28 October 2010

Department of Defense
Human Factors Engineering Technical Advisory Group #64
SubTAG: Design Tools and Techniques (DTT)

Mr. Steve Merriman (The Boeing Company, stephen.c.merriman@boeing.com) and Dr. Michael Feary (NASA Ames, Michael.s.feary@nasa.gov) chaired the DTT SubTAG meeting on 28 October 2010. The meeting was attended by 20 participants There were no changes to SubTAG leadership and there were no changes made to the SubTAG charter. Five technical presentations were made, as follows:

TITLE: Tools for Evaluation of Automation Interaction in Aerospace Applications
PRESENTER: Michael Feary, PhD, Research Psychologist, AST, NASA Human – Systems Integration Division, NASA Ames Research Center, MS 262-4, P.O. Box 1, Moffett Field, CA, 94035, (650) 604-0203, Michael.S.Feary@nasa.gov

SYNOPSIS: The addition of automation has greatly extended humans' capability to accomplish tasks, including those that are difficult, complex and safety critical. Most Human - Automation Interaction (HAI) in safety critical operations results in more efficient and safe operations, however unexpected automation behaviors or "automation surprises" can be frustrating and may result in injuries or the loss of life. This talk described current research into methods that help to identify Human – Automation Interaction difficulties during design.

The talk described three efforts: Work Domain Analysis, Human Performance Analysis, and Formal Verification of Human-Automation Systems. The development efforts support NASA and FAA research in both aviation and space application domains, and are intended to be used by automation designers and evaluators.

TITLE: New methods for visualization and situational awareness of analog signal content
PRESENTER: Charles Jorgensen, PhD, Chief Scientist of the Intelligent Systems Division, NASA Ames Research Center, MS 269-1, Moffett Field, CA, 94035, (650) 604-6725, Charles.jorgensen@nasa.gov

SYNOPSIS: This presentation described three new and highly general methods for the display of analog signals in a context of four major NASA technical problems. The problems included helicopter gearbox fault detection, visual location of abnormalities and abrasions in aircraft wiring, detection of space shuttle foam strikes, and early detection of case breach faults in launch vehicle boosters. The first method showed a quick way to convert a signal to a pattern by transforming the signal magnitudes into parameters of a graphic function such as a hyperbolic cosine or simple cosign function. This was illustrated using sst 121 accelerometer data and detected a sensor failing at a fixed value during launch.

The second method is for visual display of non-monotonic analog signals and is quite unique in that it does not depend on traditional signal sampling techniques to describe sensor information. In this method a graphic pattern is generated treating analog signals as approximate solutions to complex polynomials and permits merging multiple signal sources in a single figure to build a dynamic pattern signature of a large multi variable process. Such a signature can be used to establish normal from abnormal operating conditions to facilitate human detection. Improving the speed of visual fault detection using this method was demonstrated using a high fidelity simulation of the Orion rocket booster with a case breach fault occurring at different times in the ascent. The method appears superior to other approaches dependant on textual display of fault conditions in ease of detection and possible resistance to visual blurring caused by heavy pilot vibration during launch.

The third method involved how to visually display monotonic and closed functions. The method also processes signals to create both symbolic and graphic representations of signal features but uses a variation of a technique developed for human handwriting analysis called circuit coding instead of polynomial theory to capture the progression of the signal in time. An example of such a monotonic data stream is visual representation of common aircraft flight paths or trajectories rather than zero crossing analog signals such as those produced by sensors. Potential pilot cockpit uses of these methods was shown by a simulated aircraft control path management task. A hypothetical cockpit control display was created in which 64 or more sensors of the same type could be monitored in a very small area, text messages or ground communications could be transformed into unique visual patterns, and multivariable flight controller software performance could be monitored.

TITLE: The Use of Modeling in Requirements Derivation - Lessons From FCS-MGV Program

PRESENTER: Oded Flascher, PhD, Vice President, Director of Special Programs
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SYNOPSIS: This presentation described the methods used to derive Human Systems Integration requirements on the very complex US Army Future Combat Systems, specifically on the Manned Ground Vehicles (MGV) team. HSI credibility on the FCS program depended highly upon the ability to produce credible and valid quantitative data to support design trade-offs. Several different techniques were used to analyze physical and cognitive human-system integration in the context of nine different MGVs. For example, the effectiveness of different sized crews in the Mounted Combat System was studied using the Army IMPRINT model. Capabilities of Command and Control Vehicle crews were analyzed on a limited basis using IMPRINT and C3TRACE tools. Modeling was not conducted in all cases where quantitative data were needed, primarily because of limitations of the small HSI team and the fast pace of the program.

