

**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

September 26, 2002

From March 20, 2002 to September 19, 2002

**Henry L. Taylor, Donald A. Talleur,
Esa M. Rantanen, and Tom W. Emanuel, Jr.**

FAA Cooperative Agreement 2001-G-037

TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
INTRODUCTION.....	3
REQUIREMENTS FOR THE EXPERIMENT.....	4
EXPERIMENTAL TEAM.....	4
SUBJECTS	4
EQUIPMENT.....	5
PROCEDURES	5
Objective Performance Measures.....	5
References.....	6
RESULTS TO DATE	7
PROJECT MILESTONES	9
PROBLEMS AND SOLUTIONS	10
HARDWARE AND SOFTWARE.....	10
FINANCIAL	10
PLANNING FOR THE NEXT SIX MONTHS	11
SUMMARY.....	11

EXECUTIVE SUMMARY

This report covers the second 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:

- Recruited 58 additional subjects for a total of 204 from the local area
- Started, as of September 18, 2002, fifty-two subjects, in the study an increase of 23.
- Completed a total 211 sessions, an increase of 148 sessions. Of these 211 sessions 120 have been familiarization sessions (42 airplane, 40 PCATD and 38 FTD).
- Completed a total of 28 IPC#1 sessions and 22 IPC#2 sessions; an increase of 22 IPC#1 and 21 IPC#2 sessions respectively. The subject completes the study after IPC#2; thus 22 subjects have completed the study.

Our research project has met all projected milestones. We had planned to complete 41 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 33 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 meets 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 105 subjects will be used (35 subjects in each group; FTD, PCATD and airplane). As of the last report we had had 146 potential subjects in the potential subject pool. During these 6 months we resent Bio forms to those instrument pilots who had indicated an interest in the study but had not returned the Bio form. As a result of this action we recruited an additional 58 subjects for a total of 204 potential subjects. The subjects fall into one of four categories of instrument currency: 1) instrument current; 2) within one year of currency; 3) outside of one year of currency but within two years of currency and 4) outside of 2 years but within 5 years. The following table shows the currency status of the subjects in the database:

Currency status of Subjects in Database:	# In Project:	
Current	82	28
Within 1 year	13	1
1-2 years	29	0
2-5 years	42	5
Unable to determine	1	0
Total	167	34
Total available for scheduling:	167	

Subjects unable to regain proficiency:	Frasca 2
	PCATD 0

Of these 204 subjects, there are 52 subjects started and 34 subjects in the project who are assigned to a group.

Equipment

There was a 1 1/2 weeks period when one aircraft was out of commission due to a fuel pump failure. We operated with one aircraft during that time. We also lost two days due to electric flap problems in 16R, but these didn't affect our scheduling. We also had a data logger problem on 16R but this had a minor effect on scheduling.

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 either 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 components analyses of potential measures.

References

- Box, G. E. P., & Jenkins, G. M. (1976). *Time Series Analysis: Forecasting and Control*. Revised Edition. Holden Day
- Chatfield, C. (1975). *The analysis of time series : theory and practice*. New York : Wiley,.
- Cryer, J. D. (1986). *Time Series Analysis*. Duxbury Press.
- Gottman, J. M. (1981). *Time Series Analysis: A Comprehensive Introduction for Social Scientists*. Cambridge University Press.
- Rantanen, E. M., & Talleur, D. A. (2001). Measurement of pilot performance during instrument flight using flight data recorders. *International Journal of Aviation Research and Development*, 1(2), 89-102.
- Taylor, H. L., Talleur, D. A., Bradshaw, G. L., Emanuel, T. W., Jr., Rantanen, E. M., Hulin, C. L., & Lendrum, L. (2001). *Effectiveness of personal computers to meet recency of experience requirements* (ARL-01-6/FAA-01-1). Savoy, IL: University of Illinois, Aviation Research Lab.
- Vandaele, W. (1983). *Applied Time Series and Box-Jenkins Models*. New York: Academic Press.

RESULTS TO DATE

As of September 18, 2002 a total of 52 subjects had started the study. A total of 211 subjects have been scheduled for all types of sessions. The following table shows the sessions run as of 9/18/2002:

Sessions Run:	
Air-fam	42
PCATD-fam	40
Frasca-fam	38
IPC#1	28
IPC#2	22
P-Training	15
F-Training	25
A-Training	1
All types:	211
# of Subjects Started	52

In terms of sessions completed, there have been 120 familiarization (fam) flights, (42 airplane fam flights, 40 PCATD fam flights and 38 Frasca fam flights. Twenty-eight subjects have completed the IPC # 1 flight, and 22 subject has completed the IPC #2 flight.

