DOD HFE TAG-63
CONTROLS AND DISPLAYS SUBTAG REPORT

SUBMITTED BY:
Marianne Paulsen
SUBTAG CHAIR

05 May 2010

General Information

I. SubTAG Name: Controls and Displays

II. SubTAG Chairs: Marianne Paulsen
Naval Air Warfare Center-Training System Division
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II. Number of SubTAG Members Present: 19

III. Organizations Represented (Sampling): 15

a. NSWC PCD
b. SA Technologies
c. Eye-com Corporation
d. Design Interactive
e. NAWC-AD-Pax River
f. Draper Laboratory
g. Naval Research Laboratory
h. Lumir Research Institute
i. U.S Army Joint Systems Integration Lab
j. US Army Research Lab
k. NASA-Ames
l. NAWCTSD – Orlando
m. Purdue University
n. SPAWAR
o. Intelligent Automation

IV. Agenda

- Next Generation Neuroadaptive Controls and Displays; Achieving Human-System Synergy; Roberto Champney, PhD: Design Interactive Inc., Orlando, FL

- Determining Character Dimensions for Integrated Bridge System Displays to Support Multiple Work Contexts; Andrew Mikutel: Naval Air Warfare Center Training Systems Division, Orlando, FL

- Back to Basics: A Human Centric Hovercraft Design; John Taylor: Naval Surface Warfare Center, Panama City, FL

- Next Generation Threat System; John Dicola: Naval Air Warfare Center, Patuxent river, MD

- Wearable Eye and Head-Tracking Technology for Studying User-Computer Interaction, Measuring Operator Performance, and for use as a Field-Deployable Neuro-Diagnostic System; Dr. Bill Torch: Med. Director, Neurodevelop. Neurodiagnostic Ctr & Washoe Sleep Disorders Ctr.; Chairman, Eye-Com Corp., Reno, NV

V. Abstracts: attached at end of file

VI. SubTAG Discussion Points

a. Speaker: Champney
Q: What about soldiers wearing devices for test and evaluation when they are in the firled running, sweaty and bouncing around.
A: We do have another brief coming up later in the session that addresses use of mounted evaluation tools that can be used in the field.

b. Speaker: Mikutel
Q: Are you planning on looking at your findings with respect to performance shaping functions (e.g., the effects of motion of visual angle requirements) or graphical representations?
A: We hadn't considered that, but I will bring it up to my team for future direction.

c. Speaker: Taylor
Q: Is the new crew going to be taken from the same population?
A: Yes, from the same vast population, but there will be more stringent selection criteria.
Q: Did you look at eye movement or gaze?
A: No, that is out of our scope.

d. Speaker: Dicola
Q: The system is being developed to be used by a wide variety of platforms, but are there plans to have cust9imizable default settings for specific platforms?
A: No, but that is a great idea and I will think about adding that requirement to our future direction.

e. Speaker: Torch
No discussion

VII. SubTAG Business

a. The Controls & Displays sub-TAG will meet during TAG-64 in November 2010.
b. Chris Kijora, USCG is new potential C and D cochair.
c. Charter will be reviewed and revised as necessary.

VIII. No SubTAG actions

IX. Controls and Displays Sub TAG Chair

a. Marianne Paulsen (407)380-4743

Title: Next Generation Neuroadaptive Controls and Displays; Achieving Human-System Synergy

Presenter: Roberto Champney PhD, Sr. Research Associate, Design Interactive Inc., 1221 E. Broadway Suite 110 Oviedo Fl 32765, 321-436-8284, Roberto.champney@designinteractive.net

Abstract:

This presentation will examine the next generation of controls and displays which involve the use neuroadaptive systems. These are multifaceted systems that adapt to enhance human performance and are composed of a variety of interconnected elements; the human, system and neuro-physiological monitoring components. These systems are the next frontier of controls and displays as they involve more than the physical and cognitive static optimization of the past, where controls and displays were designed to fit within the context and constraints of the human operators and their tasks. These next generation systems aim to adjust and adapt in real-time to the human state in order to optimize or enhance human performance (i.e., optimize, expand or increase the capabilities of the human). Such augmentation may take place across a broad spectrum of human performance to enhance or expand these capabilities (e.g., attention, recognition, cognitive functions, muscle performance, learning) or to supplement for decrements in human performance (e.g., due to fatigue, sleep depravation). Thus there are a variety of human capabilities that can be augmented to maintain optimum readiness. Yet how does one go about defining and prescribing what and how to augment?

