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**COLLEGIATE PROFESSIONAL PILOT PROGRAMS: ACQUISITION AND USE
OF A LEVEL SIX FLIGHT TRAINING DEVICE IN THE ACADEMIC ENVIRONMENT**

Jeanyves Preudhomme, Chien-tsung Lu, and Richard Martinez

Abstract

Regardless of the bill of *H.R. 5900 Airline Safety and Federal Aviation Administration Act of 2010* aiming to elevate the flight hours and level of certification for pilots working for FAA FAR 121 air carriers, the ongoing pilot recruitment at regional airlines continues to grow. Simultaneously, an influx of low time and relatively inexperienced pilots are continuously flying the revenue passenger. In this case, collegiate aviation programs should take the responsibility to deliver low-time pilots, yet with sufficient knowledge and skills regarding multiple crew scenarios and complex transport aircraft systems. With this in mind, in order to ensure the quality and experience flight training at the university level, full size air carrier Flight Training Devices (FTD), and sometimes motion simulators (FFS Full flight Simulators) are used. However, the aforementioned high-end devices are not affordable to every collegiate aviation program. To make efficient use of the professional student pilot's budget and ensure a thorough and comprehensive application of systems knowledge and crew resource management concepts, a compatible alternative is an option. In this paper, a Flight Training Device (FTD)/simulator was used and the certification process and acquisition steps were described. Due to the nature of the study, Action Research Methodology (ARM) was selected. The result showed that the selected complex training device could become a standard feature of a collegiate aviation program to equip professional pilot majors with sufficient knowledge in an intensive, commercial environment.

Introduction

The *H.R. 5900 Airline Safety and Federal Aviation Administration Act of 2010* has imposed a career threat to professional flight training programs as the proposed bill requires that all pilots working for FAA FAR 121 air carriers must have at least 1500 flight hours (Government Printing Office, July 28, 2010). However, according to the bill, the Administrator of the Federal Aviation Administration (FAA) may allow specific academic training courses to be credited toward the total required hours. In this case, how to ensure the quality of a flight training program that could be recognized by the Administrator is critical. In particular, there are currently approximately 110 flight training institutions in the United States including airline, commercial, professional pilot, and flight crew colleges (Education Reference, U.S., 2010). Identifying a cost-effective way to train airline pilots pursuant to the proposed law is an urgent need.

Background

In 2008, regional airlines hired over a dozen of professional pilot undergraduates from University of Central Missouri

(UCM) with fewer than 500 hours of flight time. Although most succeeded in completing the training, three failed or experienced difficulty at one phase or another. All commented on the intensity and rigor of the training. The gap between the knowledge required of the FAA commercial pilot and the demands placed on new hires during air carrier ground school and simulator training is wide, particularly when hiring demand is high and new First Officers obtain their first job with minimal or no flight crew experience. Thus UCM's Department of Aviation faculty speculated that the potential wash out, or failure rate of initial hires at airlines could be avoided with the students' consistent and systematic exposure to a professional environment in a full size transport aircraft Flight Training Device (FTD), in a variety of classes. In the Spring of 2008, a group composed of faculty and staff, employed at the University of Central Missouri (UCM)'s aviation department undertook a study to evaluate the viability of acquiring a Transport Category Flight Training Device (FTD) that would be used principally for students in the Professional Pilot Program. The rationality underpinning

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UCM's FTD study was the viability and successful practical application of FTDs with an evaluation comparison to the ab-initio pilots enrolled in Part 142 programs conducted by Macchiarella and his associates in 2006. In their 18-year study, Macchiarella, Arban and Doherty concluded that the use of an FTD in flight training provided an effective transfer to the actual aircraft for each flight-training task. Macchiarella's project conducted on ab-initio students represented the largest scale transfer study completed in a civilian environment.

Relying on Macchiarella's findings and from inputs given to the department by industry employers during the university's advisory committee meetings, the consensus highlighted the need for a complex training device, or FTD. Used by all professional pilot enrollees, the FTD could help ease the difficult transition experienced by previous professional pilot program graduates during initial aircraft training at their first airline

job. However, one needs to consider which FTD could be the most cost-effective model for a collegiate flight training program under the budget-constraint status.

