Using Remote Psychophysiological Monitoring for Human Performance T&E

The burgeoning complexity of evolving programs—Future Combat Systems and the Stryker Brigades for the Army; Joint Strike Fighter and unmanned combat aerial vehicles for the Air Force; and the DDX destroyer program for the Navy—necessitates an intelligent and unified approach to testing the demands placed on individuals with regard to cognitive overload, distributed decision making and situational awareness. Though each of the armed services faces its own contextual challenges in this regard, many of the baseline parameters involved are the same.

A lack of available objective data has been a major limiting factor in the advancement and acceptance of human systems integration testing and evaluation. Limitations in computational power and fieldable hardware have been the major impediments to the collection of such data.

New and emerging technologies offer the opportunity to transform such testing. Advances in processing power—memory devices that are both compact and durable—along with improved sensors, make collection and analysis of objective human systems data a realistic goal. The task at hand is to harness and integrate advances made by various military, academic, industrial and medical research endeavors. Using such a "cross-pollination" approach presents opportunities for much-needed progress to take place in test and evaluation work that is relevant to human systems.

One such technology is remote psychophysical monitoring, based on 20 years of National Aeronautics and Space Administration (NASA) research to enhance individual astronaut performance. BioSentient Corporation's ambulatory system, MobileMe, and its analysis station, SentientMonitor, are designed to collect, measure and analyze multiple autonomic nervous system (ANS) parameters of *multiple* individuals simultaneously in real-time, real-life situations. This capability may prove very helpful in accurately assessing the psychophysiological status and assisting in the evaluation and enhancement of human performance in operational environments.

The systems consist of a garment (which may be worn under clothing) that houses the sensor harness; and an electronics pack (worn around the waist) containing physiologic data gathering and analysis modules that include resident and removable memory, wireless communications and power source. The standard ambulatory unit is currently configured to measure, display and transmit five ANS parameters: heart rate (derived from an electrocardiogram trace that is collected and stored); respiratory rate; finger blood volume pulse; finger temperature; and skin conductance.

Comprehensive autonomic testing usually requires a whole laboratory full of equipment and requires a person not only to be attached by wires, but also to remain stationary. The BioSentient system allows wireless collection of integrated data from multiple ANS parameters using minimal equipment, with little or no restrictions on activities.

The ambulatory system is supported by a portable central monitoring facility that receives data from the ambulatory system(s) wirelessly and/or via the Internet, and it can simultaneously measure, receive, analyze and manipulate the data of up to 30 wearers, all integrated onto one display. It calculates several heart rate variability spectra in real time and allows for two- and three-dimensional graphic comparisons of parameters.

The behavior of teams and individual team members is influenced by their psychophysiology. Monitoring and characterizing the ANS responses of more than one person simultaneously in real time will help in understanding three factors: team

Ambulatory, multi-parameter, real-time autonomic nervous system (ANS) monitoring facilitates the assessment and optimization of human performance during operational activities. Equipment pictured is BioSentient Corporation's ambulatory system that simultaneously measures, analyzes and displays multiple indicators of ANS function from multiple wearers. MobileMe, worn by the test subject at left (with components shown at lower right), collects, processes, stores, displays to the wearer and sends data wirelessly to a remote portable monitoring station (two panels, top right) that can concurrently monitor, analyze, store and integrate the data of up to 30 individuals in real-time.

dynamics, the characterization of human interface in physiological terms and patterns of synchronicity/congruence between team members.

How this psychophysiological and other data correlate to human performance parameters such as stress, cognition and situational awareness levels as they pertain to the test and evaluation of systems is being investigated by the Joint Warfighter Test and Training Capability (JWTTC). Currently, the Human Systems Integration Test and Evaluation Working Group, comprising representatives from Department of Defense test ranges/agencies, as well as academia, research centers and battle labs, is identifying the common baseline requirements needed for such measurements.

With these requirements in hand, the JWTTC objective is to develop capabilities to perform system-level tests and assessments, and system-of-systems test and evaluation, where human systems integration test and evaluation can be performed in an objective, quantifiable manner, in an operationally realistic environment. o

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