Biocybernetic Closed-Loop System for Mitigating Hazardous States of Awareness

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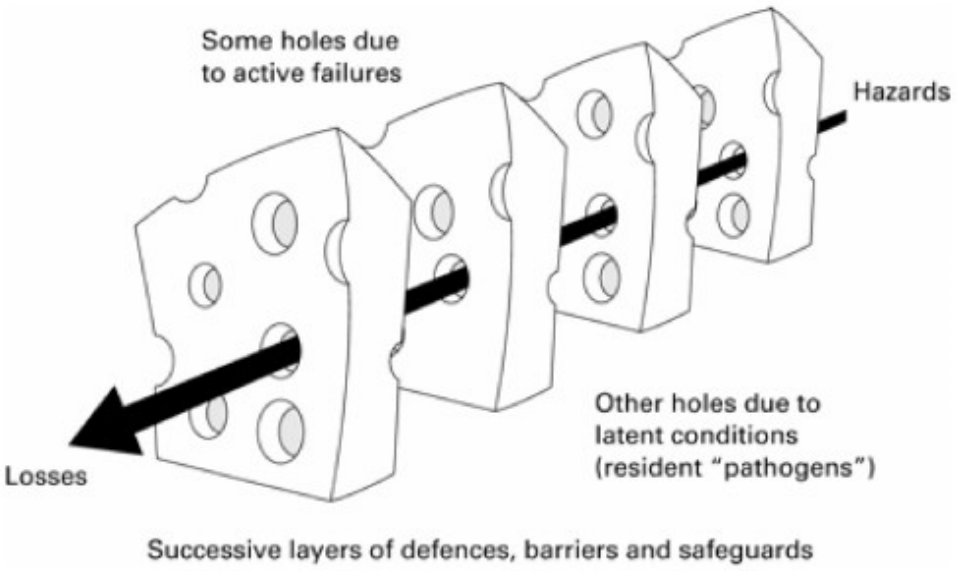
Human Error in Aviation Incidents and Accidents

- A primary goal of NASA's Aeronautics research focus is to improve the National Airspace System which already has an exceptionally high level of safety.
- ≈70% of incidents and accidents are attributed to human error

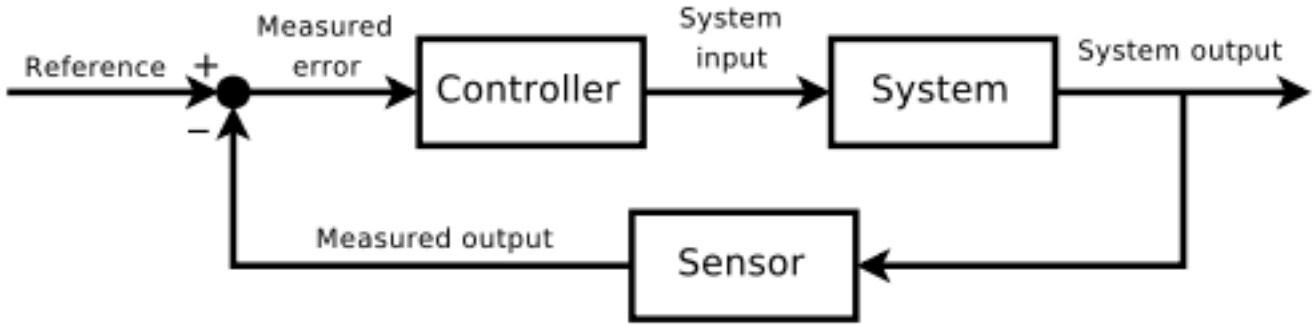


Use of Automation in Aviation and Hazardous States of Awareness

- plays a significant role in the cockpit
  - enables humans to perform beyond normal abilities (longer shifts, improved control, etc.)
- can lead to suboptimal psychological states
  - complacency
  - boredom
  - diminished alertness
  - compromised vigilance
  - lapsing attention
  - preoccupation
  - absorption

