2007

The Implementation of the FAA Industry Training Program in Technically Advanced Aircraft (TAA): Lessons Learned

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THE IMPLEMENTATION OF THE FAA INDUSTRY TRAINING PROGRAM IN TECHNICALLY ADVANCED AIRCRAFT (TAA): LESSONS LEARNED

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The proliferation of aircraft with extensive automation, collectively known as Technically Advanced Aircraft (TAA) within the last 10 years in the General Aviation industry has led to a novel approach in flight training. The FAA implemented the FAA-Industry Training Standards (FITS) program that emphasizes the importance of "real world" training exercises in the form of scenario training. The FITS curriculum, which was first empirically tested by Middle Tennessee State University (MTSU), was developed by Embry-Riddle Aeronautical University and the University of North Dakota through the FAA Air Transportation Center of Excellence for General Aviation. Over the last four years, MTSU has evaluated the FITS training approach with students in a FAR 141 accepted, combined Private Certificate/Instrument Rating syllabus in TAA. Our findings indicate the need for inclusion of several maneuver-based lessons that facilitate the physical skills training required for some tasks (e.g. landing), early in the FITS syllabus. The importance of consequences in the flight scenarios, the intensive flight instructor training required prior to FITS implementation, and the incorporation of new elements into the ground school portion of the curriculum are all "lessons learned" over the last several years of FITS implementation at MTSU.

Introduction

The proliferation of aircraft with extensive automation, collectively known as "glass cockpit" aircraft, within the last 10 years has led to increasing concerns in the industry on how to best train flight crews that have no flight experience in these aircraft [1, 9, 12, 13]. Until very recently, issues with these automated flight decks were seen as only relevant to the air carrier segment of the aviation industry, where they appear in all modern aircraft. As of late, however, an increasing number of automated cockpits are being seen in General Aviation (GA) aircraft [2]. In the GA community, an automated aircraft is generally comprised of an integrated cockpit system consisting of a primary flight display, a multifunction display including an instrument-certified Global Positioning System (GPS) with traffic and terrain graphics, and a fully integrated autopilot. This type of aircraft is commonly known as a Technically Advanced Aircraft (TAA) [11]. In a TAA, there are typically two display (computer) screens, the primary flight display (left display screen) and the multi-function display.

Given the increasing availability of TAA in the GA community, there is a need to develop a novel approach to flight training to accommodate the new technology. One major reason is that the history of accident investigation indicates that when new technologies are introduced, an increased rate of aircraft accidents occur [11]. For example, an earlier aircraft utilizing a new technology was the Piper Malibu. On May 31, 1989, a Malibu had an "in-flight" break up and crashed in Bristol, Indiana killing the pilot and two passengers. The NTSB's final report concluded that among the contributing factors was the pilot's "lack of familiarity with the make and model of the aircraft" [21]. In less than two years following the Indiana crash, four other fatal accidents involving the Malibu or Mirage occurred in the United States [21]. Lack of knowledge concerning aircraft systems and automation were believed to be contributing factors in all of the accidents [21].

In 1998, the FAA announced a "SAFER SKIES" initiative to achieve significant reductions in the number of GA fatal accidents by 2009. As part of this initiative, the General Aviation Joint Steering Committee (GAJSC) focused on the leading causes of GA accidents. In order to assess what new safety challenges occur with the advent of the TAA, the GAJSC established a TAA study team to investigate safety issues with TAA aircraft [7, 11]. Part of the impetus for this was an early observed increase in fatal accidents in the next generation TAA's, the Cirrus SR22 and SR20 [2, 21], which was characteristic of the Malibu accidents in the early to mid-90s [21]. A major recommendation in this report was that the current training format in the industry was insufficient to exploit the additional safety features of TAA, and that there was a critical need to develop a TAA training program in the GA community [11]. As a result of these recommendations, the FAA implemented the FAA-Industry Training Standards (FITS) program [10, 14]. This program emphasizes the importance of "real world" training exercises in the form of scenario training. This approach had proven successful in the air carrier industry, but had not been attempted in the GA community. This training places a major emphasis on: aeronautical decision making skills, risk management, situational awareness, and single pilot resource management using real-time flight scenarios [3, 14]. Studies from Embry-Riddle Aeronautical University (ERAU), the University of North Dakota (UND), and Middle Tennessee State University (MTSU) (see below) on the effectiveness of the FITS curriculum have resulted in the FAA accepting the FITS training approach as the industry standard for all future flight training in General Aviation [14].

