

EFFECTIVENESS OF A PERSONAL COMPUTER AVIATION TRAINING DEVICE (PCATD)  
FOR MAINTAINING INSTRUMENT CURRENCY

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ABSTRACT

This study investigates the potential of personal Computer Aviation Training Devices (PCATDs) to substitute for actual aircraft experience for maintaining instrument currency. A Jeppesen FS-200 PCATD and a Frasca-141 flight-training device (FTD) were tested. The experiment compared the flight performance of four groups after a six-month period between instrument proficiency check (IPC) flights. The control group received no training to maintain currency in this period. Three other groups received training in either the PCATD, the Frasca, or the aircraft. Preliminary results for 106 subjects are presented. The performance of the subjects on an initial evaluation flight test and a final proficiency flight test six months later were compared. All subjects were instrument current by FAA standards prior to the evaluation flight test. Forty-two percent of the 106 subjects passed the evaluation flight test while 52 percent passed the final test. Results also indicate that the additional training received during the six months had the effect of improving final flight performance as compared to the evaluation flight. In particular, both the PCATD and Frasca FTD subjects were more likely to pass the final proficiency test than the control or aircraft subjects. Poorer performance from the aircraft group was not expected. A detailed analysis of individual maneuvers was also performed in order to determine if a particular method of maintaining currency was better suited for only certain maneuvers.

INTRODUCTION

There has been an increased emphasis on the use of personal computers in flight training during the last several years (Williams, 1994). A joint industry – FAA conference concerned with the development and use of personal computers documents this emphasis. PCATDs offer a low-cost alternative to conventional ground-based training for instruction of instrument tasks. The PCATD equipment necessary to meet FAA advisory circular AC 61-126 for use in instrument flight training (computer, software, flight-control system and monitor) can be acquired at a cost of less than \$10,000. Studies by Phillips, Hulin, and Lamermayer (1993) and Ortiz (1994) showed evidence of positive transfer from

PCATDs to the aircraft, but these empirical evaluations were limited in scope. A study by Hampton, Moroney, Kirton, and Biers (1994) reported that students who were trained in a PCATD performed as well on instrument procedures in the aircraft as students trained in a Frasca 141 FTD. However, no aircraft control group was used in this study so it was not possible to determine the transfer effectiveness of the PCATD or the FTD. Early PCATDs provided many features required to practice instrument tasks; but their fidelity was low in areas normally thought to be important, such as displays, switches, out-of-cockpit scenes, control loading and flight dynamics. In addition, some PCATDs accepted control inputs from low-fidelity devices ranging from computer keyboards, single joysticks, and yoke/pedal combinations of varying quality (Peterson, 1993). The FAA's recent approval of PCATD includes guidance on the minimum level of fidelity required when using a PCATD towards the instrument rating.

Earlier studies performed by Taylor, Lintern, Hulin, Talleur, Emanuel, and Phillips (1996, 1997) and Taylor, Talleur, Phillips, Emanuel, and Hulin (1998) showed that a commercially available PCATD could be used effectively to teach instrument tasks to pilots working towards the instrument rating. Training effectiveness and transfer from the PCATD to the aircraft, when measured in terms of trials and time to criterion on critical instrument maneuvers, were generally significant for the introduction of new maneuvers. No significant transfer was found for review of previously introduced maneuvers. Total flight time to reach successful completion of the instrument rating was also substantially less for those subjects receiving PCATD training.

Federal Aviation Regulation 61.4(c) specifically allows for devices other than a flight simulator or FTD to be approved for specific purposes. In 1997, the Federal Aviation Administration (FAA) published an advisory circular which addressed the qualification and approval process for PCATDs (FAA, 1997). This advisory circular provides guidelines for the use of PCATDs in instrument training programs conducted under FAR Part 61 and FAR Part 141. In Part 141 flight schools, PCATDs meeting the requirements of

FAR Part 141.41(a) (1) may be substituted for ten of the 15 hours authorized for an approved level-1 FTD. The advisory circular did not authorize the use of PCATDs for practical tests nor for maintaining instrument currency.

