Assessment of high risk operator functional state markers in dynamic systems – preliminary results and implications

Peter Nickel, Adam C. Roberts, & G. Robert J. Hockey
Department of Psychology,
The University of Sheffield,UK

Abstract

In complex tasks, top-level task goals are typically protected by increased investment of operator effort, though decrements may occur with continued effort. However, increasing strain means that, for a period before manifest breakdown occurs, operational risk may be increased. The goal of this research is to identify markers of this developing state and switch control to computer support, using strategies of adaptive automation. A complex decision making and simulated process control task was used, with a new dynamic loading method to force breakdown through stepwise changes in task load. As the basis for person-referenced baselines for interpreting risk patterns, student operators provided data on performance and psychophysiological markers of risk (HRV, and two EEG power ratios) under a range of load conditions. The data show clear changes primarily for the EEG task load index (frontal theta/parietal alpha), which increased with lower levels of load even before control errors were made. The findings are discussed within the context of using state markers in a closed loop system for adaptive automation and their practicability for applied settings.

Introduction

There is an ongoing discussion, at least in the human factors and ergonomics community, about the most appropriate ways to use human operators in safety critical and highly complex work systems; notably transportation (railways, aviation, shipping) and process industries (chemical, pharmaceutical, power plants). Though one best way of function allocation between human and machine is assumed to be dynamic (Sheridan, 2000; Singleton, 1974), relevant criteria still remain unclear for decisions about when or what to adapt, how to infer, and who should decide (Wickens & Hollands, 2000), as well as for establishing reliable and valid predictors for these criteria. Recent efforts in promoting an assessment of the operator functional state aim at prevention of manifest human-machine system performance breakdown in complex tasks (HFM, 2004; Hockey et al., 2003). This concept focuses on detection and prediction of degradation of operator performance capacity in complex tasks. It is assumed that the detection of the development of vulnerable (high risk) operational states (where operators are still able to manage predictable

In D. de Waard, K.A. Brookhuis, and A. Toffetti (Eds.) (2006), *Developments in Human Factors in Transportation, Design, and Evaluation* (pp. 271 - 284). Maastricht, the Netherlands: Shaker Publishing.