In 2004, MTSU received the first FAA acceptance to train students for a combined Private Certificate/Instrument rating in TAA using the FITS training program. This was a novel approach, as traditionally, a student pilot is required to first complete training for a Private Certificate, then complete additional training for an Instrument rating. At the time, the MTSU training fleet of glass-cockpit Diamond DA-40s was the first such fleet of TAA trainers outside the military.

The FITS curriculum was developed by ERAU and UND through the FAA Air Transportation Center of Excellence for General Aviation (CGAR). The FITS curriculum was first tested at MTSU in 2004-05 in a NASA funded project called "SAFER." Over the last two years, the MTSU SAFER research team has published and presented the results of several studies [4-8]. In the SAFER study, student pilots at MTSU with fewer than 5 flight hours began their combined Private/Instrument training in a Diamond DA-40 with a Garmin G1000 under the FAA 8456 exemption that allowed the SAFER students to take a single practical test to gain both their Private and their Instrument privileges [4, 5]. In that study, we examined "setbacks", which was operationally defined as: any lesson that had to be repeated. Lessons from both a traditional flight training syllabus and the FITS accepted SAFER syllabus require a mastery of the subject matter before a student moves on to the next lesson. Therefore, a repeated lesson is indicative of the student experiencing problems with that lesson. These setbacks, over the course of training, in the SAFER students were compared to a group of "archival" students that received their flight training using the traditional approach. In that study we reported that the SAFER students experienced significantly more setbacks in the "pre-solo" training stages than the traditional students [4, 5]. In contrast, the traditionally trained students experienced significantly more setbacks over the rest of the training compared to the SAFER group [4, 5]. Why would this occur? One explanation is that the SAFER project with the combined Private and Instrument syllabus was, not surprisingly, very "front end loaded." This means that SAFER students were being introduced to cross-country flight planning, navigation, and instrument flight principles all before the first solo. Our research up to that point indicated that SAFER students pay a penalty for this expanded curriculum at the very start of the course. Traditional students are not exposed to cross country planning, navigation, and instrument principles before solo, and spend their time practicing takeoffs and landings in anticipation of the first solo. This focused attention on solo operations among traditional students explained why they performed with fewer setbacks in the pre-solo phase. However, it appeared that the "penalty" the SAFER students paid in the early lessons, was repaid later in the syllabus as the number of setbacks during the entire training course was less for these students compared to the traditionally trained group. Based on the above, we concluded that the evidence indicated that the largest benefit of the SAFER project is toward the end of training, when both groups are preparing for the tests that cover both the Private Pilot and Instrument Rating.