In order to maintain the recent instrument experience requirement, pilots must have tracked navigation courses, made six approaches and performed holding patterns under either simulated or actual instrument meteorological conditions during the previous six months. These recent experience requirements may be conducted in an aircraft or simulated in an approved FTD with a Certified Instrument Flight Instructor (CFII). If an instrument pilot fails to meet the recent experience requirements within the six-month period, the pilot is given a six-month grace period in order to regain instrument current status. If an instrument pilot fails to meet recent experience requirements within the twelve-month period, an Instrument Proficiency Check (IPC) must be accomplished with a CFII in order to regain instrument currency.

#### Purpose of Study

The purpose of the current study is to investigate the effectiveness of PCATDs and FTDs to meet FAA recent experience requirements for instrument flight. An IPC was given to all instrument pilots in the aircraft to establish a performance baseline (Taylor, Bradshaw, Talleur, Emanuel, Hulin, Lendrum, & Vaughn, 1999). Subjects were randomly assigned to one of four groups: three training groups and a control group. Pilots in the training groups received training in either a PCATD, FTD, or aircraft to maintain their instrument currency, while the control group received no training. After a six-month period, a final IPC in the aircraft was administered to each pilot in the study. A comparison of performance on the final IPC will determine the efficacy of a PCATD for use in maintaining instrument currency.

## METHOD

### Subjects

One hundred and six volunteer subjects were paid to participate in this study. All subjects began the experiment as instrument current pilots. They were required, as a condition of participating in the study, to refrain from engaging in actual or simulated instrument flight for a period of six months. They also agreed not to use a PCATD for instrument training during those six months.

Subject participation was solicited using mail surveys that were sent to all instrument-rated pilots in a 100-mile radius of the local area. Roughly 25% responded with interest in being a participant. A Pilot Experience and Biographical Data Questionnaire was then mailed to the interested pilots; respondents who returned the questionnaire formed the potential subject pool.

Subjects in the potential subject pool fell into three groups based on the recency of their instrument experience. Level-one pilots were instrument current. Level-two pilots could become current if they received six approaches, a holding pattern and tracked courses in an approved FTD. The level three pilots were more than twelve months out of currency and were required to successfully complete an IPC in an approved FTD prior to beginning the experiment. Over half of the subjects who returned the questionnaire were more than 12 months out of currency. Since the pool of level-one pilots (instrument current) was not sufficient to meet the required number for the study, level-two and three pilots were given the training required to become instrument current. This training was accomplished in a Level-1 Frasca 141 FTD under the supervision of a qualified instrument flight instructor.

### Apparatus

Two Jeppesen FS-200 PCATDs configured as Beechcraft Sundowners (C-23) and two approved Frasca 141 level-1 FTDs configured as generic single-engine aircraft were used. The training aircraft used were single engine Beechcraft Sundowners with a fixed-pitch propeller and fixed under carriage. An airborne performance measurement system was installed in each aircraft (Lendrum, Taylor, Talleur, Hulin, Bradshaw, & Emanuel, 1999).

### Procedure

Since subjects were required to be instrument current prior to the baseline IPC, level one pilots needed only to complete a short oral/familiarization session in which they received a standardized oral exam on instrument procedures and a ground familiarization with the Sundowner aircraft. Level two pilots were not instrument current, so they were required to complete six approaches, one holding pattern, and tracking and interception of navigation course in an FTD. After this training, level two subjects also completed the oral/familiarization session. Level three subjects were beyond one year of instrument currency and were given training as necessary to pass an IPC in the FTD. The training and procedures used for a subject to regain instrument currency were the

minimum required by FAA regulation. Once the subjects were instrument current and had completed the oral/familiarization session, they completed the baseline IPC (Taylor, Bradshaw, Talleur, Emanuel, Hulin, Rantanen, & Lendrum, 2000).

After each subject received a baseline IPC in the aircraft, the six-month period of involvement in the experiment began. At this point, the subjects were randomly assigned to one of four groups: a Control group, an Aircraft group, a PCATD group and a FTD group. The only constraint placed on the random assignment was that those successfully completing the baseline IPC were equally distributed among the four experimental groups.