Human performance of complex tasks, whether in learning or in performing such tasks are composed of multiple dimensions of processes and their decompositions. Once such breakup of dimensions was proposed by Bloom (Bloom & Krathwohl, 1956) whom defined a taxonomy of learning objectives; including the psychomotor domain, cognitive domain, and affective domain. This taxonomy may serve as a foundation from which to create a framework of neuroadaptive systems allowing for augmentation of the physical, cognitive, and/or affective states of the human operator. Existing work to date has primarily focused on physical or cognitive augmentation with, with few if any addressing the overall optimization of all three states. In order to achieve the synergy between the human and system it first necessary to increase the range of and number of sub-components of human capabilities that may be assessed, monitored and adapted for. Next generation neuroadaptive systems promise to close these gaps by achieving synergistic cooperation among human physical, cognitive, and affective states.

Determining Character Dimensions for Integrated Bridge System Displays to Support Multiple Work Contexts

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Taking the context of operation into account is an essential component of effective human computer interface (HCI) design. Unfortunately, too often, HCI designers are asked to develop HCI without sufficient information on such factors as the expected distance of an operator from the intended display. Additionally, the ergonomic and anthropometric factors to consider aboard ship vary. Despite efforts to provide common display consoles across platforms, this goal has not been fully achieved. For example, consoles used to support combat systems are much different than the consoles used on the bridge for shiphandling and navigation. Moreover, the context with which these consoles are utilized by their respective watchstations differs in such factors as seating/standing position, distances to the displays, etc. The purpose of this presentation is to outline an analysis conducted to recommend display character dimensions for an integrated bridge console from three operator working positions. Because this particular bridge console is intended for operation and viewing from several locations throughout the course of operation, both seated and standing, determining the appropriate character dimensions presented some unique challenges related to the visual angles and distances between the operator and the displays. The operator's tasks in this example required seated operations in front of several individual displays on these consoles which changes the distances and visual angles to other displays within the same console. Consequently, evaluation for recommended character heights had to focus on the operator being closer and farther away from the displays at different times. Therefore, character dimension recommendations were generated for three working positions: (1) an operator seated as if he/she is typing at a workstation, (2) an operator seated at the farthest possible point from a display, and (3) an operator standing directly behind the center console station. The analysts believed that a font height recommendation based on the farthest point away ensured that a display would be legible for all other working positions. This presentation will discuss the mathematical concepts that were used to determine an operator visual angle, which was ultimately used to calculate character height and widths in compliance with MIL-STD-1472F: *Department of Defense Design Criteria Standard for Human Engineering*. The results of this analysis provide credible recommendations that can be forwarded to display developers. For future analyses, it is recommended that human factors be considered and implemented upfront in HCI design to avoid costly design changes that may result once the system is built and in the field.

Title: Back to Basics: A Human Centric Hovercraft Design

Presenter: John Taylor, Engineering Psychologist, Code E41, 110 Vernon Ave, Panama City, FL 32407, 850-234-4515, john.k.taylor3@navy.mil

Abstract:

This presentation will discuss the process involved in designing the command station for the next generation air cushion vehicle. The Ship to Shore Connector (SSC) is the air cushion vehicle that will replace the Landing Craft Air Cushion (LCAC) vehicle later this decade. The Human Systems Integration (HSI) team was given the authority to design the command station, including the selection and location of all controls and displays.

The focal points of the design were the end users, in this case the pilot and copilot. All design elements that interface with the pilots were designed around the anthropometric measurements of the 95^{th} percentile male and the 5^{th} percentile female. This was especially true for controls and displays.

After classifying all controls into acceptable reach zones by criticality and frequency of use, they were located in the optimal positions. Displays were positioned in locations that conform to appropriate visibility zones in accordance with human engineering standards.

3D avatars representing a male and female were placed into a 3D model of the command station to assist with the validation of human interface locations. The goal was for the avatars to be able to reach all controls and to be able to see all displays, while remaining within the requirements specified in DOD human engineering standards.

The HSI team researched and selected the craft control devices and provided instrumental input to the selection of other various controls and displays. Human engineering standards were used extensively as guidance for the selection and location of all human interfaces, which should lead to an optimized command station design that will reduce human error and should ultimately result in a cost savings to the Government.