At this point, our research strongly suggested that FITS trained pilots had fewer setbacks over their entire VFR/IFR training than traditionally trained pilots. Up to this time, however, all of the FITS trained students utilized a TAA, while the traditional syllabus students had completed all of their flight training in a "round dial" aircraft. Therefore, it could be argued that the overall decrease in setbacks enjoyed by the FITS trained students were partly or completely the result of the automation, e.g. the TAA, and not the syllabus, effected the change. In other words, it was possible that the FITS flight-training syllabus had very little impact on decreasing the number of setbacks. Consequently, in a subsequent study we decided to empirically test for this possibility by comparing a group of students who had obtained their Instrument Rating in a TAA using the traditional Jeppesen syllabus with a group of FITS trained students in a TAA [6, 8]. In this study we had three groups: 1) "Traditional Syllabus Glass" group consisting of students who received their instrument flight training in a TAA using a traditional flight training syllabus, 2) a "FITS Glass" group which consisted of the sixteen students from an earlier study [4, 5] that were trained using the FITS training program in a TAA, and 3), a "Traditional Syllabus Round Archival" which consisted of the training records of students who received their instrument flight training in a round dial aircraft using the traditional syllabus. These training records served as archival data and were used to compare setbacks over the course of the Instrument training with the other groups. In addition, participants in the Traditional Syllabus Glass and the FITS Glass groups were administered several questionnaires regarding personal IFR visibility and cloud minimums which were standardized in a previous study [6, 8]. Following the completion of this study we reported that both the students using the traditional flight training syllabus with either a TAA or "round dial" aircraft, had a significantly greater number of setbacks over their training compared to the SAFER group [6, 8]. Based on these results we concluded that it appears that it is the FITS methodology, and not the aircraft (e.g., TAA) that made the difference. We also reported that the FITS trained pilots appeared to be more conservative when their personal minimums were compared to Traditional Syllabus Glass trained pilots [6, 8]. This was particularly noteworthy as both groups of pilots who were trained in a TAA, regardless of the training approach, reported feeling very comfortable with the automation in the aircraft, and also with shooting an IFR approach to minimums. Regardless of their comfort level, however, the increased visibility and cloud minimums reported by the FITS trained pilots suggested that although the FITS students are comfortable with the automation, they would be less likely to "launch" when visibility and clouds are low.

Lessons Learned

The Importance of a "Consequence" in Scenario-Based Training. Improving pilot decision making skills and judgment has long been a priority in GA. Indeed, on December 12th, 1991, the FAA published the Advisory Circular, AC-60-22, which defined aeronautical decision making (ADM) as: "a systematic approach to the mental processes used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances" [16]. Given the range of personality differences that are inherent among pilots and the recognition that pilots often make wrong decisions, a plethora of research has been conducted on pilot decision making abilities in an attempt to improve pilot judgment. The inherent logic of the FITS training approach is that aeronautical decision-making skills are improved by presenting pilot trainees with ambiguous situations in training that requires the pilot to use a more complex cognitive decision structure than he/she would normally use in the more traditional training approach. The logic is as follows: when presented with a real-time scenario, the pilot must generate a variety of possible decisions, assess their possible outcomes, and choose a decision regarding the most plausible course of action [15, 18, 19, 22, 23]. One key ingredient that must be incorporated into this schema is the consequence of the decision. If scenarios are presented using the FITS training approach but the scenario does not have any consequences associated with the decision, then the scenario may generate decisions that may not be realistic. The consequences of the pilots' decisions must be incorporated into scenario based training as these "situational variables" have a profound impact on the decision making process [17, 20, 24]. At MTSU, we have incorporated this type of "consequence based" scenario into all of our FITS flight scenarios.

Many flight instructors and flight school managers have had difficulties making the distinction between scenario-based training and what they have always done. The fact is that good flight instructors have always incorporated real-world situations into their flight training. A common practice is for a flight instructor to introduce a "what if" into the flight lesson. They will ask the student, "what if the weather started getting bad at our planned destination?" The student might respond by saying that they would divert to a different destination and the instructor would allow the student to do just that. In fact, the objective of the lesson may have been entirely about forcing the student to adjust the flight's navigation while in flight. The stated destination of the flight was never the true destination at all. We call this situation an "inside the flight" scenario. The difference between this common approach to flight training and the FITS concept of scenario training is the lack of consequences. When the student elects to divert to a new destination "inside the flight" the objective is simply the diversion and there is no consequence for failing to arrive at the original destination. But what if before the flight began, the student was presented with a reason for the flight to be conducted in the first place – a situation "outside the flight." What if the reason for the flight was to deliver a human transplant organ to the destination airport? A diversion from the original plan in this case comes with serious consequences – the possible loss of a human life. If the pilot is making a no consequences diversion decision just to meet the requirements of a lesson, the decision is easy and no real-world preparation is gained. If the pilot is making a decision and the consequences mean life or death, the decision is much harder and much more real.