Physical accommodation of the MGV crews was assessed using the Jack model. However, it was difficult to update IMPRINT and other models to reflect the myriad design changes that occurred over the development cycle so the HSI teams couldn't effectively "keep up" with their analyses. It was also difficult to reflect the impacts of design changes on Soldier performance since the task analysis and physical space claim computer aided design (CAD) models were not integrated. Even with major interfacing problems, many of the HSI analyses had significant impact on design and contributed positively to the FCS program.

Computer-based modeling proved to be the second best source of quantitative accommodation and performance data, after human-in-the-loop testing. Human based testing is generally very expensive and requires many different personnel to accomplish. As a result, human modeling tends to be the approach of choice in most instances. The use of modeling by the HSI community falls directly in line with the Honorable Mr. Carter's affordability initiative –since manpower, personnel and training are key drivers of life cycle cost for most systems.

TITLE: USCG SENTINEL Class Design Validation: Pilothouse, Galley and Mess Deck

PRESENTER: Dawn M. Gray, US Coast Guard (CG-1B3) 6014 Martins Landing Lane, Burke, VA 22015, (202) 475-5102, dawn.m.gray2@uscg.mil

SYNOPSIS: The USCG SENTINEL Class Patrol Boat project is a Department of Homeland Security (DHS) Level 1 Investment and USCG Major Systems Acquisition project. The primary objective of the acquisition is to quickly procure patrol boats to reduce or eliminate the USCG's patrol boat capability gaps. The SENTINEL will use a Non-Developmental Item (NDI) hull form that will be modified as needed to accommodate Coast Guard missions. The assumption is that the 154-foot cutter must support a crew of two (3) officers and twenty (20) enlisted personnel in accordance with the preliminary manning estimate conducted by USCG Human Systems Integration for Acquisitions Division (CG-1B3).

In order to validate operational suitability and assess how well HFE has been addressed in aspects of the design, the SENTINEL Project Management (PM) requested that CG-1B3, the USCG Office for HSI in Acquisitions, provide the required personnel to perform an assessment of the pilothouse, galley, and mess deck spaces utilizing full-scale mock-ups. The HFE assessment of the spaces was performed by collecting data through heuristic HFE assessments using HFE design standards and "best practices", usability assessments by having representative crews demonstrate scenarios, and link analysis. All data were documented as "issues and observations", but not necessarily negative as the goal is also to highlight areas where the design supports the required tasks. Identified issues were then tied to specific FRC requirements. This traceability was the key in providing the HFE Team with a means to achieve the goal of determining the ability for the FRC to meet its human performance and safety goals along with potential recommendations for enhancing the design.

This effort was publicized in CG-9's (Acquisition Directorate) July edition of "Delivering the Goods" newsletter in an article titled *US Coast Guard Embraces Human Factors Engineering*. Due to the working relationship between the FRC Sponsor's Office, the FRC Project Office, and CG-1B3, the vast majority of these items have already been addressed with many more currently being worked for mitigation. The first boat in the fleet will be delivered during the third quarter of 2011 to Coast Guard District 7 in Miami, and will vital migrant and contraband interdiction missions conducted throughout the Caribbean Sea and Gulf of Mexico.

TITLE: A Couple of Months in the Laboratory Can Save a Couple of Hours in the Library
PRESENTER: Ms. Teresa K. Alley, Defense Technical Information Center San Diego, 530 J Avenue, Coronado, CA 92118, (619) 545-7384, talley@dticam.dtic.mil

SYNOPSIS: This presentation described some of the research tools available to Human Factors Engineering and Human Systems Integration personnel through the Defense Technical Information Center and their web site - http://www.dtic.mil/dticasd. DTIC San Diego has provided support to the DOD HFE TAG for more than 30 years.