DEPARTMENT OF DEFENSE

HUMAN FACTORS ENGINEERING TECHNICAL ADVISORY GROUP (DOD HFE TAG)

MEETING 70

9–13 MAY 2016 | HAMPTON, VA

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MEETING THEME:

System-level Solutions to Support the Design, Integration and Use of Autonomy

Incorporation of autonomy into real-world operational environments will create a more complex system, with new interdependencies and new relationships among various operational elements, and will require humans and machines to work together in new and different ways. Existing system performance metrics, certification criteria, and safety standards are insufficient to address the added complexities and novel characteristics of advanced autonomy. The challenge for this TAG is to identify a path forward in addressing these and other issues, including development of system-level performance metrics, certification of complex sociotechnical systems that include autonomous components, and criteria for function allocation between humans and autonomy that consider system-level constraints.

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0715 – 0800	Meeting Registration	Outside room 108
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1500 – 1530	Break	
1530 – 1730	Modeling & Simulation (I)	262/263
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AGENDA

1530 – 1730	Test & Evaluation	201 / 202
1830	No Host Mixer	NACA Dining Room

Wednesday, 11 May		Location
0700 – 0800	Meeting Registration	Outside room 108
0700 – 0800	Tech Society/Industry Meeting	265/266
0800 – 1000	Unmanned Systems (II)	265/266
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1000 – 1030	Break	
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1100 – 1230	Lunch Break	
1230 – 1430	Mixed Reality	265 / 266
1230 – 1430	Sustained Operations	201 / 202
1230–1430	Trust in Autonomy S.I.G.	262/263
1430 – 1500	Break	
1500 – 1700	Design: Tools & Techniques (I)	201 / 202
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Thursday, 12 May		Location
0700 – 0800	Meeting Registration	Outside room 108
0800 – 1000	Cyber Security Special Interest Group (1)	265 / 266
1000 – 1030	Break	
1030 – 1230	HFE / HSI (II)	262 / 263
1230 – 1330	Lunch Break	
1330 – 1530	Poster and Demo Session	201 & Hall
1330 – 1530	Cyber Security Special Interest Group (II)	265 / 266
1330 – 1530	Design, Tools, and Techniques (II)	202
1330 – 1530	Human Factors Standardization (I)	262 / 263
1530 – 1730	Tours (meet in the hall outside room 108)	
1830 – til	No Host Dinner ***Advanced sign up required***	Vintner's Cellar

Friday, 13 May		Location
0800 – 0830	Meeting Registration	Outside room 108
0830 – 1030	Cognitive Readiness	265 / 266
0830 – 1030	Extreme Environments	262 / 263
0830 – 1030	Personnel	201 / 202
1030 – 1100	Break	
1100 – 1300	Operating Board Meeting / Working Lunch	NACA Dining Room (room 188)

PLENARY SUMMARY

Plenary Session 0800–1130 Tue 10 May 2016

Location: NASA Langley Research Center, Hampton, VA

Meeting Theme: System-level Solutions to Support the Design, Integration and Use of Autonomy

Incorporation of autonomy into real-world operational environments will create a more complex system, with new interdependencies and new relationships among various operational elements, and will require humans and machines to work together in new and different ways. Existing system performance metrics, certification criteria, and safety standards are insufficient to address the added complexities and novel characteristics of advanced autonomy. The challenge for this TAG is to identify a path forward in addressing these and other issues, including development of system-level performance metrics, certification of complex sociotechnical systems that include autonomous components, and criteria for function allocation between humans and autonomy that consider system-level constraints.

DoD HFE TAG plenary speakers are invited to bring success stories and/or current challenges in the optimization of system-level solutions to support the design, integration, and use of autonomy. Topical presentations specific to your program of interest to human factors professionals are welcome as well.

The plenary session is expected to feature 8 speakers.