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TITLE: WEARABLE EYE & HEAD-TRACKING TECHNOLOGY FOR STUDYING USER-COMPUTER INTERACTION, MEASURING OPERATOR PERFORMANCE, AND FOR USE AS A FIELD-DEPLOYABLE NEURO-DIAGNOSTIC SYSTEM

AUTHORS: William C. Torch, MD, MS and Carlos Cardillo, MS

PRESENTER: William Torch, Eye-Com Corporation, 75 Pringle Way, Suite 906, Reno, NV 89502, (775) 359-2006, BTorch@eyecomworld.com

With the goal of enhancing human factor applications for the Dept of Defense, we have been developing and testing a wearable, real-time ocular & head-tracking technology that will: i) facilitate user-computer interactions and control, ii) measure real-time drowsiness, inattention and distraction during sustained operations, and iii) measure a warfighter's anxiety level. The Eye-Com Biosensor, Communicator and Controller is an ergonomically designed, wearable electronic eye-frame that collects real-time oculometric and head movement data. The system has been integrated into several wearable platforms and validated in different environments, including in a: 1) US Navy scuba mask in a swim flume tank for future study of hypoxemia, fatigue, nitrogen narcosis; 2) US Air Force pilot helmet to monitor ocular and physiological effects of induced-hypoxia in simulated flights, as well as in UAV control and target identification; 3) US Army helicopter pilot-worn eye-frame to monitor extended time-on-task ocular fatigue during prolonged simulated hover maneuvers; and 4) on healthy civilian drivers and subjects with underlying sleep (e.g. apnea, narcolepsy) or attention deficit disorders, tested in a drive simulator under 36 hrs of continuous sleep deprivation to assess effects on driver performance and accidents. Ongoing Eye-Com validation studies include: 1) use of an advanced scuba mask with a built-in HMD and Eye-Com eye-tracking system to study ocular activity in Navy Seals subjected to swimmer fatigue; 2) correlation of oculometrics with Transcranial Doppler CBF velocity in sleep-deprived USAF pilots during simulated flights; and 3) design of a field-deployable wrap-around biosensor eye-frame/HMD system to identify oculometric and biometric markers (e.g. EKG, pulse, BP, respiration, galvanic skin response, EEG) associated with soldier mTBI/PTSD. In collaboration with military, industrial & academic partners, Eye-Com Corp will undertake new civilian drive simulation drowsiness detection studies, and advance the technology for use by enabled and disabled civilians and soldiers in gaze control of computers for assistive communication and control (ACC) of electronic & electromechanical devices. The next generation Eye-Com Biosensor-Communicator-Controller system will contribute to a myriad of Human Factors applications that will help our Nation respond to future planned & unexpected challenges.

SubTAG Agenda

Welcome and Introduction

Advanced Display Systems for CT Scanners
J. Michael Barrientos: Department of Homeland Security Science and Technology, Atlantic City, NJ

Improving Decision-Making Through Intelligent Augmented Reality
LT Brian R. Johnson: Naval Air Warfare Center-Aircraft Division, Patuxent River, MD

Redesign of the V-22 Osprey Thrust Control Lever for Congruent Control Mapping
David Rozovski: UserCentrix LLC, Lafayette, IN

Designing to Enhance Situation Awareness: Developing Emergency Management Tools with SA-Oriented Design
Laura Strater: SA Technologies, Inc., Carrollton, TX

Online Oculometric Measures as an Index of Operator Distraction, Inattention, Drowsiness, and Sleep Onset
Carlos Cardillo : EyeCom Corporation, Reno, NV

A Concept to Support Coordinated and Synchronized Distributed Team Work
Samuel R Kuper: Wright-Patterson AFB, OH

SubTAG Closing Remarks

Abstracts

Advanced Display Systems for CT Scanners

by J. Michael Barrientos of DHS S&T

Conventional X-ray line scanners implemented at checkpoints are used by Transportation Security Officers (TSOs) to screen passengers' baggage for threat objects or prohibited items. These scanners produce a 2D shadowgraph projection image for each scanned bag. The 2D projection images are generated by accumulating X-ray attenuation along the X-ray beam path through a scanned bag; however, this approach is limiting in that individual objects cannot be viewed separately since the X-ray beam path cut through the material in one path, thus making it difficult to recognize objects or resolve alarms detected by TSOs. TSOs rely on these 2D projection displays to interpret the contents of scanned bags to determine if the bag may proceed through the security checkpoint. Previous studies conducted the Transportation Security Laboratory (TSL) have shown that TSO threat detection performance to improve by 10 % using 3D displays (stereoscopic) for X-ray systems compared to 2D displays. Therefore, it is hypothesized that volumetric 3D data sets, if presented on a 3D display platform for computed tomography (CT) systems, will also significantly improve TSOs' threat detection performance.

