Evaluation of In-flight Alertness Management Technology

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An objective approach for detecting the presence of drowsiness and fatigue on the flight deck was demonstrated in a full-mission simulation. Long, uneventful flights in modern aircraft are characterized by extensive monitoring due to high levels of aircraft system automation, physical inactivity, a requirement to remain vigilant for low-frequency occurrences, dim light levels, steady background noise, reduced social and cognitive interaction, and limited environmental manipulations. Together these factors create a context in which underlying sleepiness is likely to manifest itself in the form of compromised vigilance, reduced alertness, and impaired performance. Flying at night while fatigued is further complicated by the fact that individuals are poor at judging their own level of sleepiness, often reporting high levels of alertness even though physiological measures may suggest extreme sleepiness

A controlled cockpit simulator study was conducted to evaluate the feasibility and utility of an on-line, human-centered, objective monitoring technology for tracking alertness-drowsiness and to evaluate the effectiveness of fatigue-related feedback on the alertness, neurobehavioral performance and behavior of flight crews during a simulated, long haul, nighttime flight. The alertness-drowsiness monitoring technology used is based on the PERCLOS metric; the proportion of time subjects exhibit slow eye closures. This has been validated in the laboratory as being highly accurate in detecting drowsiness-induced performance lapses. In the past, however, eye closures have been scored subjectively by a human rater. In this study, we used a fully-automated, video-based system using infrared retinal reflectance to measure PERCLOS objectively. The automated PERCLOS system was developed by the Carnegie Mellon Research Institute and is shown in Figure 1. In addition, the effects of feedback on subsequent alertness, neurobehavioral performance, and behavior were evaluated. Thus, this study represented the first demonstration of the potential usefulness of an on-line, human-centered, objective monitoring technology capable of detecting reduced vigilance (hypovigilance) and providing feedback on the flight deck.

Twelve two-man crews consisting of 28 healthy male adults familiar with glass cockpits, flew 6-hr, uneventful, nighttime flights in the Ames 747-400 FAA-certified, Level D flight simulator. Each flight was divided into four counterbalanced segments. In half of these segments, PERCLOS feedback was available on an LED gauge by indicator lights that illuminated as eye closure durations increased or by a human voice message. The first generation PERCLOS system implemented in the study consisted of online, computer analysis of video images of the subject's eyes using small cameras with infrared illumination sources mounted on the flight deck. (Figure 2). Measures of psychomotor vigilance performance, subjective sleepiness, continuous brain wave activity (electroencephalography; EEG), and continuous eye movement activity (electrooculography; EOG) were collected throughout the flight.

A PERCLOS-based alertness monitoring technology on the flight deck has potential as an on-line non-invasive alertness system for pilots who may encounter challenges in high homeostatic drive and circadian rhythm disruption. An on-line, human-centered, objective monitoring technology may be used as a backup for flight crew operations who have integrated in-flight napping or activity break policies in their standard operating procedures. This type of technology can also potentially be implemented in environments that only have less than 3 crew members during flight operations.