- Presentations of 20 minutes in length are appropriate.
- Meeting information and registration website is www.sa-meetings.com/Tag_70. There is no registration fee for this meeting.
- Conference hosting request was approved by USD(ATL) in March 2015.
- All presentations should be unclassified and releasable to Distribution A. There may be international attendees in attendance.
- Travel and per diem costs will be the responsibility of travelers' home organizations. Directions, dining, and local lodging are provided in a separate attachment.

What is the DOD HFE TAG?

The Department of Defense Human Factors Engineering Technical Advisory Group (DOD HFE TAG) is composed of technical representatives from the Department of Defense (DoD), National Aeronautical and Space Administration (NASA), Federal Aviation Administration (FAA) and the Department of Homeland Security (DHS) with research and development responsibility in human factors and related disciplines. There is no limitation on the number of uniform or civilian representatives from the above governmental entities. Representatives from organizations and activities with allied interests and technical experts in special topical areas are also invited to attend specific meetings.

Also participating in the HFE TAG are official representatives of technical societies or industry associations with a stated interest in human factors. These representatives must be credentialed by the HFE TAG before attending. Refer to the Technical Society/Industry (TS/I) site for more information.

Origin

The Department of Defense Human Factors Engineering Technical Group (DoD HFE TAG) was implemented by a Memorandum of Understanding signed by the Assistant Secretaries of the Services in November 1976 for the purpose of coordinating and communicating research and development at the working level among the services and other Government agencies involved in Human Factors Engineering. The first HFE TAG meeting convened on August 9–10, 1977 in Fort Washington, Pennsylvania.

Goals

The major goal of the HFE TAG is to provide a mechanism for the timely exchange of technical information in the development and application of human factors engineering by enhancing the coordination among Government agencies involved in HFE technology research, development, and application. The HFE TAG also assists, as required, in the preparation and coordination of tri-service documents, and sponsors in-depth technical interaction, which aids in identifying HFE technical issues and technology gaps.

Scope

Because of the diversity of the subject matter covered by the HFE discipline, the scope of the technical areas addressed by the HFE TAG is broad. For the purposes of the HFE TAG, HFE is defined as dealing with the concepts, data, methodologies and procedures which are relevant to the development, operation and maintenance of hardware and software systems. The subject matter subsumes all technologies aimed at understanding and defining the capabilities of human operators and maintainers.

Composition

The Department of Defense Human Factors Engineering Technical Advisory Group (DOD HFE TAG) is composed of technical representatives from the Department of Defense (DoD), National Aeronautical and Space Administration (NASA), the Federal Aviation Administration (FAA), and Department of Homeland Security (DHS) with research and development responsibility in human factors and related disciplines.

TAG Proponent

Dr. Patrick Mason

Director, Human Performance, Training and BioSystems (HPTB) Research Directorate
Office of the Assistant Secretary of Defense (Research and Engineering)

More information about the TAG, including details and presentations from previous meetings, is available at: http://www.acq.osd.mil/rd/hptb/hfetag

Any questions, concerns, or requirements can be directed to the 2016 TAG Chair William Kosnik, Human Systems Implementation Division, Air Force Research Lab, Wright-Patterson AFB, William.kosnik.1@us.af.mil | 937-255-3719

PLENARY SESSION SPEAKERS

Bios

Patrick A. Mason, Ph.D.

Dr. Patrick Mason is a member of the Senior Executive Service and serves as the Director of the Human Performance, Training, and BioSystems Directorate in the Office of the Assistant Secretary of Defense for Research and Engineering. His responsibilities include providing technical leadership, management oversight, policy guidance, and coordination for over $3B/year in research and engineering programs in the DoD to ensure that these areas are focused, relevant, and capable of satisfying current and anticipated defense needs.

Dr. Mason has purview over a broad range of research areas, including medical and life sciences, human performance optimization, human factors, human- system integration, exoskeletons, combat feeding, chemical and biological defense, biometrics, language and culture understanding, training, and environmental sciences. Dr. Mason is also responsible for oversight of the DoD's animal and human use policy and regulatory affairs programs.

