



Cognitive Science and Technology Augmented Cognition



Figure 1. Prototype test-bed vehicle Mercedes G500 during the experiments at Marine Corps Base Camp Pendleton



Figure 2. One of the preliminary subjects being fitted with an EEG cap

an electroencephalogram (EEG) gauge (Figure 2) to measure cognitive workloads, as well as a system that determines an individual's physical workload based on data from the vehicle itself (Figure 3, back page). In controlled experiments, subjects were pushed to their limits by engaging targets, categorizing radio traffic, and responding to call signs while their vehicle traversed a course. During the experiments, tasks were varied and assigned to crew members according to three experimental conditions:

- *Experimental (AugCog)*: tasks were rerouted when either the EEG or physical-workload classifier indicated a high-load condition on a member of the vehicle crew.
- *Controlled 1*: no routing modifications, irrespective of workload, which tests if there is any value in rerouting.
- *Controlled 2*: modulates tasks to different individuals based on *a priori* knowledge of ongoing tasks, which tests if there is value in measuring EEG signals and physical workload.

Augmented Cognition (AugCog) technology improves safety

Improved situational awareness with onboard EEG sensors may protect lives and allow for more rapid responses

Situational awareness and effectiveness in military vehicles are crucial in today's high technology world. Excessive cognitive stimulation may overload personnel and degrade their operational performance. Sandia's Cognitive Science and Technology (C&ST) program conducts research to understand the neural and cognitive aspects of human decision making in order to build technologies that emulate or augment human performance.

In collaboration with DaimlerChrysler, the CS&T team is working with U.S. Marine Corps vehicle crews, who regularly experience cognitive and physical overload during their missions, to improve their safety, increase their performance, and reduce casualties. This team has developed Augmented Cognition (AugCog) technology that operates in moving vehicles in real time (Figure 1) and includes

The EEG component correctly identified high cognitive workload conditions 84 percent of the time, and the physical workload classifier correctly identified high physical workload 88 percent of the time. In the experimental AugCog condition, the team demonstrated a statistically significant 11 percent improvement in crew performance and situational awareness over both control conditions. This validates the hypothesis that crew performance and situational awareness can be improved by measuring cognitive and physical workloads. These experiments had a relatively light workload. We expect augmented crew performance to be much higher in future experiments where the workload will be much greater.

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Figure 3: Two preliminary subjects are providing baseline EEG recordings in a relaxed state prior to experimentation



Figure 4: Interior view of the custom dashboard in the Mercedes prototype during the experiments