Regulatory Review*FAA FAR Part 60*

FAA certification allows a device to be used for training specific to certificates and ratings. In full motion devices, simulators, pilots can obtain a type rating, which is the equivalent of an Airline Transport Pilot (ATP) Certificate for that make and model of aircraft (FAA, 2008). Flight Training Devices (FTD) can be used for initial training, leading to the type rating, typically about one half of the type rating simulator time requirements. The FAA has categorized the training devices to be used for the acquisition of ratings.

In 2008, the FAA implemented FAR Part 60, which officially regulates Flight Training Devices and Simulators. As Bob Davis, Manager of the National Simulator Program (NSP), states, the purpose of FAR Part 60 is "to give a legal basis to the process of qualifying simulators" (Phillips, 2007, p. 65). The FAA also intends to be in line with Europe's Joint Airworthiness Authority (JAA) per regulatory harmonization. The focus of the FAR Part 60 primarily affects Level four to seven Flight Training Devices and Level C and D simulators, which impose a challenge to the sponsor's development of an approved quality management system.

FAA FAR 60 FTD Visual Quality Management

An emphasis on higher quality visuals is also contained in FAR Part 60. Airport models, environment, aircraft, and equipment all must faithfully represent reality. The pilot's field of view, for instance, has increased recently from 150 degrees to 180 degrees. This increased emphasis on graphics has created a requirement for updated, High Definition (HD) projection. Manufacturers and sponsors must seriously consider which graphics to include in their devices, to meet

Part 60 standards (Adams, 2008). In order for the device to maintain its FAA certified status, it needs to undergo periodic annual or semi-annual recurrent evaluations. Because computer software is widely used in Flight Training Devices and simulators, a system monitoring the integrity of the computers must be in place and available for the Principal Operations Inspector (POI) to check upon inspection.

The FAA AC 120-45A Airplane Flight Training Device Qualification

While the FAR Part 60 is regulatory, FAA AC 120-45A offers guidelines and recommendations. The FAA Advisory Circular 120-45A ranks Flight Training Devices by levels, from one to seven, while letters A through D qualify simulators. In order for a device to qualify as a level four or above, it needs to be representing a specific model of aircraft. At level seven, a device faithfully imitates the aircraft it represents. An aircraft simulator is not only aircraft specific, it also has motion, provided usually by hydraulic jacks and requiring a dedicated maintenance support team. An aircraft Flight Training Device is aircraft specific but does not have motion. Both can be FAA certified and used for training and checking according to the assigned qualification level by the Principal

Operations Inspector (POI) for levels two to five or by the National Simulator Program Manager (NSPM) for levels six and seven. The FAA has approved about 60 motion-based simulators yearly (Phillips, 2007). In the case of a convertible Flight Training Device, which can represent several aircraft, separate testing is required for each model to be FAA approved. For levels two to five, which are non-aircraft specific, the device must be representative of the set of aircraft for which it is approved, e.g. multi engine turbo-prop, etc.

Advisory Circular 120-45A and the FAR Part 60 outline the approval process and the specific performance requirements for each training device. Once the device is approved, the owner becomes a "sponsor" and the device can be used for training and to obtain experience required by the FARs for specific certificates and ratings.

To qualify as a sponsor of an FTD, the FAA FAR Part 60.7 specifies that:

"(a) A person is eligible to apply to be a sponsor of an FSTD if the following conditions are met: (1) The person holds, or is an applicant for, a certificate under part 119, 141, or 142 of this chapter; or holds, or is an applicant for, an approved flight engineer course in accordance with part 63 of this chapter. (2) The FSTD will be

used, or will be offered for use, in the sponsor's FAA-approved flight training program for the aircraft being simulated as evidenced in a request for evaluation submitted to the NSPM" (FAA, n.d.).

action taken for each discrepancy, the identity of the individual taking the action, and the date that action is taken be entered in the log.

