"Potential for Modeling Tools"

STEVEN R. HURSH, PH.D.

Institutes for Behavior Resources, Inc.

June 18, 2008: Joint Session

Abstract
An essential requirement for potential fatigue risk management systems is a technology for assessing and forecasting fatigue risk. To be practical in the near term, the technology must rely on information that is readily available within the operational setting. To be useful, the technology must be shown to be a valid predictor of performance and operational risk. To be adaptable, the technology must be able to respond to new information about the environment and the states and traits of individuals.

In the absence of a direct physiological marker of fatigue, the extensive body of evidence describing the physiology of sleep and circadian timing as it relates to human performance provides a rich foundation for biomathematical models of fatigue. Computer simulations or models of fatigue have the potential to describe the relationships between sleep, time of day, and human capabilities. Properly conceived, these models can predict with surprising accuracy the tendencies of the average person and the potential for performance degradation and attention lapses. Combined with a valid model of how work and rest schedules lead to limitations of sleep quantity and quality, such models can be used to predict changes in operator performance under dynamically changing schedules. Recent evidence has shown that such models can predict increases in accident risk and severity.

Current models provide a useful foundation for schedule design and assessment and for actuarial risk prediction. However, current models have limited ability to predict the performance of specific individuals and fall short as tools for guiding systems in real-time. Current research is focused on addressing this limitation by improving our ability to track the state of individuals across time and to more accurately represent enduring trait differences across individuals. First, research is underway to integrate monitoring technologies to provide continuous updates of several key state variables: actual sleep obtained and actual physiological circadian phase. Second, research is underway to periodically assess performance as a way to refine model parameters that reflect key trait differences in sensitivity to sleep restriction and in the properties of the endogenous circadian rhythm.

Main Points

- Effective fatigue risk management hinges on our ability to assess and forecast fatigue. In the absence of a physiological marker of fatigue, computer simulations or models can be used to describe the relationships between sleep, time of day, human capabilities, and operational risk.
- Current models of fatigue in combination with valid models of how work/rest schedules limit expected levels of sleep can provide surprisingly

accurate predictions of the tendencies of the average person and the risk of performance failure. Properly conceived, models of the average person can predict increases in accident risk and severity.

- Current models have limited ability to predict the performance of specific individuals. Current research is focused on technologies to better track the state of individuals across time and to more specifically reflect trait differences between individuals in sensitivity to sleep restriction and circadian variation.

A copy of Dr. Steven R. Hursh's biographical information and presentation slides are provided in Appendix B.