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Flight Training Success in Technologically

Advanced Aircraft (TAA)

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### **Abstract**

The introduction of glass cockpit aircraft to general aviation has received great interest from researchers over the past few years. However, little information is available on the actual effects of this transition on training syllabus completion. This study focuses on whether or not the transition from analog to glass cockpit aircraft in a university training fleet has affected instructor ability to properly train students as well as student success in flight training evaluations. Data analyzed included flight-training evaluations as well as a survey of current flight students. Findings suggest a relationship between successful flight training evaluations and the type of aircraft used.

## **Introduction and Statement of the Problem**

Transition from analog to glass cockpit training aircraft presents unique challenges to a collegiate aviation training program and requires significant curriculum modification. Although analog and glass cockpit layouts share several commonalities, such as the general position of instruments, colors, and symbols, the new technology can be difficult to learn. This study is aimed at determining whether the transition to a glass cockpit training fleet has made it more difficult for students to pass phase check evaluations. A secondary focus of the study is to determine possible factors that might contribute to such a finding.

## **Literature Review**

The transition from analog to glass cockpit aircraft has been increasingly discussed as more manufacturers are developing glass cockpit aircraft. However, not much has been written on student progress when training for the first time in such aircraft. Before the advent of technologically advanced aircraft (TAA), pilots received training in aircraft with analog instrumentation. Training on instrumentation was focused on reading the gages as well as interpreting the information that they conveyed. Students learned by using a scripted instrument scan. Such an instrument scan has been heavily researched and perfected over the past century. The layout of the instruments in the cockpit has even been modified to make the scanning process more effective.

Unfortunately, traditional instrument scanning procedures do not apply to glass cockpit aircraft. According to Mumaw, et al. (2001), there are no

documented scanning procedures in place for new instrumentation systems and as a result, pilots often create their own strategies, which are not always effective. The reason for this is has to do with the positioning of the instruments. In glass cockpit aircraft, the instruments have all been collected onto two screens with the primary flight display (PFD) containing all of the basic instruments that the pilot references in order to control the aircraft. Basic control instruments include the attitude indicator, airspeed indicator, altimeter, and the horizontal situation indicator (HSI). The multifunction flight display (MFD) is the second screen, which contains other essential information such as engine instruments, GPS moving map displays, and other systems information. The instruments look and act similarly to their analog counterparts, however, the pilot is no longer able to use traditional scan patterns since the position of the instruments has changed slightly. In addition to this, the use of tabs and pages made possible by the unrestricted size of virtual gages has made the instrument systems far more complex. The advent of glass cockpit aircraft has “redistributed rather than reduced workloads” (Baxter & Besnard, 2004, p.1). Studies are now needed to determine how the organization of this virtual data affects flight (Salas & Maurino, 2010). While these issues are a concern for all pilots looking to transition to glass cockpit aircraft, they are particularly troublesome for newer students who are just learning to fly. Newer students simply do not have the experience to make a quick transition from analog to glass. It is necessary for students to relearn how to locate and interpret the gages in glass cockpit aircraft having just recently learned how to use analog gages.

Training programs can help to alleviate some of the issues associated with perfecting a new instrument scan. A study conducted in 2008 focuses on the optimization of collegiate training programs using glass cockpit aircraft.

“Emerging theories raise questions whether or not the generalization could be made that the experienced pilot might have the cognitive skills, judgment, aeronautical decision making skills to better understand the training than the inexperienced pilot whose skill foundation is not yet concrete” (Smith, 2008, p.11). It is possible that younger students have skill sets that might help when transitioning from analog to glass cockpit aircraft regardless of experience.

Smith studied the effect of human factors on the transition from analog to glass cockpits in the collegiate flight training environment. The study found that younger students had an easier time transitioning to glass cockpit aircraft since they had grown up in the age of computer technology. In contrast, adult students had a more difficult time with the transition (Smith, 2008). While there were some differences between Smith’s subject populations based on age, experience, and other factors, she determined that in order to create an effective training program for the transition from analog to glass cockpit aircraft, a combination of scenario and skill based training methods should be used.

