

**Comparison of the Effectiveness of a
Personal Computer Aviation Training Device,
a Flight Training Device, and an Airplane in
Conducting Instrument Proficiency Checks**

Semi - Annual Report

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From September 20, 2002 to March 20, 2003

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EXECUTIVE SUMMARY

This report covers the third six months of a three-year effort to compare the effectiveness of a personal computer-based aviation training device (PCATD), a flight training device (FTD), and an airplane for conducting instrument proficiency checks (IPC). During the six-month period covered by the report, we have:

- Started, as of March 20, 2003, seventy subjects, in the study an increase of 18.
- Completed a total 331 sessions, an increase of 120 sessions. Of these 331 sessions 171 have been familiarization sessions (57 airplane, 57 PCATD and 57 FTD).
- Completed a total of 47 IPC#1 sessions and 43 IPC#2 sessions; an increase of 19 IPC#1 and 21 IPC#2 sessions respectively. The subject completes the study after IPC#2; thus 43 subjects have completed the study.
- Replaced the original vertical gyro in the flight data recorders in one of the airplanes with a digital, solid state vertical gyro. This flight data recorder is operational. We are replacing the second gyro.
- Prepared a technical report by Lendrum, Taylor, Talleur, and Emanuel (2003) which documented the flight data recorder operations manual changes.

Our research project has met all projected milestones. We had planned to complete 33 additional subjects in the experiment during this six months but only an additional 21 were completed. During the next 6 months we plan to complete an additional 20 subjects. We will also continue to develop procedures to interpret and score the information collected through the in-flight airplane performance measurement system as well as the performance systems for the PCATD and FTD.

INTRODUCTION

The specific goal of the project is to compare the performance of an Instrument Proficiency Check performed in a PCATD, a FTD, and an airplane (IPC #1) with a second IPC in an airplane (IPC #2). Currently, the PCATD is not approved to administer IPCs. The comparison of performance in a PCATD to that in an airplane will investigate the effectiveness of the PCATD as a device in which to administer an IPC. The comparison of performance in a Frasca and the airplane will determine whether the current rule to permit IPCs in a FTD is warranted. Finally, the comparison of performance of pilots receiving IPC #1 in an airplane with one Certified Flight Instructor, Instruments (CFII) and IPC #2 in an airplane with a second CFII will permit the determination of the reliability of IPCs conducted in an airplane.

REQUIREMENTS FOR THE EXPERIMENT

We will use the framework of the four essential elements for the study: the experimental team, subjects, equipment, and procedures, to describe our progress to date.

Experimental Team

Henry L. Taylor, Tom W. Emanuel, Jr., Esa M. Rantanen and Donald A. Talleur serve as co-principal investigators on this project. The experimental team continues to meet once each week by conference call. An agenda is prepared and circulated in advanced and minutes of the meeting are prepared and circulated. Under the agreement of the cooperative agreement the COTR is furnished with the agenda and minutes. The experimental team met at the Institute of Aviation August 6, 2002.

Subjects

A total of 75 subjects will be used (25 subjects in each group; FTD, PCATD and airplane). This represents a change from the original proposal and from the last six months report. The original proposal called for 105 subjects with 25 per group. Due to funding short falls the number of subjects were reduced. As of the last report we had had 204 potential subjects in the potential subject pool. The number of subjects in the subject pool has not changed but we will no longer use subjects in the potential pool who are more than 2 years out of currency and require training. As a result our current subjects fall into one of three categories of instrument currency: 1) instrument current; 2) within one year of currency; and 3) outside of one year of currency but within two years of currency. The following table shows the currency status of the subjects in the database:

Currency status of Subjects in Database:	# Started In Project:
Current	82
Within 1 year	0
1-2 years	24
2-5 years	N/A
Total	106
Total available for scheduling:	64

Subjects unable to regain proficiency:	Frasca	2
	PCATD	1

Of these 204 subjects, there are 70 subjects started (an increase of 18) and 51 subjects in the project who are assigned to a group (An increase of 17).

Equipment

One of the vertical gyros in the data logger failed and the reasonable alternative was to replace it with a digital, solid state gyro. The company that made the previous gyro had gone out of business. The replaced gyro is working perfectly. After installing and testing the new gyro a decision was made to purchase a second digital, solid state vertical gyro. It has also been installed and wiring and software changes are in progress. There was a significant period when one aircraft was out of commission due to the gyro problem during the replacement over process, but we operated satisfactory with one aircraft during that time.

