining authority for its FAA – approved training course that does not meet the minimum flight training time requirements of Part 141.

PLANS FOR THE NEXT SIX MONTHS

The work in the next six months will continue the previous work. During the next six months 28 subjects will complete the project and 25 students will complete AVI 130. The students involved in instrument training during the spring 2004 semester have enrolled in AVI 130 and 140 and will complete their work during the spring session.

SUMMARY

During the six- month period covered by the report, we have:

- Successfully completed thirty AVI 130, Basic Instruments students in the project in the fall semester, 2003.
- The total number of AVI 130 students to successfully complete the project to date is 101 students.
- Successfully completed twenty- four students in AVI 140, Advanced Instruments for the fall semester, 2003.
- The total number of AVI 140 students to successfully complete the instrument course and the project is 60
- Twenty-seven AVI 130 Basic Instruments students started the project for the spring semester, 2004 and 25 are making satisfactory progress.
- Thirty students enrolled in AVI 140, Advanced Instruments, for the spring semester, 2004 and 28 are making satisfactory.

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