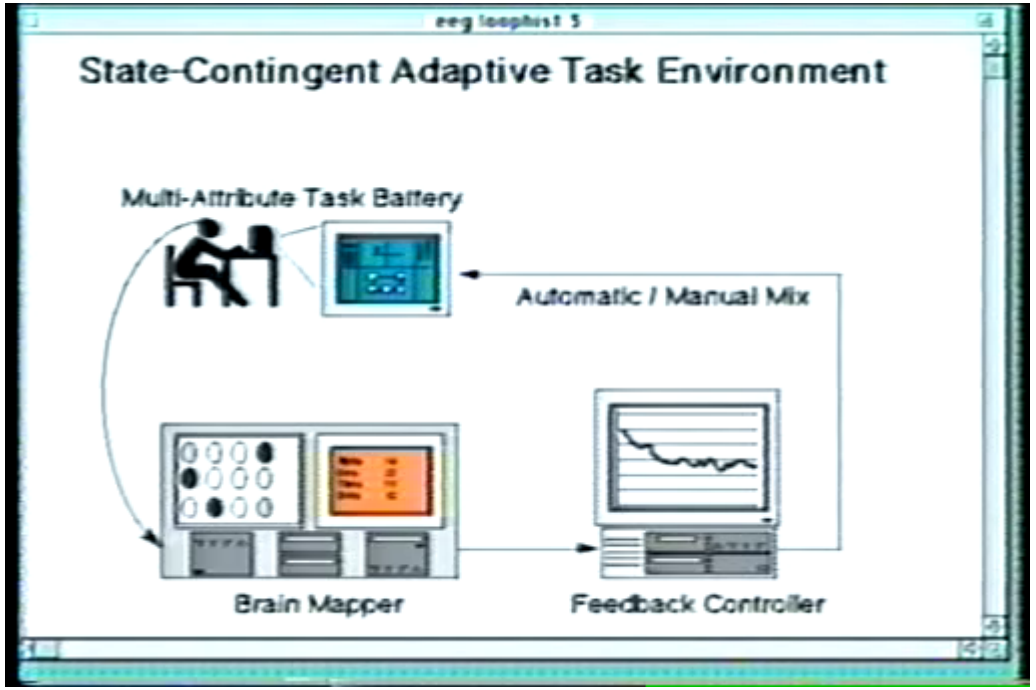
Adaptive Automation (AA)

- Adaptive Automation may be a better solution by “closing the loop”
  - allows for preventing hazardous states of awareness: disengagement, overload
  - capable of incorporating subjective and objective measures of operator state to configure automation and interface features



Psychophysiologically Adaptive Systems (PAS)

