The Transfer of Flight Training Procedures From an Advanced Airline Flight Simulator to the Classroom

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ABSTRACT

The current shortfall of aviation professionals has led employers to hire low-time, less experienced aviators to fill cockpit positions. Accordingly, the improved effectiveness and capacity of flight training programs has become a national priority. Collegiate aviation programs, in particular, are faced with resource constraints that mandate optimum use of available flight training devices. This paper suggests the use of off-the-shelf video teleconferencing technology to transmit certain aspects of flight training, such as systems operations and normal procedures, between the classroom and an advanced flight simulator or training device. Instruction that is normally limited to two or three students can now be given to a much larger audience and yet remain interactive. Limited sampling of student performance following flight simulator video teleconferencing sessions reflects the promise of this medium as a useful complement to other aviation training methodologies. This paper is not meant to be a formal research paper, but rather an overview of an innovative teaching technology that could lead to further study.

INTRODUCTION

As the costs and limitations of training aircraft operations have escalated, attention has shifted to flight simulation as a means of reducing in-flight costs while avoiding the impact of actual weather, maintenance, and safety-of-flight concerns. Flight simulation devices have provided a useful adjunct to flight training programs for a number of years. With the advent of hydraulically actuated six-axis motion systems and modern day/night visual simulations, modern flight simulation systems provide a level of training that approaches an actual in-flight experience. The technology, however, is fragile and expensive. The cost of advanced airline flight simulators and supporting infrastructure frequently exceeds that of the actual aircraft they simulate. These costs are especially prohibitive for a collegiate aviation training program.

Cognitive pre-training for flight duties includes any activity that prepares the student for experiential psychomotor training. Such activity can include a wide variety of observed, interactive or hands-on educational formats. High fidelity simulation systems are used to realistically duplicate actual in-flight conditions and provide significant cognitive pre-training to minimize orientation time associated with initial inflight operations. The level of realism associated with the most sophisticated flight simulators has prompted the FAA to certify their use for continuing training and evaluation in place of actual aircraft. Many authors have reported on research to validate transfer of training levels associated with flight simulation (i.e. Taylor, Lintern, and Koonce, 1993; Lintern, 1992; Thomson, 1989; Caro, 1988; Wood and Gerlach, 1973). Additional research has evaluated the benefit of video and motion enhancements to flight simulation devices (Lintern, 1992; Martin & Cataneo, 1980; Martin & Wang, 1978; Prophet & Boyd, 1970; Gerathewohl, 1969).

Although higher levels of physical and visual fidelity support the effective transfer of training between the flight training device and actual aircraft, past research indicates that simpler systems are equally effective in many areas of flight training. Thomson (1989) notes that cockpit orientation and procedural familiarization procedures can be effectively trained with simple cockpit procedures trainers (CPTs). CPTs provide an orientation to the location of instrument displays, switches, and controls for the depicted aircraft.

Although such devices do not provide external views and tactile cues to students, they are effectively used to practice procedures for normal and emergency systems operations. These trainers may be accurate cockpit recreations or less sophisticated wood constructions with photographic panel depictions and movable switches. Transfer of training from these systems is dependent on repetition for cognitive mastery.

Although such devices have utility, research by Brecke, Gerlach and Schmid (1976) indicates that the receipt of repetitive cues during CPT training, without systematic instructional support, may negatively affect transfer of training. Subjects who received repetitive current cues scored an average of seventeen percent lower in training effectiveness than those who received lower repetitions and systematic cues. In addition, those subjected to repetitive training reported significantly negative attitudes towards that training methodology. Repetitive aviation training formats have utility, but other options are needed to provide systematic cognitive cues.

Recent advances in computer technology offer a variety of innovations for flight education training. Modern airline crew training operations provide trainees with self-study CDs that present a comprehensive and extremely realistic depiction of aircraft systems and operations. This training medium is only limited by computer access and allows trainees to manipulate systems to more fully understand normal and abnormal operations. Some flight training schools use inexpensive computer flight-training packages that incorporate an external stick, rudder, throttle quadrant, and comm/nav radio panel for effective flight simulation. Although psychomotor depiction in such systems is limited, the orientation value is obvious and measurable.

Many authors (Mitchell, 2000; Taylor, Lintern, Hulin et al, 1999; Koonce, 1998) have reported on the effective use of computer-based training (CBT) for generic motor skill applications and general systems training. In addition, part-task trainers have proven to be effective for mastery of aircraft components such as radar and flight management systems. Part-task trainers are especially useful in the study of complex aircraft instrumentation that is normally operated independently from flight control systems (Goettl, 1996).

Flight simulators with higher physical and visual fidelity would seem to provide better transfer of training for tasks that require the most complex motor skill and visual coordination. More austere training aids, however, can have a key role in flight training while reducing the utilization rates and costs associated with advanced airline flight simulators.

