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INSIDE

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New Developments in Human-Centered Design

By DR. JEFF WILBERT, Sector Associate Technical Fellow

Over the past 24 years, Human Factors Engineering (HFE) has evolved from operator task analysis and Human Machine Interface (HMI) design and evaluation to encompass a much broader range of inter-related scientific disciplines. This expanded discipline, called Human Systems Integration (HSI) has become a major point of emphasis in the recently revised defense acquisition policy. DoD policy now requires that a comprehensive plan for HSI be in place early in the acquisition process in order to optimize total system performance, minimize total ownership costs, and ensure that the system is built to accommodate the characteristics of the user population that will operate, maintain, and support the system. By establishing a high-level of oversight and authority, an HSI team has the opportunity to review all IPTs' issues, participate in the decision process, and ensure that all requirements, design elements, and test and evaluation plans are inspected for potential impacts related to the need for human interaction. The foundation of the HSI process is the inter-communication between various stakeholder disciplines which constitute the seven pillars of HSI: manpower, personnel, training, safety, habitability, survivability, and human factors engineering.

Northrop Grumman has made great strides towards meeting our customer's expectations in the area of HSI. We have over 60 practitioners throughout the corporation with representation in each of our sectors. We also have an HSI Community of Practice (CoP) which helps us to network our resources, and share best practices and lessons learned related to analysis and design tools, methods, and processes. You can contact the author or Dr. Jennifer Foil for more information on the HSI CoP.

Photo: Northrop Grumman Corporation

Figure 1. On the left is Dr. Wilbert flying a Cessna using the Oz Flight instrumentation overlaid onto MS Flight Simulator. IHMC is currently modifying Oz to emulate Northrop Grumman aircraft. On the right is a close up of the Oz "star-field metaphor" instrumentation display.

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New Developments *(from page 1)*

Some of the more exciting developments in the HSI world are centered on a newly emerging scientific discipline referred to as Augmented Cognition. Recent advances in the development and availability of biofeedback and neurological and physiological sensing devices allow us to monitor and measure many aspects of a person's mental and physical state and their remaining performance capacity. We can monitor electroencephalogram (EEG, the brain's neural-electrical activity), electrocardiogram (EKG, the heart's electrical activity), galvanic skin response (GSR, the skins electrical conductance which varies in accordance with stress level), heart rate, and breathing rate just to name a few. What's more is that we can now do this using fairly non-intrusive methods that can be used for experimental comparison of the effects of alternate machine interfaces on human performance, or even as part of real-time systems that sense when an operator becomes stressed, confused, or overloaded and can then offer assistance through intelligent agents, decision aids, or variable-level invoked automation.

Our Human-Centered Design Lab has purchased this type of equipment and has begun to conduct research into its applicability for the analysis and design of many of our core product lines including manned-attack and C4ISR&T aircraft, unmanned aerial system ground control stations, and even the next Lunar Lander. We currently have an arrangement with the University of Iowa's Operator Performance Lab (OPL), where they not only monitor and measure neural and physiological states, but they have "hardened" their systems for in-flight use. They've even purchased a L-29 tandem seat jet trainer which may serve as a test bed for our future experimentation and demonstrations. We also have an arrangement with QinetiQ of the UK who have developed techniques to exploit these types of measurements and uses operator state as a trigger for invoked automation. When the system knows that the operator is overloaded, it can ratchet up its assistance from context-sensitive recommendations or cues, to statements of intent to execute that the operator can accept or over-ride, to full automation takeover to prevent a catastrophic event like controlled flight into terrain.

Northrop Grumman has an arrangement with Florida's Institute for Human and Machine Cognition (IHMC). At IHMC they have developed what we expect to be the next breakthrough in flight instrumentation. The Oz system, as they call it, was developed based upon prevalent theories in dual-mode visual processing capabilities. An integrated set of graphics (see figure on page 1) provides superior situational awareness of all of the critical aspects of flight control including vertical and horizontal situations, flight plan and navigation control, as well as the aircrafts physical performance (surfaces, engine parameters, etc.).

Aside from the distinct advantages that the Oz display offers the pilot of any given aircraft (e.g., reduced scan pattern, faster recognition of current situation and future trends), it offers an opportunity to provide a singular instrumentation design that can be applied to any or all future aircraft. The graphical elements are simply tuned to the performance characteristics of the aircraft in question, but the interpretation of the graphic's behavior remains the same. This would not only provide tremendous time savings and cost benefits for pilot training, and cross-platform training, but it could also optimize the ability of a single pilot to simultaneously control multiple unmanned vehicles of different varieties.

We also have an arrangement with Sandia National Labs where they have developed an embedded, intelligent learning application that captures context sensitive mission events and expert-user behavior patterns to provide real-time decision aiding, operator proficiency assessments, and automated training experience development for both individual and team training. This technology is already being funded for concept demonstration and eventual technology integration by the Office of Naval Research (ONR). The focus of the ONR is on capable manpower future training concepts. Sandia has been tasked to demonstrate the feasibility of integration into an E-2 Hawkeye training environment. The focus of our activities is on exploiting this application for implementation as a real-time decision aid to optimize mission operations in high-stress or high-workload environments. We anticipate that this can form part of the core common architecture for all future NGC weapon systems.

Investments in new technologies that help pilots and tactical crews operate their platforms, or support personnel to maintain them are essential to maintaining our competitive advantage in the pursuit of new weapon system contracts. As we move towards more integrated, information-intensive environments like the Global Information Grid (GIG), and employ more and more unmanned vehicles, the need for systems that optimize situational awareness, reduce workload and fatigue, and substitute for the lack of physical and cognitive cues that you lose when you remotely pilot a vehicle, will be the discriminators that allow us to keep that competitive advantage while providing the Warfighter with the best solutions possible. ■