Many current pilots of glass cockpit aircraft were not trained to operate them through a collegiate flight program and as a result did not have the benefit of the methods of instruction recommended by Smith. A study conducted by the NTSB in 2006 identified several accidents attributed to pilots who were not familiar with the technology available to them in their aircraft. The study

examined 2,848 conventional aircraft of which, 141 were involved in accidents. Sixteen percent of those accidents resulted in fatal injuries. They also examined 5,516 glass cockpit aircraft of which, 125 were involved in accidents. Thirty one percent of accidents in glass cockpit aircraft resulted in fatal injuries. While glass cockpit aircraft had a lower accident rate during this period than conventional aircraft, they also had a higher fatality rate. In 2006-07, the fatal accident rate for conventionally equipped aircraft was 0.45 per 100,000 flight hours, compared to 1.03 per 100,000 flight hours for glass cockpit aircraft (Fiorino, 2010). The NTSB study did not examine the age of the pilots, however, which may have affected the familiarity with the glass cockpit instrumentation. In addition to this, there was no mention of what types of training programs if any were used by the pilots. This is important, because an increase in training usually correlates to a decrease in accidents. Without knowing the extent to which pilots were trained it is difficult to assess how these accident rates correspond to glass cockpit training.

A study conducted by researchers at Middle Tennessee State University found that students training in glass cockpit aircraft with no prior experience were forced to repeat more lessons and had a greater number of setbacks in the earlier stages of flight than those students who trained in analog cockpit aircraft. Interestingly however, setbacks in analog cockpit aircraft increased over time while glass cockpit setbacks decreased. Students training in glass cockpit aircraft faced setbacks on later lessons than traditional students. Also, the total number of setbacks diminished when learning in glass cockpit aircraft. This

study also resulted in the glass cockpit trainees passing their private and instrument check rides with fewer total hours than those that trained in aircraft with analog gages (Craig et al., 2006). It must be noted, however, that the study did not list a total flight time for the private check ride alone and the advanced automation of the glass cockpit may aid the pilot significantly in instrument flight evaluations. Bottlenecks in learning, otherwise known as learning plateaus are common, however, in collegiate flight training programs they can be frustrating due to the fact that students are also limited by completion time constraints. Craig et al. (2006) also mentioned how glass cockpit aircraft lead students to focus less on visual procedures. This is due to the large size of the screen and easy access to a large amount of information, which sometimes causes students to focus inside the cockpit rather than outside.

There are unique learning challenges that result from using glass cockpit aircraft as primary trainers (Casner, 2008). The more advanced the aircraft, the more the student is required to learn. Many feel that less complex aircraft serve as better trainers since students are able to focus more on flying the airplane than learning the systems (Casner, 2008). Another study reinforces this perception with findings that suggest pilots who use glass cockpit aircraft have reduced manual flight skills (Young, Fanjoy, & Suckow, 2006). There is, however, a new wave of thinking about training in advanced aircraft. Since most transport category aircraft now boast full glass cockpits, training in technologically advanced aircraft allows students to become familiar with these



systems at an earlier stage, thereby preparing them more effectively for professional flying careers.

### **Methodology**

In order to conduct the current study, researchers began by conducting a literature review of studies related to glass cockpit transition with a special focus on the use of glass cockpit aircraft in the training environment. Once this was completed the researchers issued a survey (see Appendix) to students at the target institute who completed a phase check in the Spring and Fall 2010 semesters. The survey was anonymous and voluntary in order to obtain more unbiased and truthful answers. Survey questions focused on whether or not the student participated in a phase check in the Spring and Fall of 2010, as well as their perceptions of the phase check, their familiarity level with the aircraft, and problem areas. Three problem areas were selected from the phase check examination rubric for their potential of being affected by the transition from analog to glass cockpit aircraft. Problem areas included VOR orientation, cross country procedures, and maneuvers. The students were questioned on their performance in these areas in order to obtain student perceptions. The researchers used an online survey system since this provided a quick and accurate way in which to compile the results. A copy of the survey can be found in the Appendix. In order to determine the pass/fail rate of phase checks for the Spring and Fall 2010 semesters, phase check data was obtained directly from the flight department. Since this study is focused on the potential relationship between the transition to glass cockpit aircraft and student success, phase check