During the six-month period, subjects in training groups received two training sessions of approximately 1.8 hours each in the PCATD, FTD or aircraft. The device used was dictated by group assignment. These training sessions consisted of six approaches, holding procedures and tracking and interception of navigation courses. VOR, ILS, and LOC BC approaches were practiced during the two sessions. Regulations require that at least one non-precision approach be flown partial-panel (attitude and heading indicator unavailable) during an IPC, so training on this maneuver was provided during the second session. A final IPC in the aircraft was given at the end of the six-month period. The Control group received only the baseline and final IPC flights.

A standardized IPC scenario, which included a Visual Flight Rules (VFR) phase that was completed in 15-20 minutes, was developed for the baseline IPC flight. This phase was designed to familiarize the subject with the handling characteristics of the Sundowner. A VOR approach, a holding pattern, steep turns, recovery from unusual attitude and an ILS approach were conducted following the VFR phase. Each IPC check pilot, using practical test standards criteria as a guide, completed a data sheet indicating performance on the maneuvers. The data sheet indicated whether or not the maneuvers were successfully completed, and whether or not the pilot successfully completed the IPC. The IPC check pilots received training to standardize the scoring of the IPC. The final IPC was identical to the baseline IPC except that the subjects performed one extra VOR approach using partial panel procedures.

## ANALYSIS

### Baseline and Final IPC Flight

The pilot performance data (i.e., pass/fail scores for each maneuver element, maneuver, and the flight) recorded by the check pilots during the baseline IPC flight and final IPC flight were analyzed at hierarchical levels. Four of the six maneuvers in the IPC flights (VOR approach, holding pattern, steep turns, and ILS approach) at the first level contained several criteria that the subjects were expected to meet (e.g., altitude within 100 feet of a certain value on the final segment of the VOR approach). Not all segments of a given maneuver required the scoring of the same flight variables of interest since some variables are not relevant to those maneuvers. Each maneuver contained one or more distinct segments (such as initial approach segment, procedure turn, final approach segment). The check pilot scored performance on each of these flight variables within each segment of a maneuver. All judgments at this level were made with direct reference to FAA instrument practical test standards (PTS) criteria for performance of each maneuver.

The next hierarchical level was the check pilots' subjective judgment of individual maneuver performance. Data were recorded to indicate if the subject met the overall PTS standards for each of the six maneuvers in the IPC flight (the VOR approach, holding pattern, steep turns, unusual attitude recovery, ILS approach, and use of ATC procedures and communications throughout the IPC flight).

The last hierarchical level of data recorded was the check pilots' subjective judgement of whether the subject passed the entire IPC.

## RESULTS

Table 1 illustrates the number of pilots that passed/failed the baseline IPC flight by the recency of experience level. Of the 106 subjects who completed the baseline IPC, 45 received a pass rating by the IPC check pilot. Of the 32 pilots in the level 1 (instrument current pilots), only 14 passed the baseline IPC in the aircraft. Nine of 15 pilots in level 2 (those within the 12 months of currency) passed the baseline IPC after receiving training in the FTD. Twenty-two of 59 pilots in level 3 who passed an IPC in the FTD passed the baseline IPC in the aircraft.

Table 1. Baseline IPC pass/fail rates by recent experience level.

Experience Level	Pass		Fail		Total
	N	%	N	%	
1	14	44	18	56	32
2	9	60	6	40	15
3	22	37	37	63	59
Total	45		61		106

A total of 55 of 106 subjects passed the final IPC. Table 2 illustrates the number of pilots that passed/failed the final IPC for each of the four experimental groups. The pass/fail rates for each group were analyzed using Chi-square tests. The first analysis was performed to determine whether the treatment (assignment to group) had an effect on the pass/fail ratio for the final IPC flight. One anticipated effect was that the Control group might suffer deterioration of flight skills over a 6-month period with no instrument flight practice. When all groups were compared, the treatment (i.e., group assignment) influence on the final IPC pass/fail ratios was statistically significant,  $\chi^2(3, N=106) = 9.27, p < 0.05$ .