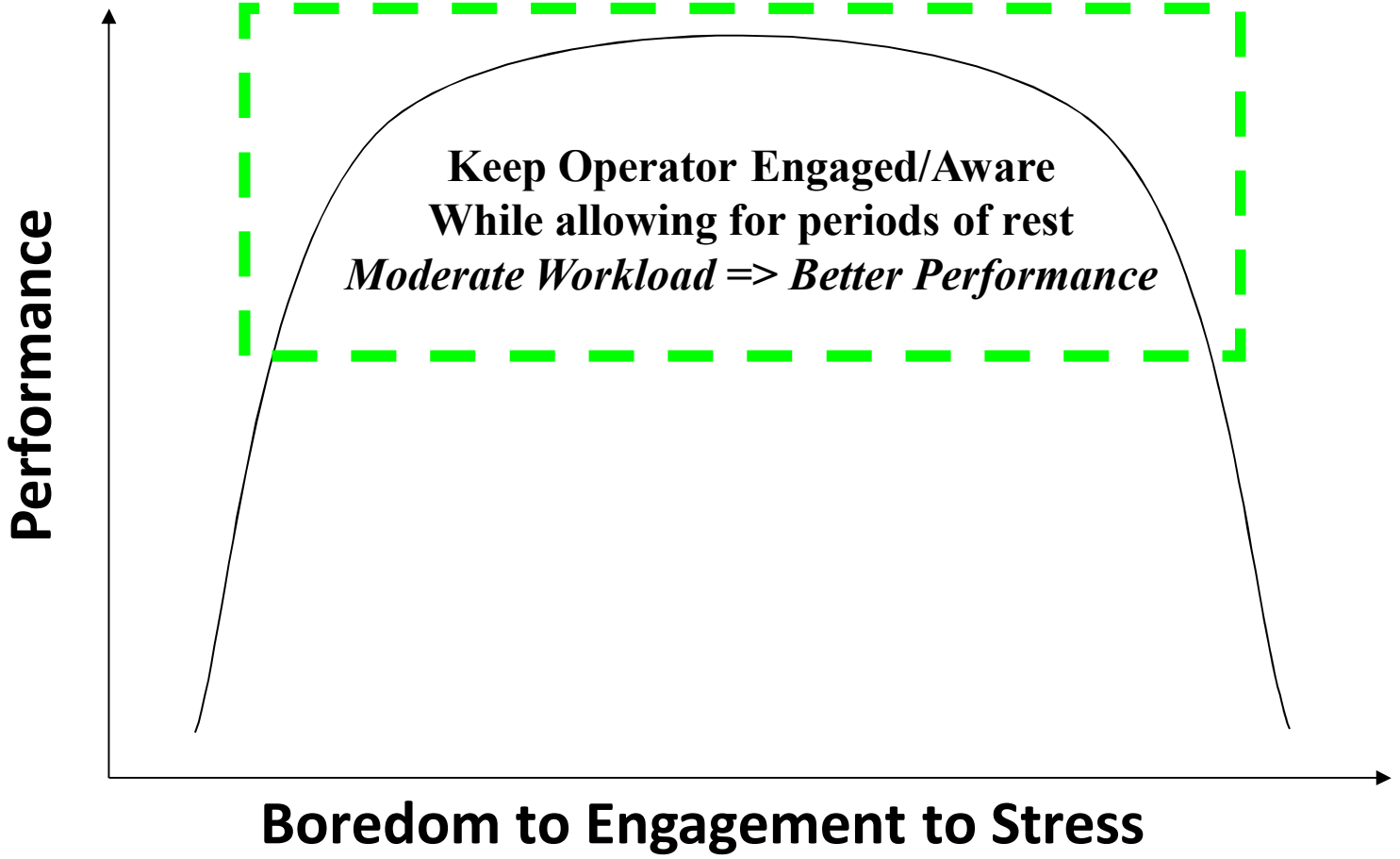
- Adaptive Automation as a Special Case of a Closed-Loop System



Pope et al. (1995)

Future Directions

- Psychophysiologically adaptive automation: a means for maintaining effective operator state

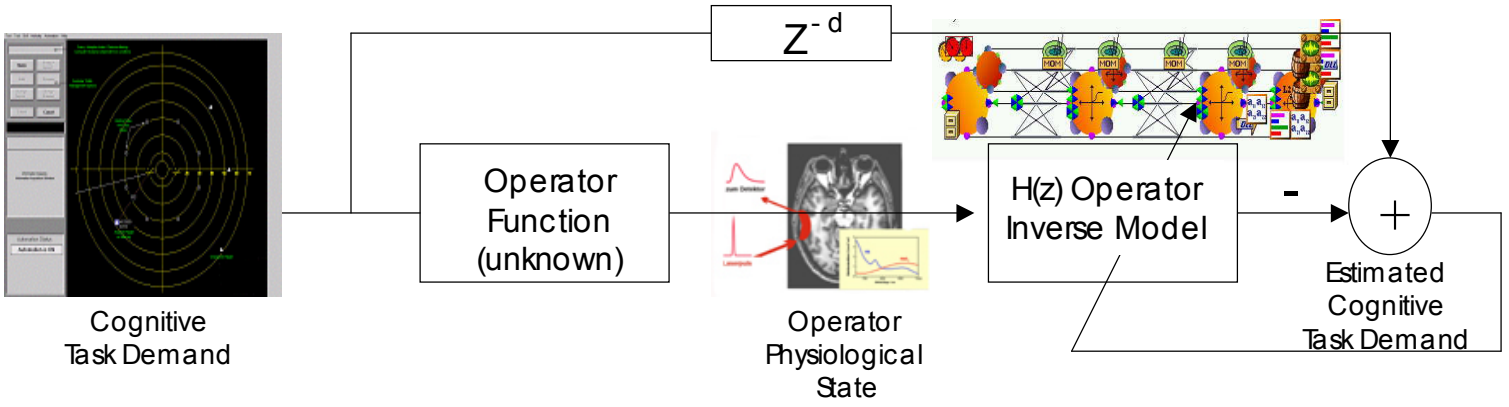


Future Directions

- Empirical evidence demonstrates voluntary control psychophysiological responses previously considered involuntary. (deCharms, et al., 2005; Vernon, et al., 2003)
- Further investigation and modeling of factors affecting the fluidity of that relationship is needed.
- Self-regulation ability be utilized to optimize overall human-machine system effectiveness.
- Instrument Functionality Feedback (IFF) Training (Palsson & Pope, 1999)