(iii) The discrepancy log be kept in a form and manner acceptable to the Administrator and is kept in or adjacent to the FSTD. An electronic log that may be accessed by an appropriate terminal or display in or adjacent to the FSTD is satisfactory" (FAA, 2008, p.2).

In addition, to initially approve the device, a pilot, qualified in that type of aircraft, must conduct a flight test including specific tasks. The FTD must perform and handle similarly to the aircraft it represents.

To remain qualified as an FTD sponsor, the FAA also requires, among other things, that the sponsor have a quality management system currently approved by the NSPM in accordance with FAR Part 60.5 (FAA, 2008). A Qualification Performance Standards document (QPS) exist for each type of FTD as explained in Part 60 Appendixes A through E. Part 60.9 outline the FTD's operator/sponsor requirements and responsibilities. The FAR Part 60 Appendix B, gives an example of what is expected of a Level five (Multi engine, Turbo prop airplane) FTD (see Appendix A)

Because the FTD is designed to replicate the aircraft, procedures used by operators of the actual aircraft also are imitated. Airlines keep a maintenance log of each aircraft, detailing each write up or maintenance entry, action taken, responsible technician, and reference number. Part 60 requires that the sponsor of the FTD:

- (1) Maintain a discrepancy log
- (2) Ensure that, when a discrepancy is discovered, the following requirements are met:

- (i) A description of each discrepancy is entered in the log and remains in the log until the discrepancy is corrected as specified in §60.25(b).
- (ii) A description of the corrective

Airlines use a Minimum Equipment List (M.E.L.) to outline what equipment needs to work for a flight and to explain what the consequences are for a failed element. In parallel, Part 60 prohibits flight in the FTD for purposes of training or testing if there is any Missing, Malfunctioning, or Inoperative (M.M.I.) part, required by the Statement of Qualification. In addition, maintenance personnel have to repair or replace the defective or missing part within 30 days. A list of those required MMI parts must be available at all times to users of the device. The intent is clearly to replicate real life procedures as closely as possible.

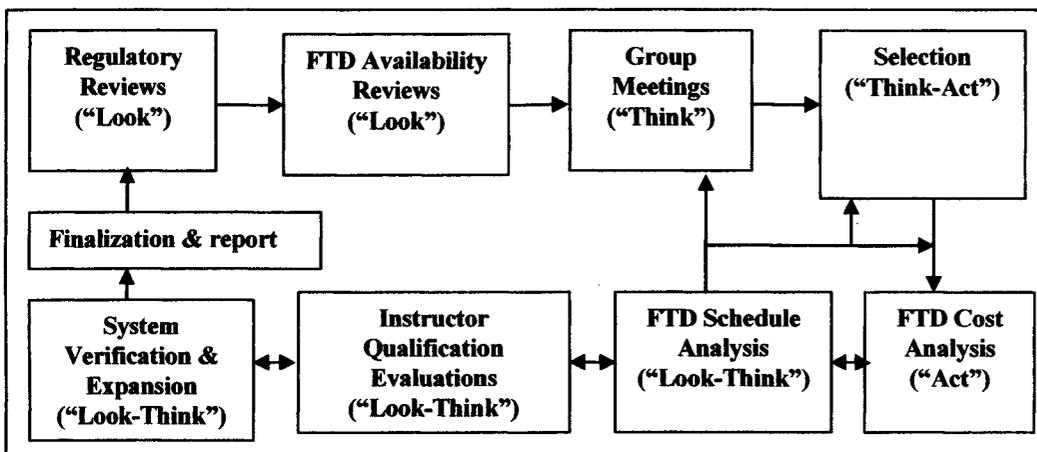
Research Strategy

Research Question

What is the most cost-effective FTD that will meet the requirement of FAR Part 60, at a collegiate flight training program?