Implementation Issues. Over the last four years, MTSU in collaboration with our colleagues at ERAU and UND, has been evaluating the FITS training approach. In fact, in the Spring 2007 semester MTSU adopted the FITS combined Private/Instrument training as the Professional Pilot program standard, and this was not a small step. Making the change from the traditional curriculum to the FITS program required a coordinated effort among researchers, curriculum writers, flight school managers, flight instructors and students. First, we completed a revision to the original Private/Instrument syllabus. The primary revision was to reduce the steep initial learning curve that confronted the SAFER students. As stated previously, the SAFER students suffered more setbacks in their training before the first solo than did traditional students. One of the lessons learned from SAFER was that despite the scenario based approach, there are still some skills that require repetition to master, and landing an airplane is one of those skills. The original syllabus had ten "out-and-back" scenarios as its first ten lessons, followed by a first solo flight. It was assumed that the twenty landings accomplished at the end of each leg of the first ten lessons would accumulate enough landing skill to allow a student to fly solo by that point. This assumption did not prove correct. The students were not ready to solo and required repeated lessons (setbacks) to achieve solo skill level. To help remedy this problem, we applied this lesson learned into the syllabus revision to allow for several maneuver-based, landing repetition lessons.

The scenario based learning concepts and procedures were a significant challenge to the everyday operation of a flight school. The original SAFER students trained in all TAA airplanes, but that is not possible with all students participating. When accommodating a larger population of students, all the airplanes of the flight program, both round dial and TAA, are needed so decisions had to be made about which lessons within the syllabus required a TAA, which required round dials, and which could use either.

The nature of scenario-based training is that the instructor really does not know what decisions the student will make along the way and therefore, they really do not know what the lesson outcome will be. This being the case, the instructor does not know when the scenario will end – so how does one schedule for that? Traditionally, flight schools schedule the instructor, student, and airplane together in set time blocks. Two hours is common. But scenarios must be flexible and allow for different in-flight decisions to take place. If the student in the scenario elects to divert from the original plan, the lesson could take less or more time than predicted. The fact that airplanes must operate on a schedule, while scenarios do not operate with any predictable schedule, presents a large challenge. The MTSU flight school does not have the complete solution to this issue, but has gone to scheduling a student/ instructor pair in a four-hour time block. This gives the instructor the freedom to allow the scenario to progress to its logical conclusion instead of being scripted to fit the flight school's strict schedule.

Learner center grading is also a challenge to traditional schedules. At the conclusion of a scenario lesson, the student and instructor separate and complete an evaluation sheet independent of each other. After completing the evaluation sheet, the two come back together and compare evaluations. Often the student and instructor have assigned the same grade on a particular task, but just as often there are disagreements. The evaluation disagreements will spark discussions that lead the student to explore different options, decisions, and outcomes to the scenario. This has proven to be extremely valuable to the student, but this process is time consuming and must be planned for in scheduling.

Another vital lesson learned deals with the flight instructors themselves. The flight instructors used in the first SAFER project were selected for their open-mindedness in addition to excellent instructing skills. That original group participated in all the training sessions that were available at the time and worked with a small number of students. Having the total population of flight students use scenario-based training means the total population of flight instructors must be trained in the use of this technique. The current staff of instructors were already "in the pipeline" when scenario-based training was adopted and most were trained using traditional methods. We have learned that you must start early with staff development and training because this transition requires the instructors to change long-held attitudes and beliefs. For example, one of the most frequent objections voiced by flight instructors during initial FITS training was in response to the third lesson in the syllabus (the first flight in an aircraft), which calls for a "cross country" flight. Because of their own experiences in flight training, flight instructors envisioned several tedious hours teaching their students conventional cross country flight planning before the student ever saw an airplane. However, the real intent of this lesson is simply to introduce the student to a very normal, real world scenario of departing one airport, flying to another, and landing. The introduction of a sectional chart to the student, and the use of pilotage to navigate to a nearby airport, are sufficient for a lesson at this level, and should not be overwhelming to the student. In a somewhat similar instance, the introduction of VOR approach procedures on lesson seven caused initial consternation among flight instructors. But once it was understood that an instructor-assisted conduct of a "visual" VOR approach (where the student could look out of the cockpit and physically see what the aircraft's VOR indications meant) was a natural outgrowth of a lesson on VOR orientation and navigation, instructor concerns were alleviated.