An analysis of the data collected as of 9/19/2002 is shown in the following table.

Group	N	IPC#1				N	IPC#2			
		Pass	%	Fail	%		Pass	%	Fail	%
Aircraft	9	3	33%	6	67%	7	2	29%	5	71%
FTD	9	2	22%	7	78%	7	3	43%	4	57%
PCATD	10	2	20%	8	80%	8	2	25%	6	75%

Currency	N	IPC#1				N	IPC#2			
		Pass	%	Fail	%		Pass	%	Fail	%
Current	24	7	29%	17	71%	22	7	32%	15	68%
Within 1 year										
Within 1-2 years										
2-5 years (Frasca)	1	0	0%	1	100%					
2-5 years (PCATD)	3	0	0%	3	100%					

		IPC#2		Total
		Pass	Fail	
IPC#1	Pass	1	5	6
	Fail	6	10	16
Total		7	15	

The number of subjects is not adequate to draw any conclusions at this time.

SURVEY OF USE OF OWN AIRPLANE

The last page of the bio survey ask about subjects bringing their own aircraft to the project We determined approximately how many of the respondents would potentially be asked to fly their plane in the study if we had run the project with the "4th" experimental group. The results of the survey indicated that a number of subjects would have been eliminated from consideration as good candidates to fly their plane in the study. There were 180 initial responses of interest in the project, 120 were willing to fly to CMI for the project, 115 willing to act as PIC,112 with dual controls,104 with otherwise acceptable aircraft,90 with appropriate insurance,89 would agree to a aircraft logbook inspection,76 that actually have 25 hours or more experience in the their aircraft (42%). Of 180 respondents, 42% would agree, and meet the criteria for bringing their own aircraft. Due to normal subject losses, we estimate that this number would probably be closer to 30%. These means about 54 subjects would likely have participated with their own aircraft. This number may be optimistic given that many of these pilots would bring aircraft with problems that would preclude their use in the project. Experience indicates that we would lose a good number of subjects who, thinking their aircraft was "ok", would bring a aircraft that would not pass our inspection. Avionics are also problematic in that, as shown by our previous experiences, we can get airborne and sufficiently far away from CMI before we deduce that the avionics are not working correctly. These subjects would be lost if this happened during actual data collection.

ABSTRACT AND PRESENTATION

An abstract on the study has been submitted for the 12th Biennial International Symposium on Aviation Psychology to be held in Dayton, OH April 14-17,2002.

A presentation was made at the Research Roundtable at the annual meeting of the University Aviation Association, September 13,2002, in Orlando, FL.

PROJECT MILESTONES

The project milestones are based on a start date of September 20,2001.

PROJECT MILESTONES

<u>Task</u>	<u>Date</u>	<u>Completed</u>
Identify Subject Pool	January 20, 2001	X
Complete Check Pilot Standardization	January 20, 2001	X
Begin Experimental Testing	February 7, 2002	X
Interim Six Month Report	March 20, 2002	X
Interim Six Month Report	September 20, 2002	X
Interim Six Month Report	March 20, 2003	
Interim Six Month Report	September 20, 2003	
Interim Six Month Report	March 20, 2004	
Complete Experimental Testing	May 20, 2004	
Prepare Data File	June 20, 2004	
Complete Analysis	July 20, 2004	
Final Report	October 31, 2004	

PROBLEMS AND SOLUTIONS

Hardware and Software

There were no hardware or software problems associated with the PCATDs or the Frascas, during the past 6 months. The Sundowner aircraft have had some avionics problems with the data logger and with a fuel pump and electrical flaps problems but these have been solved. During the time 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. The proposal indicated a need for the \$302,550 through September 30,2002, based on a start date of August 21, 2001. Since we started about one month late the current funds should be sufficient at least through October 31,2002. In addition we have not spent as much as projected on subjects and equipment usage since we haven't completed the number of subjects projected through September 19,2002.

We expect that this rate will increase in the fall 2002. We anticipate that we may need additional funds prior to 2/25/03. We will closely monitor our expenditure rate.

Subjects

In the last report we indicated that we planned to complete 41 additional subjects during the current 6th month reporting period. We have completed 21 additional subjects and have 31 additional subjects started and at various stages of the project. 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 following four other factors affected the number of subjects completed:

- 1) There was no experimenters available during most of August, 2002;
- 2) Many subject have cancelled;
- 3) Two subjects who exceeded a month to complete IPC#2 were rescheduled for IPC#1 after another month wait;
- 4) The move to the new building cost the better part of two weeks scheduling.

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 32 additional subjects during the next six months. We will continue to refine the performance measurement functions. We will monitor the expenditure rate closely for a potential shortfall prior to 2/25/03.

SUMMARY

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