Announcing the Final Examination of Jonathan Harris for the degree of Doctor of Philosophy

Time & Location: April 7, 2017 at 9:30 AM in Engineering II 312
Title: Investigating the Impact of Levels of Experience on Workload During Nuclear Power Plant Operations

The human-machine interface (HMI) of a Nuclear Power Plant (NPP) Main Control Room (MCR) is complex. Understanding HMI factors that influence Reactor Operator (RO) performance and mental workload when controlling an NPP is important. The Nuclear Regulatory Commission began a program of research known as the Human Performance Test Facility (HPTF) with the goal of collecting human performance data to better understand cognitive and physical elements that support safe control room operation (Hughes, D’Agostino, & Reinerman-Jones, 2017). The HPTF team developed an experimental methodology to evaluate mental workload using perceived ratings, performance measures, and physiological correlates. This methodology focuses on tasks commonly performed during operations in an NPP. These tasks include monitoring plant parameters, following defined procedures, and manipulating controls to change the state of the NPP. O’Hara and colleagues developed a framework for task classification (O’Hara & Higgins, 2010). Reinerman-Jones and colleagues modified this framework such that monitoring and detection are separate task types (Reinerman-Jones, Guznov, Mercado, & D’Agostino, 2013). The task types (i.e., checking, detection, and response implementation) selected for experimentation are composed of steps within defined operating procedures that are rule-based.

Testing workload using sufficient numbers of ROs is impractical due to limited availability (Leis, Reinerman-Jones, Mercado, Barber, & Sollins, 2014). The HPTF has developed the “different but equal” principal. This principal attempts to simplify complex tasks, such that novices can perform them and experience equivalent workload trends as an expert would when performing the original task. The validity of using the “different but equal” principal with novices in place of experts is uncertain. This research addresses this uncertainty by comparing novices and experts using the “different but equal” principal. Novices performed four tasks within each of the three task types using a simplified Instrument and Control (I&C) panel and a reduced 3-way communication instruction set. Experts performed the same four tasks within each task type with a fully configured I&C panel and a complete 3-way instruction set. Overall, the experts across the three task types tended to rate level of perceived workload lower than novices. However, experts also rated themselves as performing worse for the three task types than novices. Experts performed better than novices when it came to identifying correct I&C; however, their 3-way communication performance was worse. Physiological measures from EEG between the two groups were not statistically different. ECG findings did show a slight difference.

The methodology and associated findings has applicability for MCR designs and regulation recommendations. Novice populations are easier to access than experts and the present research shows that when properly designed, novices can serve in complex operator positions.

Major: Industrial Engineering

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Approved for distribution by Lauren Reinerman-Jones, Committee Chair, on March 20, 2017.
The public is welcome to attend.