Procedures

All subjects have participated in a VFR familiarization flight in each of the following: FTD, PCATD and airplane. The subjects also receive a review of the aircraft systems and instrumentation in each device. Following the familiarization session, all subjects are assigned to one of three groups and have received a baseline IPC flight in the FTD, PCATD and airplane (IPC#1) according to which group they are assigned. IPC#1 is flown with a CFII who acts both as a flight instructor and as an experimental observer. The initial IPC (IPC#1) is used to collect baseline data and to establish the initial level of proficiency for each subject who participants in the project. Following this the subject is given the second IPC (IPC# 2).

Objective Performance Measures

Objective pilot performance assessment in the present project will be done through several measures derived from the data furnished by the flight data recorders (FDRs) on board the aircraft used for the Instrument Proficiency Check (IPC) flights as well as the data outputs from the Elite Personal Computer Aviation Devices (PCATDs) and Frasca Flight Training Devices (FTDs). In the previous study (Rantanen & Talleur, 2001; Taylor et al., 2001) we used five measures that were derived from the FDR data for a number of flight parameters: (1) standard deviations, (2) root mean square error, (3) number of tolerance exceeded, (4) cumulative time tolerance was exceeded, and (5) mean time to exceed tolerance given the momentary trend at a time of observation. These measures will be used in the present study as well. However, we will also investigate the use of time series analysis methods to detect more fine-grained features in the data than was possible with the above-mentioned metrics. In particular, we will investigate the use of:

- correlation functions, to distinguish pilot-induced effects from noise in the data,
- linear regression models to investigate linear trends in the data, and
- spectral density functions and Fourier approximations to identify periodicity in the data.

At this time, the following milestones have been reached:

- The compatibility of the data from all three devices (airplane FDR, PCATD, and Frasca data output) with the data reduction software (segmentation and performance measure extraction) has been confirmed.
- Literature review of the time series analysis techniques best applicable to the data collected in this study is well under way (including but not limited to Box & Jenkins, 1976; Chatfield, 1975; Cryer, 1986, Gottman, 1981; Vandaele, 1983), as is development of the algorithms to automate most of the initial data analysis (i.e., measure extraction).

It should be noted, however, that the development of objective performance measures based on time series analysis techniques is very much dependent on exploratory data analysis, that is, visual inspection of the raw data recovered from the FDRs and FTDs and subsequent identification and quantification of features that might prove useful in characterizing differences in the subject pilots' performance. Hence, it is clear that this work cannot fully commence until all the data have been collected. The final battery of objective measures will be determined by factor- and principal component analyses of potential measures.

RESULTS TO DATE

As of March 20 2003 a total of 70 subjects had started the study. A total of 331 sessions have been or all types of sessions. The following table shows the sessions completed as of 3/20/2003.

Sessions Run:	
Air-fam	57
PCATD-fam	57
Frasca-fam	57
IPC#1	47
IPC#2	43
P-Training	25
F-Training	44
A-Training	1
All types:	331
# of Subjects Started	70

In terms of sessions completed, there have been 172 familiarization (fam) flights, (57 airplane fam flights, 57 PCATD fam flights and 57 Frasca fam flights). Forty-seven subjects have completed the IPC # 1 flight, and 43 subject has completed the IPC #2 flight.

An analysis of the data collected as of 3/20/2003 is shown in the following three tables.

Table 1. Pass/Fail for IPC#1 and IPC#2 for the Three Groups

Group	N	IPC#1				N	IPC#2			
		Pass	%	Fail	%		Pass	%	Fail	%
Aircraft	15	4	27%	11	73%	13	7	54%	6	46%
FTD	18	5	28%	13	72%	16	7	44%	9	56%
PCATD	16	3	19%	13	81%	15	8	53%	7	47%

Table 1 shows the pass/ fail numbers and percentages for the three groups for IPC #1 and IPC #2 for the pilots who have completed IPC1 and 2 respectively. After a little less than two-thirds of the have completed IPC 1 and 2 a clear trend has develops which indicates that all groups perform better on IPC #2 than on IPC #1. For the Aircraft Group this is most likely due to the effect of learning from the experience of IPC#1. This also may be the best explanation for the Frasca and the PCATD Groups.