Dr. Mason participates on numerous committees within the Federal Government. Dr. Mason is the DoD representative on the White House National Science and Technology Council's (NSTC) Committee on Environment and Natural Resources. He serves as a co-chair of the NSTC's Subcommittee on Toxics and Risks and as the DoD representative on the NSTC Subcommittee on Life Sciences, NSTC Subcommittee on Social, Behavior, and Economic Sciences, and NSTC Interagency Working Group on Neuroscience. Within the DoD, Dr. Mason is the OSD senior member on the following Communities of Interest: Armed Services Biomedical Research Evaluation and Management (ASBREM), Autonomy, Counter Weapons of Mass Destruction (C-WMD), and Human Systems (HS). He is a member of the DoD Sustainability Council and serves as the AT&L Senior Language Authority on the Defense Language Steering Council. Dr. Mason serves as the OSD Proponent for the Human Factors and Engineering Technical Advisory Group (HFE TAG), Deployed Warfighter Protection Program (DWPP), and Genetics and Synthetic Biology Research for Human Performance Council (GSBR HPC). He serves as the chair of the Combat Feeding Research Executive Board (CFREB) and Human Performance Optimization Health Sciences Advisory Committee (HPO HSAC). Dr. Mason is a co-chair of the Warrior Injury Assessment Manikin (WIAman) Program, Irregular Warfare Senior Technical Advisory Group (IW STAG), and Joint Human Systems Integration Steering Committee (JHSISG).

Internationally, Dr. Mason serves as the United States representative on The Technical Cooperation Program (TTCP) Human Resources and Performance (HUM) Group and as the United States voting member on the North Atlantic Treaty Organization (NATO) Human Factors and Medicine (HFM) Panel. He organized and served as the co-chair of the United States—Singapore Cognitive Sciences workshop (2012) and as the co-chair of the United States—Singapore Human Systems Workshop (March 2014). He recently served as the DoD lead for the United States – India Workshops on Directed Energy and Autonomy/Cognitive Sciences (September 2014). Dr. Mason regularly reviews proposed international Project Agreements, as well as documents for the Committee on Foreign Investment in the United States (CFIUS).

Dr. David W. Miller, Chief Technologist

Dr. David W. Miller began his term as the NASA chief technologist on March 17, 2014. He serves as the agency's principal advisor and advocate on NASA technology policy and programs.

NASA's Office of the Chief Technologist coordinates, tracks and integrates technology investments across the agency and works to infuse innovative discoveries into future missions. The chief technologist leads NASA technology transfer and technology commercialization efforts, facilitating internal creativity and innovation, and works directly with other government agencies, the commercial aerospace community and academia.

Miller serves as chief technologist through an intergovernmental personnel agreement with the Massachusetts Institute of Technology, where he is the Jerome C. Hunsaker Professor in the Department of Aeronautics and Astronautics and was the Director of the Space Systems Laboratory.

Miller has a strong NASA connection, having worked with a broad range of NASA programs including the space shuttle, the International Space Station, the JWST Product Integrity Team, and the NASA CubeSat Launch Initiative. Most recently, he was the Principal Investigator for the Regolith X-ray Imaging Spectrometer for the OSIRIS-REx asteroid sample return mission, and a NASA Institute of Advanced Concepts fellow. He also recently served as the Vice Chair of the Air Force Scientific Advisory Board.

He was the principal investigator for the Synchronized Position, Hold, Engage and Reorient Experimental Satellites, or SPHERES, project on the International Space

Station. SPHERES are bowling-ball-sized free-flying satellites that have been tested for various capabilities on the ISS since 2006. Miller was also the co-principal investigator for the Middeck Active Control Experiment, which was flown on STS-67 and again on the International Space Station.

At M.I.T. Miller's work focuses on developing reconfigurable spacecraft concepts that permit repair, inspection, assembly, upgrade, fractionation and multi-mission functionality through proximity operations and docking of modular satellites using universal, standardized interfaces. He has also helped develop a technique to control satellite formations, without the need for propellant, using high temperature superconducting electromagnets. His other research includes vibration suppression and isolation, and thin face-sheet active and adaptive optics.