Table 2. Final IPC pass/fail rates by group.

Group	Pass	Fail	Total
<i>Aircraft</i>	12	14	26
<i>FTD</i>	19	8	27
<i>PCATD</i>	16	11	27
<i>Control</i>	8	18	26
Total	55	51	106

A series of planned-comparison tests were performed. The first test evaluated the potential benefit of PCATD for maintaining instrument proficiency. The PCATD group had a significantly higher proportion of IPC passes than the control group,  $\chi^2(1, N=53) = 4.34, p < 0.05$ . Practice in a simulator (either in the FTD or in the PCATD) resulted in significantly higher IPC pass rates compared to the no practice (i.e., control) group,  $\chi^2(2, N=80) = 8.18, p < 0.05$ . However, the FTD and PCATD groups' IPC pass rates were not different from the aircraft group's,  $\chi^2(2, N=80) = 2.52, p > 0.05$ , nor was the PCATD group different from the FTD group,  $\chi^2(1, N=54) = 0.73, p > 0.05$ .

Since only 45 of the 106 subjects passed the baseline IPC, and 55 of the 106 who completed the final IPC passed, a post-hoc analysis was conducted to compare the subjects who passed/failed the baseline IPC and the final IPC. Table 3 shows that 34 subjects who passed the baseline IPC also passed the final IPC and 40 subjects who failed the baseline IPC also failed the final IPC. Eleven subjects who passed the baseline IPC subsequently failed the final IPC following the six

months of recent experience training. Twenty-one subjects who failed the baseline IPC subsequently passed the final IPC after the six months training.

Table 3. Comparison of pass/fail for baseline and final IPC.

		<i>Final IPC</i>		
		Pass	Fail	Total
<i>Baseline IPC</i>	Pass	34	11	45
	Fail	21	40	61
	Total	55	51	106

Although we were able to closely match the pass/fail rates for the baseline IPC, the match was not perfect due to several subjects dropping out of the experiment prior to completion of the final IPC checkflight. Therefore, we computed improvement and deterioration ratios for each group. A pilot who failed the baseline IPC may benefit from practice in the aircraft, PCATD, or FTD during the course of the experiment, which may allow the pilot to pass the second IPC flight (i.e., the improvement ratio). A pilot who passed the first IPC flight may retain that level of skill, or deteriorate somewhat, and fail the second IPC flight (i.e., the deterioration ratio). Figure 1 depicts these scores by group.

Since the Control group received no instrument flight practice for six months, no significant improvement was expected for this group. For our Control group, only two subjects who failed the baseline IPC flight passed the final IPC. Given the lack of practice, this result (12.5%) is a fair reflection of the test/retest reliability of an instrument proficiency check flight. Of the control group subjects who passed the first IPC flight, 40 percent failed the second check flight, indicative of the deterioration of their skill over the study period with no instrument flight practice.

The Aircraft group had an improvement score (33%) almost three times the improvement score of the Control group. The Aircraft group also had a large deterioration score of 36.4%, which was quite close to the deterioration score of the Control group. Both the FTD and PCATD groups had even greater improvement scores and lower deterioration scores than either the Aircraft or the Control group. The trends for the PCATD and FTD groups approached significance. The PCATD group improved during the study period (improvement score of 37.5%), (McNemar's test statistic of  $\chi^2(1, N=27) = 3.57, p = 0.058$ ) as did the FTD group (improvement score of 57.1%), ( $\chi^2(1, N=27) = 3.60, p = 0.057$ ). The deterioration score of the PCATD group was only 9.1%, while the deterioration score for the FTD was 15.4%.

