e-Learning: The Future of Pilot Safety Training

Introduction

The number of new pilot jobs is expected to grow at least 40% over the next decade and the volume of air traffic is expected to triple by 2025 (Federal Aviation Administration, 1993; Raisinghani, Chowdhury, Colquitt, & Reyes, 2005; Sams, 2006). In addition to new positions becoming available, the general pilot population is aging and the number of replacement pilots required to cover retirements are also significant (Raisinghani et al., 2005). This requires aviation psychologists to focus on ideal teaching practices and emerging instructional technologies to meet future instructional demands in the aviation industry.

Despite the need for crew resource management (CRM) that is economical and that can be widely distributed, computer-based CRM training has received minimal attention (Brannick, Prince, & Salas, 2005). A common perception in the industry is that CRM training is ill suited to computer-based learning (CBL) due to the team focus and the active practice requirement which is typically conducted in a flight simulator (B. Olah, personal communication, May 24, 2007).

A recent adaptation of CRM is single-pilot resource management (SRM) training. SRM adapts concepts from CRM to the single-pilot environment. Topics included in SRM include situation awareness, workload management, aeronautical decision making, and automation management. This training is gaining attention as single-pilot aircraft are undergoing a rapid increase in technological sophistication evidenced by technically advanced aircraft (TAA) and very light jets (VLJs) (Strait, 2006).

In SRM training, the team focus is eliminated and PC-based flight simulators can be embedded into the training as a method of active practice (Koonce & Bramble, 1998). E-learning offers several advantages for SRM including supporting tactile learners, geographic flexibility, and cost savings.

Ideally, instructional materials should support auditory, visual, and tactile learners. However, traditional non-technical instruction is delivered in a lecture format with visual aids. This training method best supports auditory and visual learners. The problem is that the majority of pilots, 44%, are tactile learners (Raisinghani et al., 2005). Delivering this content in an online environment would allow for the design of interactive materials that better support pilot learning.

Although no research evaluating a fully online and comprehensive CRM training course could be found, significant research has been performed on the use of inexpensive personal computer (PC) based simulations and games for crew training. Several PC-based flight simulation programs exist which are marketed for licensed pilots to refine their skills (Koonce & Bramble, 1998). In addition, several games are available that offer a variety of aircraft, the ability to fly out of virtually any airport, weather controls that reduce ceilings and visibility, and the capability to fail certain systems or instruments for practice purposes (Koonce & Bramble, 1998). Yet, with the option of purchasing yoke, throttle lever, and rudder pedals, these low-fidelity simulations become more than just a game (Koonce & Bramble, 1998). This reasonably priced alternative to high-fidelity

flight simulators could allow students to complete the practice component of CRM or SRM training from a PC.

Many organizations utilize high-fidelity simulators for CRM instruction and practice (Helmreich, Merritt, & Wilhelm, 1999). High-fidelity simulations are characterized by high scene detail and motion platforms. However, current investigations have shown no differences in training transfer between high- and low-fidelity simulations (Salas, Bowers, & Rhodenizer, 1998). Research suggests that low-fidelity simulation is effective as long as it simulates the cognitive processes required in the real world, termed psychological fidelity (Bowers & Jentsch, 2001). This has lead to the conclusion that high-fidelity is not a requirement for effective training and transfer (Baker, Prince, Shrestha, Oser, & Salas, 1993; Koonce & Bramble, 1998; Salas et al., 1998). Following, Jentsch and Bowers (1998) conclude that aviators find low-fidelity simulations realistic and acceptable for CRM training.

Brannick and colleagues (2005) conducted an investigation into the transfer of training of pilot assertiveness taught with a PC-based simulator. Brannick et al. (2005) found positive quasi-transfer from a PC-based simulator to a high-fidelity simulator, providing strong evidence that inexpensive simulators can effectively teach CRM skills (Brannick et al., 2005).

Guided Mental Practice

Brannick and colleagues (2005) investigation suggests that CRM training could be delivered via computer through training incorporating low-fidelity flight simulation and yoke, rudder, and throttle peripherals. However, bulky and expensive peripherals limit online distribution of CRM training. The present investigation assessed two practice options in a situation awareness training program: (a) practice in a computer-based flight simulator utilizing yoke, throttle, and rudder pedals, and (b) guided mental practice (GMP) where the learner watched a video of a flight simulator scenario and imagined themselves as the pilot.

Wiley and Voss (1999) determined the practice exercise does not matter, it is the mental process it facilitates that results in enhanced learning. "Humans have the ability to generate mental correlates of perceptual and motor events without any triggering external stimulus, a function known as imagery" (Jackson, Lafleur, Malouin, Richards, & Doyon, 2001, p. 1133). Research has determined that this imagery, or mental practice, is a powerful instructional tool for improving performance on both cognitive and psychomotor skills (Driskill, Copper, & Moran, 1994).

GMP describes practice that takes place without any hands-on interaction yet is facilitated by a computer-based flight simulator scenario embedded within an asynchronous training program. Within GMP, participants are asked to view a video of a flight simulator in a scenario and imagine themselves as the pilot of the flight. GMP differs from traditional mental practice, which is typically an entirely internal imagery process, as an external medium guides the learner through the practice exercise. Utilizing GMP in a computer-based SRM or CRM training program would allow the training to be offered without any external peripherals.