Miller developed a unique, multi-semester, hands-on class at M.I.T. that immerses undergraduates in the end-to-end lifecycle process of developing and operating aerospace vehicles, some of which evolved into ISS laboratories. He has extended this educational model to the graduate level to provide Air Force officers with hands-on satellite development experience with five satellite systems currently under development.

Miller earned his undergraduate and graduate degrees from MIT, and has been part of the faculty there since 1997.

Robin R. Hemphill, MD, MPH

Army Veteran
VHA Chief Safety and Risk Awareness Officer
Director, National Center for Patient Safety

Dr. Hemphill is a graduate of George Washington University Medical School. She completed an Internship in Internal Medicine followed by Emergency Medicine at the Joint Military Medical Centers in San Antonio, TX. After residency she was on active duty at Brooke Army Medical Center as an Attending Physician. During this time she was the Director of Risk Management and the Assistant Residency Director. She was involved in curriculum development for military emergency medicine residents and evaluated systems for methods of proactive error reduction.

PLENARY SESSION SPEAKERS

Bios

After the completion of her military obligation she joined the faculty at Vanderbilt University in the Department of Emergency Medicine as the Associate Program Director. She published in a variety of areas while at Vanderbilt and was involved in curriculum development and implementation of disaster preparedness issues for students, residents, nurses, and faculty within the University. Previously she was the Medical Director for the Tennessee State HRSA Hospital Bioterrorism Preparedness at Vanderbilt. She was also involved in local planning and preparedness issues for the City of Nashville and was the Medical Director for the developing Nashville Urban Search and Rescue Team. During this time she was also the President of the Tennessee College of Emergency Physicians. While at Vanderbilt she completed a Masters in Public Health with a focus on syndromic surveillance.

Several years ago Dr. Hemphill was awarded a Robert Wood Johnson Health Policy Fellow-ship and served in Senator Jeff Bingaman's office. She worked on a variety of issues including health care quality, health care disparities, FDA issues, and public health preparedness legislation. After the completion of the Fellowship, Dr. Hemphill joined the Health Care Solutions Group at Vanderbilt serving as the Associate Director. In this capacity she focused on policy related to state-based coverage initiatives and health care quality.

She moved from Vanderbilt to Emory University to be the Di-rector of Quality and Safety for the Department of Emergency Medicine. In this position, she improved the quality of health care delivery within the Emory system. And also conducted research to better inform state and federal health policy in the area of quality, value and efficiency.

On April 25, 2011, Dr. Hemphill joined VHA as the Chief Safety and Risk Awareness Officer and Director, National Center for Patient Safety. She continues to practice as an emergency medicine physician.

Richard D. Arnold, Ph.D.

Richard Arnold serves as Director, Aeromedical Research at Naval Medical Research Unit Dayton

(NAMRU-D). His Naval research career began in 1999 when he was commissioned as a US Naval Aerospace Experimental Psychologist. After completing officer indoctrination training at Newport, RI and the aeromedical officer's course and flight training at NAS Pensacola, FL he was assigned to Naval Aerospace Medical Institute, Pensacola, FL where among other duties he administered the Navy's aviation selection testing program. He was subsequently assigned to Naval Air Warfare Center, Training Systems Division, Orlando, FL, where he conducted research on simulation technologies and training effectiveness. Upon leaving active duty service in 2006 Dr. Arnold worked as a private consultant until 2008, at which date he returned to the Navy as a staff scientist at Naval Aerospace Medical Research Laboratory (NAMRL), NAS Pensacola, FL. He was promoted to Scientific Director in 2010. His research at NAMRL included work in aviation personnel selection and fatigue countermeasures. As Scientific Director he was responsible for execution of NAMRL's research mission, spanning a range of aeromedical and aviation human factors topics such as motion sickness countermeasures, spatial orientation, fatigue effects and countermeasures, hypoxia detection and mitigation, visual performance, personnel selection, and aeromedical standards. In 2011 he relocated with the laboratory, as directed by the Base Realignment and Closure Act of 2005, to Wright-Patterson AFB, OH, at which time the Research Directorate of NAMRL became the Aeromedical Research Directorate of the newly established NAMRU-D. Dr. Arnold is an active member of the Aerospace Medical Association, serves on the Executive Committee of the International Symposium on Aviation Psychology, serves on the Editorial Board of Theoretical Issues in Ergonomic Science, and has served as an ad hoc reviewer for numerous scholarly publications.