Research Methodology

The researchers applied Action Research Methodology (ARM) throughout the study. As AR methodology is a scientific approach available for the researchers to merge themselves in a research setting for evidence discovery, researchers experience the first-hand challenges, process cognition and available knowledge, and implement selected strategies (Reason & Bradbury, 2001). The AR procedures or the "Look-Think-Act" loop have been utilized as an acronym in the qualitative research discipline for decades. A flow-chart is provided below:



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The final report of this study will follow the ARM steps as addressed in the following section.

Result - FTD Availability and Group Meeting

Per ACM's "Look-Think-Act" process, after the regulatory review, the purchaser must identify the specific purpose prior to the acquisition of the training device, determining, for instance, who will use it, for what training whether students will use it to receive initial exposure to complex systems or if the device will be contracted out to satisfy type rating requirements.

FTD Selection and Utilization

UCM's Reasoning For FTD Selection

The University of Central Missouri's aviation department opted for a 737NG. The 737 New Generation aircraft was chosen for its predominance in the airline industry. It is equipped with the newest technology available to modern airliners including EFIS glass panels with standby integrated display instruments, two fully functional FMS or Flight Management Systems, two autopilots which, when used together allow auto land approaches. The 737 NG has a combination of large transport aircraft systems such as hydraulic controls, pneumatic environmental systems, AC electrical with DC back ups. It also uses traditional engineering concepts for flight controls, with a manual reversion for elevator and aileron movements. This variety of systems, as well as the wide use of the actual aircraft worldwide makes the 737NG a logical choice for a professional aviation department. The Flight Training Device is equipped with 180 degree day and night visuals provided by three HD projectors, sound, and flight controls with a digital electrical control loading system to ensure realistic feel. The training device is static but provides wider visuals than full motion simulators. The instructor's station gives control over airport selection, detailed weather conditions, selective failures, repeat maneuvers and includes a freeze option to allow for potential explanations.

FTD Cost Analysis

Most airlines training departments, staffed with dedicated maintenance crews operate several full motion simulators 20 hours a day, seven days a week. Some carriers rent out their devices to other airlines with or without instructors. Such maximized use enables operators to generate substantial return on their devices while fulfilling their own training needs. An hour of full motion simulator rents out for an average of \$400 varying with the aircraft. Other simulator owners specialize in providing simulator training needs to a variety of airlines that do not own flight training devices or simulators. During the periodical economic downturns, while airlines park aircraft temporarily to reduce capacity, training devices still enjoy full use for retraining of pilots.

Indeed, when an airline downsizes and parks aircraft, it has to shift crews to other equipment based on seniority, as

dictated by contracts. Because of the relatively high initial expenditure and ensuing low variable cost, when compared to an aircraft, the training device makes greater financial sense with high use. Indeed, the rental income potential outweighs the space and maintenance fees associated with the operation of the device. The 737-800 aircraft costs an average of \$80,000,000 (Boeing, 2010) and the baseline hourly cost of operation for the average B-737 is \$2,000.00 (ICAO 2000). In comparison, full-motion simulators cost from one to more than 15 million dollars based on the specific aircraft demand, while a 737 NG Flight Training Device averages \$350,000 to \$500,000 and can rent out from between \$100 to \$200 per hour per seat.

FTD Schedule Analysis

Depending upon the size of the training facility and the amount of users, several instructors and a fleet of training devices may be justified. Because the device can and should be used as much as possible, the department can schedule several instructors on one device. Due to the increased intensity of the training that takes place in a FTD/simulator, four-hour sessions with one instructor and two students preceded by a one hour brief and followed by a one hour debrief can render productive results. Thus five four-hour sessions can be scheduled in a 24 hour period and still permit maintenance action, as necessary. Simulators are usually slated for two to four-hour maintenance checks daily while non-motion FTDs usually only require monthly maintenance check ups beyond the occasional and easily resolved software issues. Trained computer technicians can resolve most issues remotely.