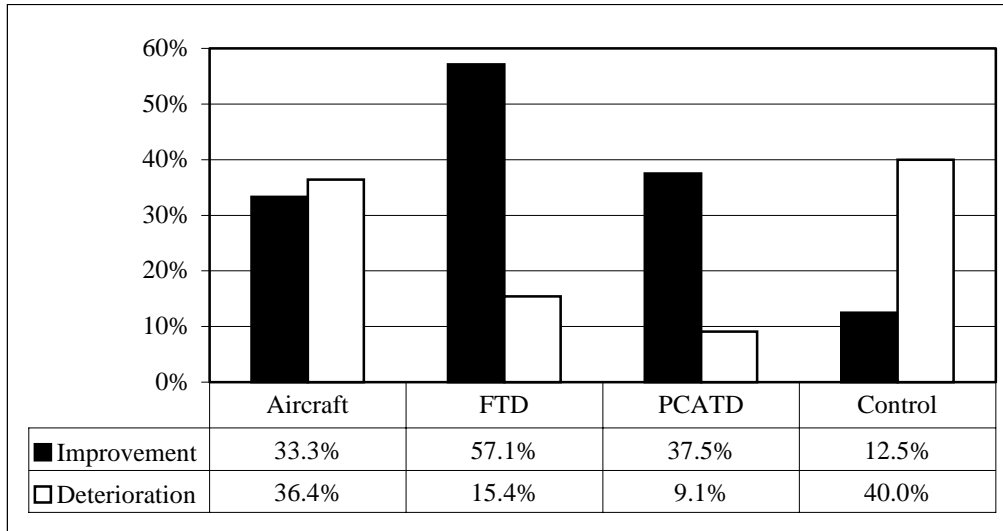


Figure 1. Skill improvement/deterioration by group.

An ANOVA was run in an effort to better understand how the performance on maneuvers for each group changed from the baseline IPC to the final IPC. Since each subject received a pass/fail score for each of the six maneuvers, it was possible to compute an overall maneuver-score-change across all six for all subjects. These overall scores were standardized and the groups were compared using an ANOVA. No main effect,  $F(3, 105) = 1.1, p > 0.05$ , for a change in performance between the baseline and final IPC, when considering the raw maneuver pass/fail assignments, was found.

A post-hoc analysis was performed for each experimental group to determine if any of the six individual maneuvers showed improved performance between the two IPC flights. While the FTD group showed some improvement on the holding pattern, the change was not significant. The FTD group showed no change in performance between IPC flights for the other maneuvers. The PCATD group showed a substantial, but non-significant improvement for the VOR approach. Significant improvement for holding patterns,  $\chi^2(1, N=27) = 5.4, p < 0.05$  and the ILS approach,  $\chi^2(1, N=27) = 5.4, p < 0.05$ , were found. No other PCATD group maneuvers approached a significant change in performance. The Aircraft group showed a slight improvement on the VOR approach and holding pattern, but the Control group failed to show substantial improvement on any maneuvers. None of the changes in performance for the Aircraft or Control groups were significant.

## DISCUSSION

The main results indicated that the PCATD was effective for maintaining instrument currency and that the control group performed significantly worse than the FTD and PCATD groups.

An interesting finding concerns the instrument proficiency demonstrated on the baseline IPC flight in the aircraft. Overall, only 42.5 percent of the 106 instrument current pilots passed the baseline IPC in the aircraft. Forty-four percent of instrument current pilots at the start of the study (level 1) passed the IPC. This finding has implications for the adequacy of current FAA regulations which guide maintenance of instrument currency. In any case, it is clear that an instrument **current** pilot is not necessarily an instrument **proficient** pilot. Fifty-nine pilots who were more than 12 months out of currency (level 3) received instrument training in an approved flight-training device and subsequently passed an IPC in the FTD, but only 22 (37%) of those pilots passed the baseline IPC in the aircraft.

The results also showed a clear benefit for groups which received training during the six months between the baseline and final IPC flight. The findings also showed that the Aircraft group did not perform as well as the FTD or PCATD group. Given the initial proficiency status of our instrument current subjects, and the minimal practice received by the training groups to maintain currency, it is possible that the Aircraft group was disadvantaged by having to practice

in a less efficient training environment than the FTD or PCATD.

Analysis of the improvement/deterioration ratios showed that the PCATD was as effective as the level-1 FTD for maintaining instrument skills during the six-month period. In addition, the ratios for the PCATD, as compared to the FTD group, show a similar pattern of improvement/deterioration. This is evidence that the PCATD was not only effective for maintaining instrument currency but for maintaining instrument proficiency

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