A state-of-the-art advanced airline flight simulator presents opportunities for repetition and orientation desired in a procedures trainer while providing the psychomotor responses that effectively simulate actual in-flight conditions. A flight simulator session normally includes a prebrief by an instructor to review systems operations, switch locations, and procedures. The prebrief is followed by a two to four hour simulator experience that permits the crewmembers to visually and tactilely experience the designated flight operations from their assigned positions. After the flight, a post-flight session is conducted to review student performance and suggest areas for improvement.

Initial flight qualification training for aircrew members may include as much as 10 to 30 hours of flight simulator time conducted over a relatively short training interval. In addition, periodic refresher and upgrade training are conducted for aircrews each year. Some collegiate flight training programs are able to provide their students with the same number of hours of advanced flight simulator training as their professional contemporaries. However, such collegiate training is usually spread over an extended school year period of many weeks. Integrating student academic schedules with flight simulator availability presents a particularly difficult problem for collegiate flight program managers. If the flight student group is large, and flight simulator sustainability is dependent on outside users, the problem is magnified.

Each year, the four-year undergraduate flight program at Purdue University prepares approximately seventy freshman students to begin commercial aircrew duties upon graduation. The last two years of education for these students are focused on advanced aircraft operations. Significant classroom activity is oriented to the transition from general aviation aircraft to complex turboprop/turbojet aircraft. Classroom instruction and flight simulator activity support training in multi-engine corporate and airline aircraft.

Purdue operates two Boeing 727 flight simulators that are comparable to those used by major airlines. Both simulators are expensive to maintain and are annually certified by the FAA. Each week, upper division flight students receive a two-hour simulator period supplemented by four to six hours of classroom systems and procedures instruction. Simulator student utilization rates currently approach 50 hours per week for each simulator. Airline flight training personnel also use the simulators for up to 60 hours per week to evaluate potential hires and conduct new-hire and recurrent proficiency training. Additional simulator utility is limited by periodic and recurring maintenance.

Effective classroom instruction complements flight simulator activity. Kemp (1985) states that significant interaction between the learner and educational media is key to effective instruction and learning. Active participation enhances the learning process. Teachers and instructional designers should select media that will require opportunities for the student to engage in the learning process (Heinch, Molenda, and Russell, 1993). To bridge the gap between classroom lectures and flight simulator training, the authors have designed an interactive video transmission system to bring the advanced flight simulator experience into the classroom. Such interactive video serves as a logical step to introduce aircraft systems and procedures. Using this format, a large number of students can experience high fidelity simulation within the classroom. This interactive environment addresses individual learning styles while meeting the instructor’s need for flexibility. In addition, preparation time for flight simulator sessions is reduced.

SIMULATOR TELECONFERENCING

The authors use a basic video conferencing system to transmit images between the flight simulator and classroom. Initial setup of this system includes the establishment of electrical and network connectivity within the flight simulator. Broadcast transmission between the flight simulator and classroom locations is accomplished through predetermined network paths that are initialized within a video conferencing unit. At the heart of the transmission system is the Polycom Viewstation, a relatively small, portable, video conferencing unit with an embedded web server. The unit can be mounted on a tripod, installed in a fixed position, or placed on a podium. In the flight simulator, the Polycom unit is placed on a tripod behind the pilot stations and can be remotely controlled to view all instrument panels. The Polycom unit is connected to a small video monitor in the flight simulator, which provides a split screen presentation of simulator images and the classroom audience. Finally, a remote microphone/ speaker unit is strategically placed in the simulator to facilitate conversation between the classroom and the simulator. In the classroom, a second Polycom unit transmits images of the student audience to the simulator and a multimedia projection system is used to project simulator images on a large screen. Instructors at both locations can remotely operate either camera unit. The cost for two Polycom units and supporting accessories used in this project was less than $10,000.

For operational flexibility and security, Polycom components are not permanently installed in either the flight simulator or the classroom. Polycom components are lightweight and easily transported. Operation of the Polycom system in any location is limited only by the ease with which electrical power and network connectivity can be established. Setup of the system is simple and takes less than five minutes. When connectivity has been established, the classroom and simulator instructors act in concert to lead the class through a preplanned instructional scenario. Interaction between the instructor stationed at the flight simulator and individual students, although not experimentally verified, seems to enhance classroom participation and the level of training transfer. The number of training scenarios possible is limited only by the instructor's imagination. Typical Polycom scenarios could include: a cockpit instrument orientation, systems operations under normal and/or emergency conditions, normal procedures training, and crew resource management orientation. In addition, a "walk-through" of upcoming simulator activity could greatly reduce the pre-brief and orientation time required during the actual simulator training period.