Instructor Certification

To offer training toward the acquisition of a rating or certificate, instructors need to be appropriately rated in the device or type of aircraft. For example, to give college students instruction in an FTD aimed at obtaining a 737 type rating, the instructor needs to be type rated in the 737. At the collegiate level, most students will be too young to meet the FAA type rating requirements. A non-rated but proficient instructor is therefore sufficient for most college applications. A department may however choose to type rate its FTD instructors so as to increase competency, expertise level, and marketability. For most college students, therefore, the hours spent training in the FTD, while not being logged for a type rating, can be logged to meet other requirements. Instrument currency requirements can also be partially met.

System Verification and Expansion

The proposed FTD/simulator and training program aims to provide students first hand exposure to complex systems operation and integration. It logically follows a ground school class on the aircraft systems during which relationships between systems are examined. For most students, it is the first look at multiple crew operations. Students learn the harmonious division of labor in the

cockpit, the efficient use of checklists for verification of flow completion. For all students, this is an opportunity to use the Flight Management System in a Line Oriented Flight Training scenario. The relationship between the FMS and the autopilot and auto throttle is examined. Combined with a study of Crew Resource Management Concepts, the FTD provides students with a more realistic venue during emergency situations. Students learn about gathering of essential information, assessment of risk and task prioritization.

Conclusion

Flight simulators have been ranked as one of the five leading technologies that has affected the aviation industry over the last 50 years (Gormley, Garvey, 2008). With the increasing fixed and variable cost associated with aircraft operation, the use of simulation will continue to make financial and logistic sense in the foreseeable future. The training devices' relatively low acquisition and upkeep costs provide operators with the ability to generate revenue as well. With increased focus on safety and experience from the government, as evidenced by the new ATP requirement for all pilots of air carriers, it is evident that airlines will expect new hires to be familiar with the transport aircraft category systems and operations. Simulators and Flight Training Devices (FTDs) can affordably bridge the experience gap between college and the professional environment. To respond more quickly and to meet industry's demands more accurately, collegiate professional pilot programs can position themselves to

offer their students the tools to succeed in today's demanding and dynamic aviation marketplace. In addition, college classes can make use of an FTD that includes the following:

- Transport Category Aircraft Systems: FTD practice combined with classroom lecture, individual time on an interactive Computer Based Training Module and in a "paper trainer"- three D plywood cockpit replica used for checklist practice and switch familiarity.
- Flight Management Systems (FMS): FTD practice of automation and FMS/IRS/Autopilot interactions.
- Crew Resource Management (CRM): Classroom study of human factors in aircraft accidents and practice scenarios in the FTD aimed at exploring crew interactions in normal and abnormal situations.
- Line Oriented Flight Training (LOFT): Airline style scenarios replicating actual flights from departure to shut down, with dispatch paperwork and typical operations.
- Outside contracts for interview preparation and initial training toward the ATP. The bulk of the ATP and a Type-Rating can indeed be conducted in a static FTD, and finished in a full motion simulator for the check ride, resulting in substantial cost savings. →

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aviation, general aviation operations, aviation industry career development, aviation curriculum development, ground school from Private Pilot to CFI. His current responsibilities at UCM include teaching at both an undergraduate and graduate level, student advisement, recruitment, retention, assessment and program development.

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Appendix A
Qualification Performance Standards for Airplane Flight Training Devices