Thomas E. Nesthus, Ph.D.

Dr. Nesthus worked for KRUG Life Sciences under contract with the USAF Crew Technology Division, Brooks Air Force Base, TX from 1986-1992. He supervised staff members involved in diverse aerospace medical research projects. Additionally, he was responsible for providing human factors performance research support for the Sustained Operations Branch, Flight Motion Effects Branch, Cockpit and Equipment Integration Lab, and High Altitude Protection Function of the USAF Armstrong Research Laboratory. His research experience at Brooks, AFB included (1) the evaluation and man-rating of aircrew high altitude and high-G protection ensembles and also the cockpit integration of aircrew chemical defense ensembles, (2) pilot performance during severe hypobaric and acceleration stress, (3) evaluation of the effects of hypobaric and hypoxic hypoxia on attention, cognition, and psychomotor performance, and (4) the assessment of cognitive performance and fatigue during sustained operations with Airborne Warning and Control System Weapons Directors (AWACS WDs).

PLENARY SESSION SPEAKERS

Bios

He was hired by the FAA Civil Aerospace Medical Institute's Aerospace Human Factors Research Division in 1992. Focal research activities have included laboratory and field studies evaluating performance and fatigue associated with flight and cabin crewmembers, ATCSs, TechOps Specialists, and aviation maintenance technicians. He participates on numerous performance and fatigue-related DOT and interagency working groups. He chaired the Aerospace Medical Association's Human Factors Committee (11 yr) and the DOD Human Factors Engineering, Sustained and Continuous Operations Technical Advisory Group (13 yr). He provides consultation and human performance expertise, as requested by the National Transportation Safety Board and the Department of Justice. He testified on pilot fatigue factors associated with the crash of Colgan Air Flight 3407 during the NTSB's public hearing. Since the formation of the FAA's Aviation Rulemaking Committee in 2009, he has remained the FAA's science representative assisting the Air Transportation Division with the development and roll out of 14 CFR Part 117 Flightcrew Member Duty and Rest Requirements. Ever since the full implementation of the new rule in January 2014, he has assisted the FAA Flight Standards Division with the scientific evaluation of Fatigue Risk Management System (FRMS) proposals submitted by air carriers needing relief from the regulation in the form of an alternative method of compliance for flight operations that would exceed rule limitations. Appropriate fatigue mitigation approaches and policies are to be developed and scientifically demonstrated with data collected by the air carrier and evaluated by the FAA before authorization is granted as an Operation Specification for that particular flight operation.

Col Christopher J. Borchardt

Col (Dr.) Christopher J. Borchardt is the Human Systems Integration Advisor, Headquarters, Air Combat Command, Langely AFB, Virginia. He is responsible for delivering human performance solutions to warfighter operations in adverse conditions as well as monitoring and assessing human performance requirements in newly developing weapons systems.

Lt Col Borchardt was commissioned through the Health Professions Scholarship Program following undergraduate studies at Andrews University in Michigan and prior to attending medical school at Loma Linda University in California. As a lifelong aviation enthusiast he earned an FAA private pilot license while in college. His experience includes supporting C-21, C-141, KC-135, F-16, and F-15E Strike Eagles missions in garrison and deployed. He has participated in eight USAF accident and safety investigation boards to include the only B-2 Stealth Bomber loss and the combat loss of an F-16 northwest of Baghdad.

Lt Col Borchardt is board certified in Aerospace Medicine and Occupational Medicine by the American Board of Preventive Medicine and is a fellow of the Aerospace Medical Association. He has performed hurricane relief efforts in Honduras and combat medevac critical care air transport throughout Iraq in Army UH-60 Black Hawk helicopters.