data was compiled for the first semester in which the glass cockpit aircraft were flown as well as for the previous semester in which traditional cockpit aircraft were used. Phase check data was gathered for each student in both semesters and was coded accordingly. In order to ensure complete anonymity, a third party collected the phase check data from the student logbooks and created coded copies with all identifying personal information removed for each student. Phase check data for 35 students was used in this study. As a result of coding, student information was kept confidential and researchers were not able to equate phase check data to any particular student. With all the data collected, the researchers then began the analysis process to determine whether or not there was a relationship between the flight training evaluations and the type of aircraft in use as well as the possible reasons for such a correlation. The researchers compiled phase check grades for 35 students as well as whether their score increased or decreased from the Spring 2010 to the Fall 2010 semester. Survey answers were compiled automatically by an online survey software and the researchers looked for trends in the data. The researchers understand that there may be bias introduced into the data as a result of different student experience levels. The purpose of the study was to look at the effects on students of the transition from analog to glass cockpit training aircraft. In order to accomplish this, students were traced as they progressed over two sequential flight courses. Students in the second course should perform better than they had in the earlier course. Although grading practices are different for each of the examiners, and such bias is recognized, this study does not account for these differences.

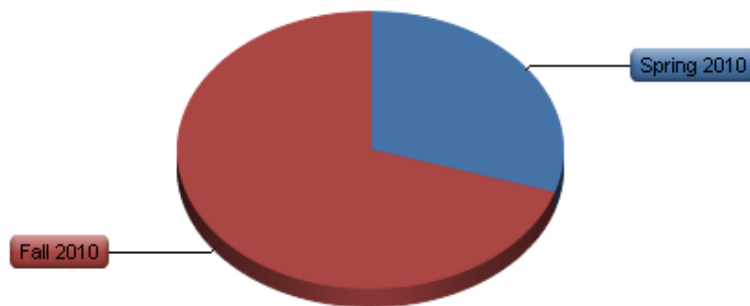
## Results

Phase check results for 35 students were analyzed. Scores averaged 4.44 out of 5.00 possible points. This equates to a B average in the flight courses and is a passing grade. Eighteen of the 35 students, or 51.43 % saw a decline in scores between their Spring 2010 and Fall 2010 phase checks. The amount that the scores decreased varied from student to student, however, the average decrease was .29 points.

These results are surprising. Students should be performing better on the second phase check than they did on the first one as a result of an increase in experience. The maneuvers performed on both phase checks are very similar and the standard progression of learning suggests that the student's performance should increase over time. The study data does not show this to be the case. It is possible that the variation in results is due to the specific tasks at hand, which do vary slightly between the two courses, grading differences between the examining instructors, or student preparation. However, it is also likely that the change in training aircraft and lack of instructor familiarity in the new aircraft contributed to the results. In order to determine the potential causes of the decline in phase check scores, a survey was issued to students currently in the program.

There were a total of 45 responses to the survey. Some responses were from students who were not in the program for both semesters. Therefore, these responses were discarded. Upon analysis of the surveys, more students felt less prepared for the Fall 2010 phase check than the preceding Spring 2010 phase

check. Seventy percent of students felt less comfortable on the Fall 2010 phase check and five students believed they were not fully prepared for that phase check by their instructor. Thirteen out of 30 indicated that they had more difficulty flying the glass cockpit aircraft than the analog cockpit aircraft and that student preparation level was less than desirable. Ninety two percent of students felt well prepared for the Spring 2010 phase check and 76 percent felt well prepared for the Fall 2010 phase check. Interestingly, even though a majority of students felt well prepared for both the Spring 2010 and the Fall 2010 phase checks, 21 out of 30 or 70 % of students felt that the Fall 2010 phase check was more difficult. Only nine students believed the Spring 2010 phase check was more difficult. Figure 1 represents the number of students who fell into each of these two categories.