| The performance parameters in this table must be used to program the FTD if flight test data is not used to program the FTD. | | |
|---|--|---|
| Applicable test | | |
| Entry No. | Title and procedure | Authorized performance range |
| 1. Performance | | |
| 1.c | Climb | |
| 1.b.1. | Normal climb with nominal gross weight, at best rate-of-climb airspeed | Climb airspeed = 120–140 knots. Climb rate = 1000–3000 fpm (5–15 m/sec). |
| 1.f. | Engines | |
| 1.f.1. | Acceleration; idle to takeoff power | 2–6 Seconds. |
| 1.f.2. | Deceleration; takeoff power to idle | 1–5 Seconds. |
| 2. Handling Qualities | | |
| 2.c. | Longitudinal Tests | |
| 2.c.1. | Power change force | |
| | (a) Trim for straight and level flight at 80% of normal cruise airspeed with necessary power. Reduce power to flight idle. Do not change trim or configuration. After stabilized, record column force necessary to maintain original airspeed | 8 lbs (3.5 daN) of Push force to 8 lbs (3.5 daN) of Pull force. |
| | OR | |
| | (b) Trim for straight and level flight at 80% of normal cruise airspeed with necessary power. Add power to maximum setting. Do not change trim or configuration. After stabilized, record column force necessary to maintain original airspeed | 12–22 lbs (5.3–9.7 daN) of force (Push). |
| 2.c.2. | Flap/slat change force | |
| | (a) Trim for straight and level flight with flaps fully retracted at a constant airspeed within the flaps-extended airspeed range. Do not adjust trim or power. Extend the flaps to 50% of full flap travel. After stabilized, record stick force necessary to maintain original airspeed | 5–15 lbs (2.2–6.6 daN) of force (Pull). |
| | OR | |
| | (b) Trim for straight and level flight with flaps extended to 50% of full flap travel, at a constant airspeed within the flaps-extended airspeed range. Do not adjust trim or power. Retract the flaps to zero. After stabilized, record stick force necessary to maintain original airspeed | 5–15 lbs (2.2–6.6 daN) of force (Push). |
| 2.c.4. | Gear change force | |
| | (a) Trim for straight and level flight with landing gear retracted at a constant airspeed within the landing gear-extended airspeed | 2–12 lbs (0.88–5.3 daN) of force (Pull). |

| | | |
|------------------------------------|--|---|
| | range. Do not adjust trim or power. Extend the landing gear. After stabilized, record stick force necessary to maintain original airspeed | |
| | OR | |
| | (b) Trim for straight and level flight with landing gear extended, at a constant airspeed within the landing gear-extended airspeed range. Do not adjust trim or power. Retract the landing gear. After stabilized, record stick force necessary to maintain original airspeed | 2–12 lbs (0.88–5.3 daN) of force (Push). |
| 2.b.5. | Longitudinal trim | Must be able to trim longitudinal stick force to “zero” in each of the following configurations: cruise; approach; and landing. |
| 2.c.7. | Longitudinal static stability | Must exhibit positive static stability. |
| 2.c.8. | Stall warning (actuation of stall warning device) with nominal gross weight; wings level; and a deceleration rate of not more than three (3) knots per second | |
| | (a) Landing configuration | 80–100 knots; # 5° of bank. |
| | (b) Clean configuration | Landing configuration speed + 10–20%. |
| 2.c.8.b. | Phugoid dynamics | Must have a phugoid with a period of 30–60 seconds. May not reach 1/2 or double amplitude in less than 2 cycles. |
| 2.d. | Lateral Directional Tests | |
| 2.d.2. | Roll response Roll rate must be measured through at least 30° of roll. Aileron control must be deflected 1/3 (33.3 percent) of maximum travel. | Must have a roll rate of 4–25 degrees/second. |
| 2.d.4.b. | Spiral stability Cruise configuration and normal cruise airspeed. Establish a 20°–30° bank. When stabilized, neutralize the aileron control and release. Must be completed in both directions of turn. | Initial bank angle ($\pm 5^\circ$) after 20 seconds. |
| 2.d.6.b. | Rudder response Use 25 percent of maximum rudder deflection. (Applicable to approach or landing configuration.) | 3°–6° /second yaw rate. |
| 2.d.7. | Dutch roll, yaw damper off (Applicable to cruise and approach configurations.) | A period of 2–5 seconds; and 1/2–2 cycles. |
| 2.d.8. | Steady state sideslip Use 50% rudder deflection. (Applicable to approach and landing configurations.) | 2°–10° of bank; 4°–10° of sideslip; and 2°–10° of aileron. |
| 6. FTD System Response Time | | |
| 6.a. | Flight deck instrument systems response to an abrupt pilot controller input. One test is required in each axis (pitch, roll, yaw) | 300 milliseconds or less. |

