In human-computer systems, such as supervisory control systems, large volumes of incoming and complex information can degrade overall system performance. Strategically integrating automation to offload tasks from the operator has been shown to increase not only human performance but also operator efficiency and safety. However, increased automation allows for increased task complexity, which can lead to high cognitive workload and degradation of situational awareness. Adaptive automation is one potential solution to resolve these issues, while maintaining the benefits of traditional automation. Adaptive automation occurs dynamically, with the quantity of automated tasks changing in real-time to meet performance or workload goals. While numerous studies evaluate the relative performance of manual and adaptive systems, little attention has focused on the implications of selecting particular invoking or revoking strategies for adaptive automation. Thus, evaluations of adaptive systems tend to focus on the relative performance among multiple systems rather than the relative performance within a system.

This study takes an intra-system approach specifically evaluating the relationship between cognitive workload and situational awareness that occurs when selecting a particular invoking-revoking strategy for an adaptive system. The case scenario is a human supervisory control situation that involves a system operator who receives and interprets intelligence outputs from multiple unmanned assets, and then identifies and reports potential threats and changes in the environment. In order to investigate this relationship between workload and situational awareness, discrete event simulation (DES) is used. DES is a standard technique in the analysis of systems, and the advantage of using DES to explore this relationship is that it can represent a human-computer system as the state of the system evolves over time. Furthermore, and most importantly, a well-designed DES model can represent the human operators, the tasks to be performed, and the cognitive demands placed on the operators. In addition to evaluating the cognitive workload to situational awareness tradeoff, this research demonstrates that DES can quite effectively model and predict human cognitive workload, specifically for system evaluation.

This research finds that the predicted workload of the DES models highly correlates with well-established subjective measures and is more predictive of cognitive workload than numerous physiological measures. This research then uses the validated DES models to explore and predict the cognitive workload impacts of adaptive automation through various invoking and revoking strategies. The study provides insights into the workload-situational awareness tradeoffs that occur when selecting particular invoking and revoking strategies. First, in order to establish an appropriate target workload range, it is necessary to account for both performance goals and the portion of the workload-performance curve for the task in question. Second, establishing an invoking threshold may require a trade-off between workload and situational awareness, which is influenced by the task's location on the workload-situational awareness continuum. Finally, this study finds that revoking strategies differ in their ability to achieve workload and situational awareness goals. For the case scenario examined, revoking strategies based on duration are best suited to improve workload, while revoking strategies based on revoking thresholds are better for maintaining situational awareness.

Major: Industrial Engineering

Educational Career:
Bachelor’s of Economics-Government, BS, 2004, Claremont McKenna College
Master's of Industrial Engineering, MS, 2011, University of Central Florida

Committee in Charge:
Dr. Christopher D. Geiger, Chair, IEMS
Dr. Waldemar Karwowski, IEMS
Dr. Petros Xanthopoulos, IEMS
Dr. Lauren Reinerman-Jones, IST

Approved for distribution by Dr. Christopher D. Geiger, Committee Chair, on May 28, 2013.

The public is welcome to attend.