Application of Neural Networks to Adaptive Automation

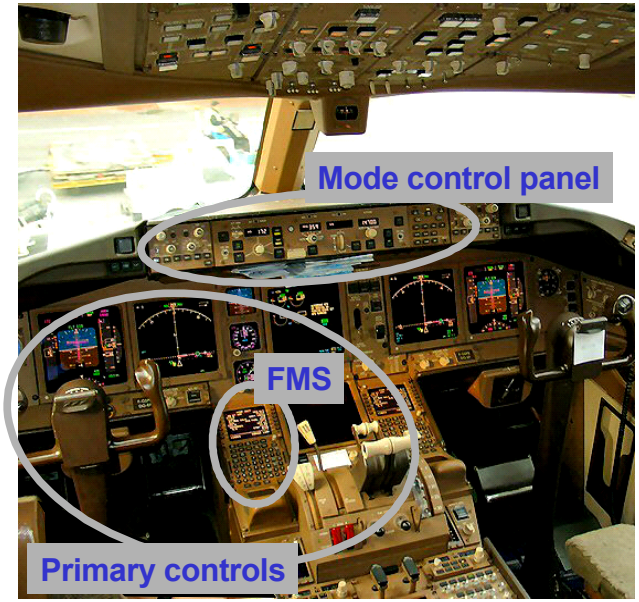
- One proposal for cognitive augmentation through adaptive aiding for air traffic control employs involves a method of inverse modeling using artificial neural networks to update the PAS from previous work. (Pope, et al.)



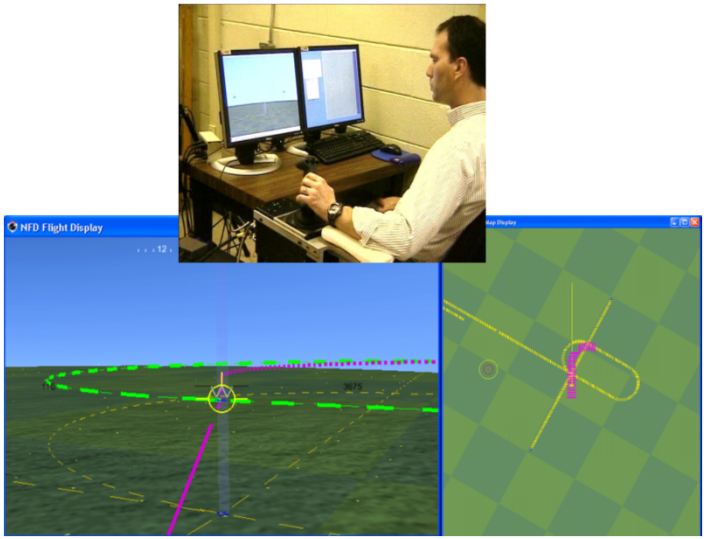
The Naturalistic Flight Deck

- Enables Increased Situational Awareness
  - Flemish, et al., 2003; Schutte, et al., 2007

Current state of the art:
Separate interface for
each automation level
Three ways to move the aircraft



H-inspired:
Single interface allows efficient
management of all levels
One way to move the aircraft



Conclusion

- Ongoing research includes investigations of operator/automation interaction in updated version of the NASA MATB.
- Validation of candidate psychophysiological indices of operator state
  - EEG-based Engagement Indices
  - Autonomic Workload Indices
  - Effects of Individual Differences
  - Application of Neural Networks

To appear in:

- Desmond, P., Matthews, G., & Hancock, P. (Eds.). (in press). Handbook of Operator Fatigue. Hants, UK: Ashgate Publishing.