EDUCATION

- 1992 Biology & Health Sciences, Andrews University, Berrien Springs, Michigan (matriculated to medical school prior to degree)
- 1995 Aerospace Medicine Primary, USAF School of Aerospace Medicine, Brooks AFB, Texas 1996 Doctorate of Medicine, Loma Linda University School of Medicine, Loma Linda, California
- 1997 Transitional Internship, Kettering Medical Center, Kettering, Ohio
- 2002 Air Command and Staff College (correspondence)
- 2003 Master's degree in Public Health, University of Texas, San Antonio, Texas
- 2005 Residency in Aerospace and Occupational Medicine, USAF School of Aerospace Medicine, Brooks AFB, Texas
- 2010 Air War College (correspondence)

ASSIGNMENTS

- July 1997–June 1999 Medical Director, Flight Medicine Flight, Wright-Patterson AFB, Ohio July 1999–June 2002 Flight Surgeon, Bioenvironmental & Acceleration Branch, AFRL, Wright-Patterson AFB, Ohio
- June 2002–June 2003 AFIT Master's Degree, University of Texas, San Antonio, Texas
- June 2003–May 2005 Residency in Aerospace Medicine, Brooks AFB, Texas
- June 2005–July 2008 Chief, Aerospace Medicine, Seymour-Johnson AFB, North Carolina July 2008–June 2010 Chief, Human Performance Sustainment Division, 711th Human Systems Wing, Brooks City-Base, Texas
- June 2010–June 2012 Commander, 436th Aerospace Medical Dental Squadron, Dover AFB, Delaware
- June 2012–December 2012 Deputy Commander, 380th Expeditionary Medical Group, Al Dhafra, UAE
- December 2012–Human Systems Integration Advisor, Headquarters, Air Combat Command, Langely AFB, Virginia

PLENARY SESSION SPEAKERS

Bios

FLIGHT INFORMATION

- Rating: Command Flight Surgeon, FAA Private Pilot
- Flight Hours: more than 1500
- Aircraft Flown: C-141B, C-141C, CES182R, UH-1V, UH-1N, C-21A, C-5A, T-6A, T-38A, T-37B, C-130H, C-130J, C-20B, C-37A, KC-135E, KC-135R, KC-10, E-4, T-1A, C-17A, UH-60A, UH-60L, F-16D, F-15E

MAJOR AWARDS AND DECORATIONS

- Meritorious Service Medal with one oak leaf cluster
- Air Medal
- Air Force Achievement Medal
- Iraq Campaign Medal
- Humanitarian Service Medal

OTHER ACHIEVEMENTS

- Federal Aviation Administration designated Aviation Medical Examiner (1997)
- Air Force Materiel Command Flight Surgeon of the Year (2000)
- Associate Professor, Wright State University School of Public Health (1998-2002) Diplomate of American Board of Preventive Medicine in Aerospace Medicine (2005) Diplomate of American Board of Preventive Medicine in Occupational Medicine (2008) Fellow and Life member, Aerospace Medical Association

EFFECTIVE DATES OF PROMOTION

- Second Lieutenant Apr 21, 1992
- Captain May 25, 1996
- Major May 25, 2002
- Lieutenant Colonel May 25, 2008

Col Bill Mueller

Col Bill Mueller is the Special Assistant to the Director of Engineering for Human Systems Integration at the Air Force Life Cycle Management Center. In this role, he is responsible for developing HSI capability within AFLCMC's Systems Engineering enterprise. Col Mueller is also the director of the USAF Pilot-Physician Program. Previously, Col Mueller served as the Director for Human Systems Integration at the 711HPW. Col Mueller is a Command Pilot and Chief Flight Surgeon with over 3,000 flying hours as an instructor and aircraft commander in the T-37, T-38, RF-4C, and B-1B aircraft.

PLENARY SESSION SPEAKERS

Bios

Karl F. Van Orden, Ph.D.