A goal of DHS Science and Technology Directorate (S&T) is to improve operator performance through technology. To help meet this goal, DHS S&T has been working with the security industry to develop automated detection capabilities for CT scanners, including seeking better ways to present the image so that operators of such systems will be provided with a better representation of a bag without having to open or tamper with its content. Thus, DHS S&T will conduct a Human Factors assessment on an Advanced Display System (ADS) for CT in order to determine if such a system can improve operators' performance for resolving alarms. An ADS is a 3D display which presents volumetric images. Performance metrics that will be evaluated include threat detection (i.e., Hit rate), false alarm rate, and response times.

Improving Decision-Making Through Intelligent Augmented Reality

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SYNOPSIS:
A major challenge in developing effective decision support tools lies in the way in which information is presented. This challenge is particularly acute in high risk, high Ops Tempo domains, where operators must fuse information from many different information sources quickly. While every domain has its unique characteristics, Human Factors lessons learned in one domain should transfer, to some extent to other domains. For example, a major challenge in aviation is how to deal with the anticipated growth of air traffic in the United States. Current systems are unable to process and provide flight information in real time in order to manage this congestion. To combat this concern, the Next Generation Air Transportation System (NextGen) will provide operators with networked-access information, precise navigation, and Trajectory-Based Operations (TBO). TBO will mitigate air traffic congestion by providing operators with precise navigation information so the operator follows a safe path that ensures proper aircraft separation. This concern with safely moving air traffic is similar to helping coordinate multiple actions with ground troops. Imagine that one or more soldiers challenged with navigating through a potentially hostile environment are pinned down by an enemy sniper. The challenge is to safely navigate the soldier away from the sniper while minimizing exposure – in a setting that is dynamic, fluid and for which only partial information is available. Using TBO as one metaphor, we are currently developing an Intelligent Augmented Reality Model (iARM) framework that will include: 1) an open source operating system that supports geo-location/triangulation, 2) data services that integrate voice, video, and images for facial/object recognition, and pattern analysis, and 3) a hardware platform that integrates a computer processor, encrypted wireless, camera/video, and visor display. iARM will address various issues confronting soldiers today. Currently, access to information may be slow and inaccurate, information may be context-ignorant, systems do not learn over time, and handheld devices may distract from environmental information. iARM's primary goals are to reduce cognitive load in times of duress (e.g., present a flee path), create a model to enhance a collective memory of soldiers' historical perspectives (e.g., sniper kill happened here) with environmental cues, and provide a naturalistic and unintrusive information display to augment the field environment.

Redesign of the V-22 Osprey Thrust Control Lever for Congruent Control Mapping

David Rozovski
Lead Engineer & General Manager
UserCentrix LLC

Since 1942, all rotary and fixed wing aircraft have been designed with controls that map congruently to their primary thrust vector. For example, the throttle in a fixed wing aircraft moves forward in order to accelerate forward while the collective in helicopters moves upward in order to increase lift. This design criterion eliminates the need for the pilot to conduct a mental transformation to map the control movement to the vehicle control strategy. Although the pilot's ability to perform such a mental transformation can be dramatically improved through training, control reversal errors have been seen with non-congruent control mappings even for highly skilled pilots. Such events are more common under high workload, high stress conditions.

Thrust-vectored aircraft, such as the tiltrotor, pose a problem in attempting to apply this design principle, since a fixed-axis controller will only be congruent when the thrust is aligned with the controller's axis. For example, an airplane style throttle inceptor only maps properly when a tiltrotor is in "airplane mode," while a helicopter style collective only maps properly when a tiltrotor is in "helicopter mode." Currently, the V-22 Osprey utilizes a helicopter-style inceptor, resulting in non-congruent mapping when the V-22 is operating as a fixed-wing aircraft.

A variable-axis thrust inceptor has been designed for tiltrotor aircraft that maps congruently to the magnitude and direction of the thrust vector. This device, known as the Rotational Throttle Interface, maintains a congruent mapping from control axis to thrust vector throughout the entire flight regime by rotating its control axis to match the thrust vector of the engine nacelles. A non-functional prototype has been constructed, and completion of the first fully functioning prototype is slated for Q4 of CY2009. Experiments are being planned using NASA's Vertical Motion Simulator to test whether the Rotational Throttle Interface improves V-22 pilot situation awareness, workload, and performance over the current inceptor.