This would allow pilots to complete the training from any computer at a time that is convenient. This dramatically reduces the cost of delivering training, improves accessibility, and automates performance tracking.

Method

To assess the feasibility of computer-based SRM training thirty six licensed pilots were recruited. The pilots were separated into three equal groups: (a) computer-based training incorporating hands-on practice with a yoke, throttle, and rudder pedals, (b) computer-based training incorporating guided mental practice, and (c) a control group that did not complete any training. Following, all participants completed a performance evaluation in a high-fidelity flight simulator in which the situation awareness global assessment technique (SAGAT) was administered (Endsley, 2000). The SAGAT required the pilot to fly a predetermined flight plan within the high-fidelity flight simulator. During the flight a researcher paused the simulation at random intervals, the pilot was asked to turn away from the control panel, and queries about the status of the flight were asked.

Results

The sample included a total of 36 individuals. Each of the three defined groups (hands-on training, guided mental practice training and control group) had 12 individuals. There were a total of 32 males (88.9%) and 4 females (11.1%).

Performances of individuals in the sample were measured using the situation awareness global assessment technique (SAGAT). Based on a univariate analysis, there were significant differences across groups at the 0.05 level ($p = 0.001$). In order to assess the nature of the group differences, a post hoc Least Significant Difference procedure was performed. This procedure allowed performing multiple pairwise comparisons in order to determine which groups had significantly higher or lower scores than others.

For the SAGAT variable, it was found that the control group had lower scores than the mental practice ($p = 0.001$) and hands-on practice ($p = 0.003$) groups. However, no significant differences were found between the mental and hands-on groups ($p = 0.665$).

Conclusions

The results of this study indicated that computer-based training, incorporating either hands-on or GMP, improved pilot situation awareness.

Recommendations

The results of this investigation suggest that guided mental practice (GMP) is a promising instructional strategy that allows for the online delivery of SRM training. Utilizing GMP, training programs can be developed that require no peripheral devices and can therefore be completed at any personal computer. GMP may also allow for asynchronous computer-based CRM training, although additional work is required to develop and assess team training methods in a computer-based learning environment.

References

Baker, D., Prince, C., Shrestha, L., Oser, R., & Salas, E. (1993). Aviation computer games for crew resource management training. *The International Journal of Aviation Psychology, 3*(2), 143-156.

Bowers, C. A., & Jentsch, F. (2001). Use of commercial, off-the-shelf, simulations for team research. In E. Salas (Ed.), *Advances in human performance* (pp. 293-317). Amsterdam, NL: Elsevier Science.

Brannick, M. T., Prince, C., & Salas, E. (2005). Can PC-based systems enhance teamwork in the cockpit? *The International Journal of Aviation Psychology, 15*(2), 173-187.

Driskill, J. E., Copper, C., & Moran, A. (1994). Does mental practice enhance performance? *Journal of Applied Psychology, 79*(4), 481-492.

Federal Aviation Administration. (1993). *Pilots and aviation maintenance technicians for the twenty-first century: An assessment of availability and quality.* Washington, DC: U.S. Department of Transportation.

Helmreich, R. L., Merritt, A. C., & Wilhelm, J. A. (1999). The evolution of crew resource management training in commercial aviation. *The International Journal of Aviation Psychology, 9*(1), 19-32.

Jackson, P. L., Lafleur, M. F., Malouin, F., Richards, C., & Doyon, J. (2001). Potential role of mental practice using motor imagery in neurologic rehabilitation*. Archives of Physical Medical Rehabilitation, 82,* 1133-1141.

Jentsch, F., & Bowers, C. A. (1998). Evidence for the validity of PC-based simulations in studying aircrew coordination. *The International Journal of Aviation Psychology, 8*(3), 243-260.

Koonce, J. M., & Bramble Jr., W. J. (1998). Personal computer-based flight training devices. *The International Journal of Aviation Psychology, 8*(3), 277-292.

Raisinghani, M. S., Chowdhury, M., Colquitt, C., & Reyes, P. M. (2005). Distance education in the business aviation industry: Issues and opportunities. *International Journal of Distance Education Technologies, 3*(1), 20-43.

Salas, E., Bowers, C. A., & Rhodenizer, L. (1998). It is not how much you have but how you use it: Toward a rational use of simulation to support aviation training. *The International Journal of Aviation Psychology, 8*(3), 197-208.

Sams, D. (2006, July 23). *Training schools see increase in students as pilots still in demand*. Gwinnett Daily Post. Retrieved on August 30, 2006 from http://www.aviationschoolsonline.com/news.php.

Strait, B. (2006). *Welcome to very light jet magazine*. Very Light Jet Magazine. Retrieved February 13, 2007 from http://www.verylightjetmagazine.com/editorial.html.

Wiley, J. & Voss, J. F. (1999). Constructing arguments from multiple sources: Tasks that promote understanding and not just memory for text. *Journal of Educational Psychology, 91*(2), 301-311.

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