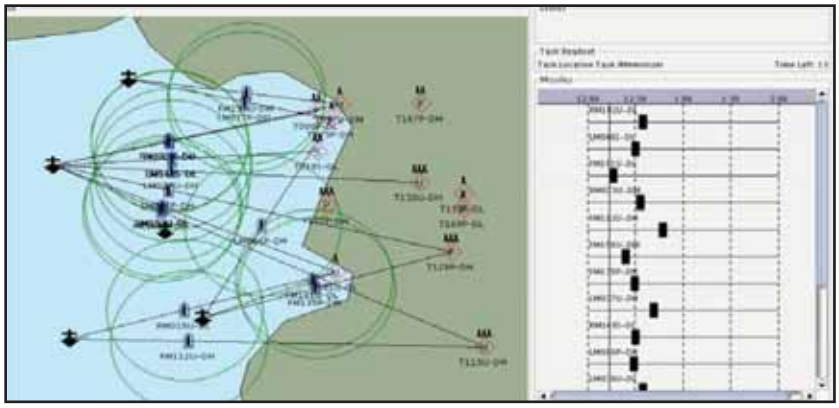
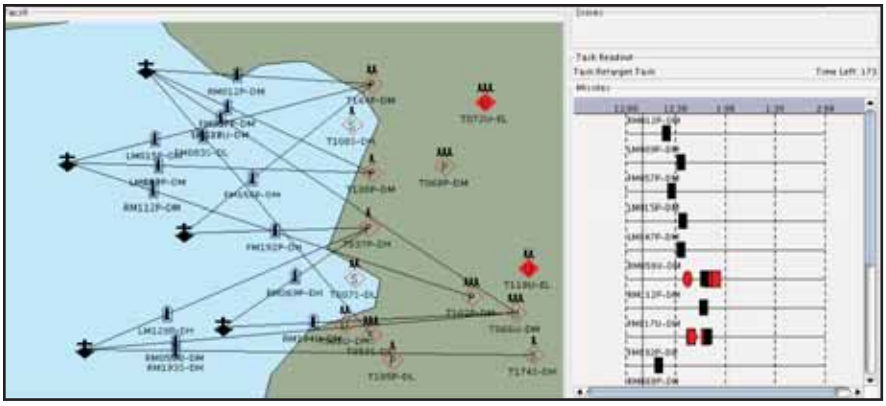
HCI Assessment of Spatial and Verbal Working Memory Management

Working memory overload is one of the key contributors to operator errors during complex tasks. Recent investigations suggest that working memory capacity can be enhanced by utilizing verbal, spatial or alternative sensory modalities in a complimentary manner. Monitoring working memory load and delineating the verbal and spatial components would greatly enhance the speed and efficiency of the human-system interaction. In this investigation EEG data were first acquired while participants performed three simple working memory tasks. The auditory recognition task required a participant response as to whether a spoken Missile ID matched one of the previously presented missile ID sets. During mental addition, a series of sequentially presented numbers were supposed to be mentally tallied until prompted to report the total. In the "spatial-task", participants were briefly presented a grid containing from three to five missiles. After 40 seconds, the grid reappeared and participants had approximately four seconds to identify the locations of missing missiles.

Two scenarios were developed to assess complex working memory demands. The "location" task was separated into three parts: encoding, rehearsal, and recall. During the encoding period, participants were given 15-seconds to relate targets with available missiles within the coverage zone. For the 45-second rehearsal period, participants were able to continue memorizing the target-missile relationships with the coverage zone circles removed. During the recall period, participants needed to identify targets which were not within missile coverage zones.





For the "Retarget" task, participants were provided 10 minutes to reallocate missile coverage to as many emergent targets as possible, while maintaining coverage on as many high and medium default targets as possible. The Task Readout, to the right of the missile-target map, provided information to the participant helpful in determining a retargeting strategy. This information included the amount of time from missile-target intercept and closest missile to emergent target.

To optimally discriminate verbal-spatial working memory, algorithms were fitted to each individual based on information obtained during two short baseline conditions (i.e., missile ID for the verbal and missile location for the spatial workload). When these algorithms were applied to the complex "spatial" working memory tasks, the mean percentage of epochs correctly classified as spatial workload with was 88% during encoding, 76% during rehearsal and 65% during recall. During the complex "verbal" task the mean percentage of epochs correctly classified was 76% during encoding and 81% during retargeting. These results demonstrate the potential for measuring verbal-spatial workload during a task similar to the Tactical Tomahawk Weapons Control System and suggest a way for building individualized models through the selection of easy to acquire baseline data.

Berka, C., Levendowski, D. et al. (2005). EEG Indices Distinguish Spatial and Verbal Working Memory Processing: Implications for Real-Time Monitoring in a Closed-Loop Tactical Tomahawk Weapons Simulation. 1st International Conference on Augmented Cognition. D. D. Schmorrow. Las Vegas, NV.