During instructor training, it also became clear that additional instructor guidance regarding the scenarios to be flown would be required. In the original SAFER project, there was not a separate "instructor guide". However, since many newly-minted flight instructors have very limited exposure to "real world" scenarios themselves, more comprehensive notes were needed to insure that instructors were able to conduct the scenarios as envisioned by the curriculum authors. In addition, a detailed discussion of each lesson's scenario during flight instructor meetings, including appropriate and inappropriate decision-making given the circumstances presented, is a key component of successful implementation. Since low flight time, conventionally trained instructors have not necessarily experienced many scenarios themselves, it is obviously critical that they understand and can apply appropriate decision-making strategies before expecting their students to do the same.

Finally, while simply an administrative concern, it proved to be hard for flight instructors to manage the long task performance lists that are a part of every FITS curriculum lesson. Trying to refer to a sometimes lengthy task list in a cramped cockpit was difficult. To address this issue, a checklist style list of all the tasks required at any point in the curriculum was developed, which fits on the front and back of one 8.5x11 inch sheet of paper. For each lesson, the appropriate tasks to be accomplished on that lesson are printed in bold, for easy reference by the flight instructor. Now, it is a simple matter for the instructor to utilize the task checklist for a particular flight lesson, instead of having to refer to the actual curriculum while in the aircraft.

The implementation of FITS flight training has also necessitated changes in the conduct of ground training. While the ground school classes have remained roughly segregated into the conventional "Private" and "Instrument" components, there is a need to expose students to instrument concepts at a very early stage. While there is not time to fully explain ILS approaches, for example, in the first few weeks of a Private ground school, it is not too difficult, while discussing visual approach guidance systems (VASI, PAPI) to go ahead and explain in general terms what an ILS approach is. Then later in the course, when VOR navigation is covered, ILS navigation can also be discussed. This manner of introducing important topics at least provides students with a rough framework for what they are beginning to experience in flight training.

The use of the glass Diamond DA-40s from the beginning stages of training requires students to become familiar with the Garmin G1000 system very early in training. To accommodate this, the Private ground school now has an added component, which requires students to complete a self-paced Garmin G1000 tutorial. Students complete quizzes at the end of each training module and discussions of the appropriate use of the technology occur throughout the class.

Additionally, efforts have been made to incorporate scenarios that require student decision-making into the ground school classes, to better prepare students for what they will experience in flight. As with flight training, good ground instructors have long incorporated "real life problems" in ground training. Unfortunately, it is easy to fall into the trap of having so much material to cover that time is not taken to discuss the "what ifs". But, with awareness, this problem can be alleviated. For example, instead of just working through the specifics of aircraft electrical systems in class, providing a problem-based case study for students to reflect on results in much more growth in student decision-making capability. Regarding electrical systems, students can be given a scenario such as the following: "You are on a night VFR cross country, 50 miles from your destination airport, and experience an alternator failure. What are the ramifications of this failure, and what actions will you take to handle the situation?" By allowing students to work on this type problem as a homework assignment and then discussing the case in class, students are able to grapple with applying good decision-making skills at a very early point in their training.

Summary

This successful implementation of a FITS training syllabus does not happen over night. The lessons learned to this point have improved the product used today, but it is still an ongoing process. The faculty and staff at MTSU are discovering better ways to deliver this teaching philosophy everyday.

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