A typical 30-minute Polycom session might focus on normal and abnormal engine starting problems for a jet aircraft. Students would be provided with a handout at the start of class that outlines information related to the topic. The instructor would control the Polycom unit in the flight simulator to view the overhead starter panel, the throttle quadrant, and the engine instrument panel. Questions are typically asked of the audience by the instructor in the simulator to draw student attention to appropriate aspects of the starting system. Students may be asked to direct the starting sequence. Abnormal operations are encountered and students are asked for appropriate measures to return to normal operations. At frequent intervals during the presentation, students are encouraged to interact with the instructor in the simulator to better understand the systems operation being discussed. The Polycom methodology has been used to date with engine starting procedures, fuel system management, flight engineer systems operations, and electrical systems operations. In each case, student feedback was very favorable and subsequent simulator performance, as evaluated by assigned simulator instructors, indicated improved levels of training. To attain further value from this medium, classroom Polycom sessions have been recorded on a VCR. Sessions can be reviewed for lesson improvement, use by students who missed the class, or in a distance education format.

METHODOLOGY/EVALUATION

The innovative simulator transmission process is still in its infancy and beta testing of the concept still in progress. Each Polycom session is evaluated by students and participating instructors. Students provide feedback through written evaluation forms using a Likert rating scale and/or verbal debriefings after each session. Feedback to date has been very favorable. After the first Polycom presentation, 20 of the 60 students rated the session as outstanding, 37 students as good, 2 students as fair, and 1 as poor. Students indicated they especially liked the interactive nature of the presentation while observing actual flight simulator activity. After the initial sessions, a few students criticized the uneven lighting in the simulator that was projected through the classroom projection system. In response, additional lighting was placed in the simulator prior to the next presentation. After the last Polycom session, 32 of the 61 students rated the overall presentation as excellent, 28 students rated it as good, and 1 student rated it as fair. No students scored it as poor or not worthwhile. Students suggested that instructors provide a written subject matter outline with each presentation, improve camera resolution for better focus, and slow down the flow of information in particularly complex areas. A majority of students suggested that more of this medium be included in future instruction.

In addition to student feedback, input was solicited from advanced airline flight simulator instructors regarding actual student performance following Polycom sessions on fuel system and APU operations. The survey instrument posed five questions regarding student performance, using a Likert rating scale. Simulator instructors reported that 81 percent of 68 enrolled students needed little or no help in operating the addressed systems and 19 percent needed some assistance. No students were observed to be unable to accomplish the subject systems' operations. Finally, the Polycom academic instructor team completed independent, written evaluations immediately following each Polycom presentation. These evaluations were reviewed to highlight improvement opportunities for future presentations.

Limitations of the Polycom Viewstation medium revealed to date include: minimal low light capability, an inability to quickly focus on new objects in the simulator, equipment expense, local area network connectivity, two instructor requirement, and ensuring concurrent simulator availability during the scheduled academic class period. Despite these limitations, students and instructors alike have enjoyed and benefited from the process. Evaluation of this medium is ongoing and seems to support findings by Caro (1988) that visually mediated learning systems can be highly effective, if discriminatory cues are provided in response to appropriate stimuli. Thomson (1989) notes that increased levels of feedback during flight simulator training sessions are associated with higher levels of training transfer. Future research with the Polycom system should reveal the impact of video teleconferencing on this aspect of flight training and suggest opportunities for aviation distance education.

CONCLUSION

The Polycom system provides an effective, flexible alternative to aspects of expensive flight simulation systems. The initial purchase and maintenance costs of this interactive medium are relatively small when compared with those of advanced flight simulation systems. Although the Polycom will not replace flight simulator aspects such as tactile-focused cognitive pre-training, it provides an effective supporting mechanism for the acquisition of visual cues and training reinforcement. The objective of this project was not formal research but rather to initially evaluate this technology. Subsequent investigation may reveal additional cognitive pre-training opportunities. Payne (1982) suggests that the transfer of training value of any cognitive pre-training system (such as the Polycom) hinges on many factors, including instructor consistency/ability, student level of understanding, and the particular task under evaluation. Future research into Polycom methodologies should carefully consider bias associated with these factors.

Students learn new material in different ways and those learning styles may change as students progress through college. Quilty (1996) suggests that instructors should employ a variety of instructional methods to address the wide variety of cognitive biases and learning styles present in the typical classroom. The Polycom system provides collegiate aviation programs with another method to enhance transfer of training. In addition, the Polycom system has potential applications for other laboratory environments, especially those where space or safety considerations limit the size of the participant student group. The authors believe that the Polycom or similar technology can be used to effectively bridge the training gap between the classroom and a flight simulator or training device. Such technology may be extremely useful in collegiate aviation's quest to meet the airline industry's need for sufficient numbers of high quality, professional pilots.

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