Designing to Enhance Situation Awareness:
Developing Emergency Management Tools with SA-Oriented Design

Laura Strater, Sr. Research Associate, SA Technologies, Inc.,
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Emergency management poses many challenges to Incident Response personnel who arrive on scene and must quickly gather information from civilian observers, victims, other on-scene personnel, and off-scene organizations in order to rapidly assess and respond to the situation. During an emergency response, the coordination of resources is critical, yet remains a challenge as it is difficult to maintain situation awareness (SA) in such a distributed and dynamic environment. Post-disaster analysis has determined that a portion of FEMA's failure in response to hurricane Katrina was due to the organization's inability to obtain and maintain a 'clear picture' of the developing situation at the disaster site (Mitre, 2005). At that time, no system was in place to (a) share information from the ground up, and (b) track supply movements on the ground. Furthermore, the National Strategy for Homeland Security report (2007) singles out the importance of supporting SA in conducting effective operations, in order to effectively mobilize and deploy people, resources, and capabilities. This challenge is exacerbated by the dynamic environment and the number and diversity of organizations that must coordinate and share resources to address the situation. To address this need for rapid SA and critical information sharing, we describe the SA-oriented design process applied to the development of tools to support emergency management personnel in disaster response.

SA-oriented design is an iterative, three-stage process that is uniquely targeted to the development of displays and information systems that support the goals, decisions and information needs of the system user (Endsley, Bolte & Jones, 2003). For this effort, we focus on the design and development of a tool positioned to support an Incident Commander in monitoring the status of personnel and organizations involved in incident response. The tool is the Collective Observations of Human, Organizational, and Relational Terrain (COHORT). Using the SA-oriented design process, we began our research and development with an analysis of the information requirements for an Incident Commander, using the goal-directed task analysis methodology. The result of this analysis is a goal hierarchy, which delineates the commander's goals, decisions and SA requirements. Using this analysis, we designed user interfaces for the tool that support the information needs of the user, collocating the information that supports a particular goal and/or decision on a single screen. Analysis of the tool focuses not only on performance, (i.e., how well the Incident Commander performs in an experimental paradigm) but also on how well he or she is able to gather the relevant information from the tool in order to gain an accurate understanding of the current situation. Our goal is to demonstrate the use of SA-oriented design to effectively design a web-based portal that would support individual, team and shared SA concerning (a) the conditions on the ground, (b) the location and status of personnel, (c) status of tasking, and (d) the location of supplies and needed resources within and between private and public agencies. With COHORT in place and in use by team leaders from diverse organizations, the ability to efficiently coordinate the allocation of supplies, equipment and personnel will lead to more effective relief activities, and ultimately save time, money and lives.

A Control and Display System Design for Synchronizing DIstributed Command and Control Teams

Mr Samuel R Kuper, Senior Industrial and Systems Engineer

The Air Force Research Laboratory's Human Effectiveness Directorate is conducting a R&D program called Synchronized Distributed Operations (SDO). The program is performing on-going cognitive work analyses and developing new displays and controls supporting increased cohesion, agility, efficiency and effectiveness of distributed, multi-organization teams and teams of teams. Field research conducted under the program concluded that one key challenge for C2 teams is remaining coordinated and synchronized across multiple dimensions and levels while conducting local and shared work activities.

The SDO program is using a spiral approach in developing a control and display system concept demonstration called the Adaptable Distributed Activity/Process Toolkit (ADAPT). The ADAPT concepts provides a unified controls and displays for establishing, referencing, and manipulating connections and interrelationships between people, processes, products, schedules and tools. Performance evaluations on the first spiral of the ADAPT concept (called ADAPT-TSP) were conducted with multi-organizational teams performing rapid Course of Action development. Among others, the evaluations measured significant decreases in procedural burden and increases in situation awareness when compared to existing work aids.

The ADAPT concept demonstration is currently being generalized to support coordinated and synchronized Crisis Action work by studying C2 operators at USSTRATCOM, USTRANSCOM and USNORTHCOM. The resulting ADAPT concept is anticipated to have many general characteristics useful to other distributed teams, including mixed DoD and non-DoD teams.

This presentation will discuss key cognitive work analysis findings, the ADAPT work aiding concept progress, performance evaluation results, and future plans.