Phase Check	Response	%
Spring 2010	9	30%
Fall 2010	21	70%
Total	30	100%

Figure 1. Most Difficult Phase Check

The areas in which students felt least prepared in the glass cockpit aircraft included aircraft systems and G1000 operation. Sixty percent of students listed these two topics as problem areas. Students felt least prepared to utilize more than just the basic functions of the G1000. Forty eight percent of students felt best prepared for commercial maneuvers and navigation. Students that responded felt that more focus should be given to aircraft systems, G1000 operation, and the differences in maneuvers when transitioning to the new aircraft. Four out of 32 students also mentioned the issue of pilots becoming distracted by the automation and neglecting to perform maneuvers visually. This topic has been widely debated in the aviation community when discussing glass cockpit transition. While there were areas in which students felt less prepared, most felt prepared for the three target areas examined in this study. Students felt most prepared for VOR orientation, followed closely by cross country navigation, and commercial maneuvers. Only 15 out of 40 students felt uncomfortable or very uncomfortable with the three focus areas. Figure 2 details the responses from students regarding the three target areas.

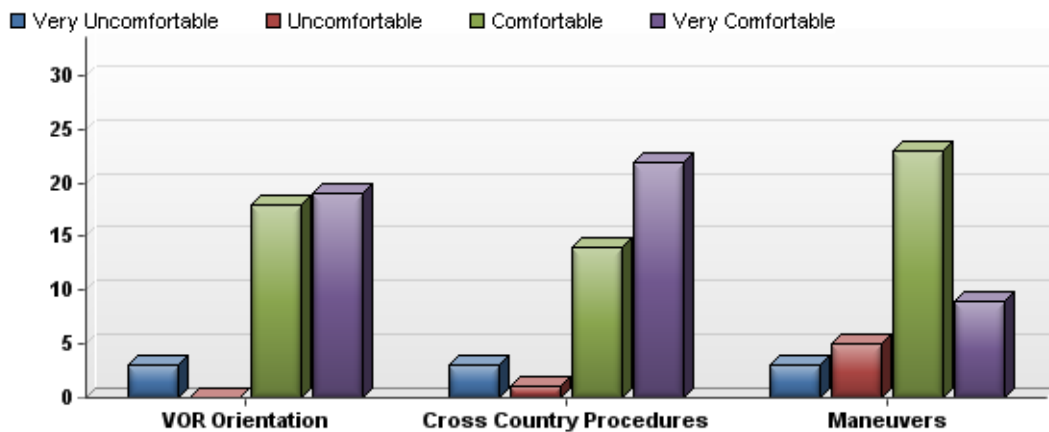


Figure 2. Target Areas Distribution

## Conclusions

Findings from this study suggest that the transition to glass cockpit training aircraft had an impact on student success rates. This result is based upon findings that suggest over half of students in the sample obtained a lower phase check score in the Fall 2010 semester after the new aircraft were introduced. A survey of students in the sample suggests a majority of them felt that a glass cockpit phase check was more difficult than an analog one the previous semester. Thirteen out of 30 indicated that they had more difficulty flying the glass cockpit aircraft than the analog cockpit aircraft. Seventy percent of students felt less comfortable on the Fall 2010 phase check, which was conducted in glass cockpit aircraft. Overall, 18 of the 35 students, or 51.43 % saw a decline in scores between their Spring 2010 and Fall 2010 phase checks. Further research could be conducted to determine the effects of the transition from analog to glass cockpit aircraft over a period of time longer than a single semester. Additionally, this study focuses on the effects of such a transition in a collegiate flight training environment. The same study could be conducted in a different setting or with a different target population. Finally, this study could be expanded to determine the appropriate changes if any that should be made to a training syllabus in order to help facilitate a smooth transition from analog to glass cockpit training aircraft.

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## Appendix

### Study Survey

**Which Course?**

- AT145
- AT243
- AT248

**Did you feel well prepared?**

- Yes
- No

**If your answer to the above question was no, then why not?**

**Which phase check did you find more difficult?**

- Spring 2010
- Fall 2010

**Did you take a phase check in the Spring 2010 Semester?**

- Yes
- No

**Which Course?**

- AT145
- AT243
- AT248

**Did you feel well prepared?**

- Yes
- No

**If your answer to the above question was no, then why not?**

**Did you take a phase check in the Fall 2010 semester?**

- Yes
- No



Why?

Which areas did you feel most prepared for in the Cirrus?

Which areas did you feel least prepared for in the Cirrus?

Which aspects of flying the Cirrus should be given more emphasis in training?

In the Cirrus, how comfortable were you with...

	Very Uncomfortable	Uncomfortable	Comfortable	Very Comfortable
VOR Orientation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cross Country Procedures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maneuvers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>