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A Proposal to Reduce Unsafe Aviation Maintenance Task Handovers with a Virtual Training Solution

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Abstract

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Safety researchers have documented maintenance errors happen when outgoing crews inadequately communicate to incoming crews at task/shift handover. Poor task handovers are especially likely for low-frequency problems, when complacency is present, or with new technicians. Highly experienced maintenance personnel may have prevented the poor handover. Backup safety procedures catch most errors, but correcting the remaining increases risks to safety, such as those not caught until after the plane is rolled out of the hanger. The cumulative effect of handover errors increases the exposure to additional threats and errors during reworks and replacement of aircraft on the line among others. This poster introduces a virtual training solution adapted to reduce aviation maintenance handover errors. The solution pairs experienced personnel with less experienced personnel. It also increases virtual handover frequency for infrequent problems so that less experienced personnel are prepared to make successful handovers even for problems they have never experienced on the job.

Introduction

The efficiency and efficacy of aviation maintenance are critical to the safety of air operations. With the current safety record as a backdrop, the aviation community is focusing on reducing the risks of injury and damage. Example methods employed that have aided in the current climate of safety are procedures and practices that capture and correct errors before they can lead to an accident. Even when no injury results exposure to additional threats and errors can increase. In any domain where two or more people work sequentially on tasks, there is a challenge of properly informing those who will take over the task concerning the state of the operation (Parke, Hobbs, & Kanki, 2011; Parke & Kanki, 2008). Although some tasks may be routine, there are non-routine cases when the next shift arrives or the task is at a point to be transferred to the next maintainer and requires an explanation to those receiving the task.

An instance where this was particularly apparent was the cause of the crash of an Embraer 120 that suffered a structural breakup in flight and crashed near Eagle Lake, Texas (NTSB, 1992). During the investigation, it was found that a second shift mechanic removed screws from the tops of both the left and right horizontal stabilizer leading edge assemblies. This was done in the course of removal and replacement of the deicing boots. Several factors interfered with the third shift fully completing the maintenance on the deicing boots. However, a critical issue was a lack of communication concerning the removal of the screws from the tops of both the left and right boots. The Embraer 120 is a T-tail aircraft with the top of the horizontal stabilizer not being visible from the ground. Without complete information on the state of the aircraft, the right boot was removed and a new boot bonded and secured. However, the aircraft was placed into service without the top screws.

Given the complexities of the aviation maintenance environment with numerous complex tasks, it is an ongoing challenge to avoid such oversights (Loukopoulos, Dismukes, & Barshi, 2009). Maintenance teams are faced with communication challenges throughout the shift, particularly during task handovers. Even with robust procedures and substantial levels of training, opportunities for shift handover errors are ever-present. The required communication skills present unique challenges for novice members of maintenance teams, thus opening opportunities for the application of virtual training methodologies (Shebilske, Gildea, Freeman, & Levchuk, 2009; Shebilske, Goettl, Jordan, & Day, 1999).

Proposed Training Solution

Aviation maintenance environments place demands on team members to engage in frequent, proactive exchanges of potentially complex information (Jiang, Master, Kelkar, & Gramopadhye, 2002). The time pressure and complexity increase the criticality of selecting what information to convey, when, to whom, and in what format. Training communication skills for such time-compressed environments is complicated by the time compression itself. One of the most effective ways to teach communication skills is through demonstration, role playing, and timely, corrective feedback. A virtual training approach is proposed that provides the opportunity for experienced developers to model effective communications, guide newer employees, and provide feedback. The training environment is designed to provide opportunities to practice identifying critical information, determining who needs the information, selecting the appropriate time to push or pull the information, and using various information transfer methods. This training approach supports cataloging lessons learned for use in future training scenarios.

Previous research conducted with military teams in time-pressured, complex, operational environments indicates that team training in virtual environments can yield significant gains in performance (Gildea, Schneider, & Shebilske, 2007; Shebilske, Gildea, Ieoger, Volz, & Yen, 2005). Similar results have been found with training for aviation maintenance teams (Kraus & Gramopadhye, 2001). Specifically, this past research has supported the concepts embodied in observational learning and the benefits of modeling skills by experts (Shebilske, Jordan, Goettl, & Paulus, 1998) combined with practice followed by feedback (Shebilske, Gildea, Freeman, &

Levchuk, 2009). The strengths of distributed training in virtual environments include: (1) the ability for geographically separated individuals to practice in concert, (2) an environment conducive to exploring the problem space with the latitude to learn from errors, (3) the capability of presenting critical incidents and lessons learned in a shorter amount of time than required to naturally experience such situations in the real world, and (4) the opportunity to practice in a virtual context that is representative of the work environment, thus supporting transfer of training.

The proposed virtual training environment is based on the Neverwinter Nights™ gaming engine, which has been used by a number of organizations for training development and delivery. The version that will be modified for this effort has been developed by the Culture and Cognition Lab at Wright State University to support multicultural training for teams. This platform supports the capture and analysis of expert behaviors conveyed during the training. This information can lead to a systemization of the knowledge for implementation in future iterations of the training. This effectively leads to the training suite serving as a research vehicle to enhance understanding of team interactions.

The authors have previously adapted virtual training environments to train teamwork skills for time-critical asset allocation and multinational team training (Shebilske, Levchuk, Freeman, & Gildea, 2010). These training environments provide the foundation for a means to expose maintenance teams to virtual training for communication or operational interactions. Based on prior experience analyzing new domains, defining requirements, and developing the training system, the authors will extend the extant training environment to maintenance teams.

Operational Benefits

As in the brief example of engine failures, in general, noticing and correcting errors earlier results in less exposure to risk for the passengers, crew, and associated personnel. If a maintenance team effectively manages a handover verbally with supporting written turnover sheets, the risks are reduced. Any errors in the handover can potentially lead to rapidly escalating threats as the time progresses before the error is noticed and corrected. The progression through installation, close up, signoff, returning to the line, etc. at each succeeding step adds additional complexities and time to rectify the error.

Although there are numerous tasks that could benefit from the implementation of such a training approach, we focus on the critical boundaries between team members where information flow is often informal and perhaps semistructured. Those who have been on maintenance teams for extended periods tend to build an understanding of what information is required and at what time by others on the team. When communication is effective delays and costs decrease. Such problems are more likely to occur while training and integrating junior mechanics into work flows. Managers could increase safety and shorten delivery times by more effectively transferring the schemas and complex skill sets to new employees.

By providing a training countermeasure that allows mechanics to practice handovers, with the presentation of lessons learned and interaction with highly experienced mechanics, the probabilities of ineffective handovers should be reduced, which will improve safety and lower costs. A collaborative, virtual training tool will provide the framework and vehicle for training delivery and for cataloging lessons learned to further improve ongoing training.

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