Table 2. Pass/Fail for IPC#1 and IPC#2 by Currency Status

Currency	N	IPC#1				N	IPC#2			
		Pass	%	Fail	%		Pass	%	Fail	%
Current	34	8	24%	26	76%	30	12	40%	18	60%
Within 1 year	6	2	33%	4	67%	5	5	100%	0	0%
Within 1-2 years										
2-5 years (Frasca)	4	1	25%	3	75%	4	1	25%	3	75%
2-5 years (PCATD)	5	1	20%	4	80%	5	4	80%	1	20%

Table 2 shows the Pass/Fail Ns and percentages for IPC 1 and 2 by currency status. Of the 34 pilots who were current, only 8 (24%) passed IPC#1. In the study by Taylor, Talleur, Bradshaw, Emanuel, Rantanen, Hulin, and Lendrum (2001) 45 instrument current pilots out of 106 (42%) passed IPC #1.

Table 3. Pass/Fail for IPC#1 and IPC#2

	IPC#2		Total
	Pass	Fail	
IPC#1 Pass	4	9	13
IPC#1 Fail	17	14	31
Total	21	23	

Table 3 shows the Pass/Fail rate for IPC# 1 and IPC# 2. Four of the pilots who passed IPC#1 also passed IPC#2, but 9 of the pilots who passed IPC#1 failed IPC# 2. Seventeen of the pilots who failed IPC# 1 passed IPC# 2 but 14 of those who failed IPC# 1 also failed IPC#2. A total of 13 pilots passed IPC#1 (30%), and 21 pilots passed IPC #2 (48 %).

PROJECT MILESTONES

The project milestones are based on a start date of September 20, 2001 and the revised schedule based on the funding reduction for year 3 and 4.

<u>Task</u>	<u>Date</u>	<u>Completed</u>
Identify Subject Pool	FY 2002, Q1	X
Complete equipment modifications	FY 2002, Q1	X
Complete Check Pilot Standardization	FY 2002, Q2	X
Begin Experimental Testing	FY 2002, Q2	X
Interim six- month report	FY 2002, Q2	X
Interim six- month report	FY 2002, Q4	X
Interim six- month report	FY 2003, Q2	X
Interim six- month report	FY 2003, Q4	
Complete experimental testing	FY 2004, Q1	
Prepare data file	FY 2004, Q2	
Complete analyses	FY 2004, Q2	
Interim six- month report	FY 2004, Q2	
Final Report	FY 2004, Q3	

PROBLEMS AND SOLUTIONS

Hardware and Software

There were no software problems associated with the PCATDs or the Frascas, during the past 6 months. One Sundowner aircraft had a failure of the vertical gyro associated with the data logger. A new digital, solid state vertical gyro was purchased and installed. A technical report by Lendrum, Taylor, Talleur and Emanuel (2003) was published documenting the changes to the data logger system. A second vertical gyro has

been purchased and installed and wiring and software changes are in progress. During the six- month period we always had one aircraft for scheduling.

Financial

The project has received a total of \$302,550 for a period through 2/25/03. The first increment of \$68,383 was received September 20,2001 and the second increment of \$234,166 was received 2/25/02. Due to lack of funds we have submitted a revised budget and revised proposal as follows: for FY 2003, \$99,440 from February 26,2003 through September 30,2003 and for FY 2004 of \$65,775 from October1, 2003 through February 26,2004 for a total of \$165,215. This represents a budget reduction of \$293,848. The principle change was in the number of subjects per group, which was reduced from 35 per group to 25 per group. This represents a reduction in total subjects from 105 to 75. Since funds have not been available a no cost extension has been requested and approved for 2 months (April 27,2003).

Subjects

In the last report we indicated that had completed 21 additional subjects. As of March 20, 2003, we have started seventy subjects, in the study, which represents an increase of 18. We have completed a total of 47 IPC#1 sessions and 43 IPC#2 sessions; an increase of 19 IPC#1 and 21 IPC#2 sessions respectively. The subject completes the study after IPC#2; thus 43 subjects have completed the study. As we reported in the last report, it has taken longer to complete the three-familiarization sessions than expected. Once the fam sessions have been completed we have had good success in getting the IPC#1 and #2 sessions scheduled and completed. The principle factors that have affected the number of subjects completed during the last six months are many subjects canceling and due to weather. During the next year, we anticipate that we will make up for the shortfall of subjects who completed the study. We appear to have enough subjects in the pool to complete the study.

PLANNING FOR THE NEXT SIX MONTHS

We plan to complete 20 additional subjects during the next six months. We will continue to refine the performance measurement functions.

SUMMARY

The project continued smoothly during the third 6 months. The subject pool appears adequate and there are no operational problems at the present time.

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