Senior Technologist for Decision Optimization
Space and Naval Warfare Systems Center Pacific
San Diego, California

Dr. Karl F. Van Orden is the Senior Technologist for Decision Optimization at the Space and Naval Warfare Systems Center Pacific in San Diego, California. He is responsible for leading research and development in human factors, cognition and decision processes to improve the performance of warfighters working with complex Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems. He was appointed to the scientific and technical cadre of senior executives in 2015.

Dr. Van Orden joined the Navy as a Medical Service Corps Research Psychologist in 1986 and held a variety of research and leadership positions while assigned to the Naval Medical Research

Institute in Bethesda, MD; the Naval Submarine Medical Research Laboratory in Groton, CT; and two tours at the Naval Health Research Center in San Diego. From 1998 to 2001, he was assigned to the Space and Naval Warfare Systems Center Pacific conducting prototype command and control console development studies for improving operator interfaces and information management within the AEGIS shipboard air defense warfare system. He developed novel realtime workload measures and developed and patented a system to detect fatigue in operators.

After retiring from active duty, Dr. Van Orden served as the Director of Research and Development at the Naval Health Research Center from 2006 to 2015, which grew from 180 to over 350 personnel. From 2007 through 2012, he worked to develop a strong portfolio in psychological resilience studies while serving as a Technical Development Agent for the Office of Naval Research's Human Performance, Training, and Education Program within the Expeditionary Maneuver Warfare Department.

Dr. Van Orden has received numerous military and civilian performance awards, including the Navy Superior Civilian Service Award in 2015. He is a member of the American Association for the Advancement of Science, the Association for Psychological Science, and the Human Factors and Ergonomics Society.

PLENARY SESSION SPEAKERS

Bios

Dr. Van Orden received his Bachelor of Arts degree in Psychology from Syracuse University in 1982. He received his Master's degree in 1986 and his Ph.D. in Biological Psychology (visual perception and psychophysics) from Syracuse University in 1988.

Lieutenant Colonel Troy P. Faaborg

Lt Col Troy Faaborg is the Chief, Air Force Human Systems Integration, Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering, at The Pentagon. Lt Col Faaborg advises the Assistant Secretary of the Air Force for Acquisition on Air Force- and Department of Defense-level human systems integration policies, processes and programs. Lt Col Faaborg also defines and advocates human-centered operational and technical requirements, and assesses human performance and human factors safety and suitability in the weapon system technical planning and management process.

Lt Col Faaborg was born and raised in Burlington, Iowa, and he graduated from Iowa State University with a Bachelor's Degree in Health and Human Performance. He was commissioned into the Air Force through the Reserve Officer Training Program, and was selected to be an Aerospace and Operational Physiologist in the Biomedical Science Corps. His career as an Aerospace and Operational Physiologist includes a variety of assignments in aircrew training, education, and safety. Lt Col Faaborg is a Fellow in the Aerospace Medical Association and has served as the chair of the Association's Aerospace Physiology Certification Board. He has also served as the President of the Aerospace Physiology Society, a constituent organization of the Aerospace Medical Association. Lt Col Faaborg and his wife Jennifer have two sons, Noah and Jonas.

EDUCATION AND CERTIFICATION:

- 1998 Bachelor of Science in Exercise Physiology/Iowa State University
- 2003 Master of Aeronautical Science/Embry-Riddle Aeronautical University
- 2003 Master of Science in Applied Human Factors Engineering/University of Illinois at Urbana-Champaign
- 2004 Squadron Officer School/Maxwell AFB, Alabama
- 2007 Board Certification in Aerospace Physiology
- 2009 Air Command and Staff College (non-resident)/Maxwell AFB, Alabama
- 2009 Master of Military Operational Art and Leadership/Air University
- 2015 Certified Acquisition Professional (DAWIA), Science & Technology Manager Level I
- 2015 Certified Acquisition Professional (DAWIA), Engineering Level I

ASSIGNMENTS

1. June 1998–July 1999, Aerospace Physiologist, Wright-Patterson AFB, OH
2. July 1999–July 2001, Aerospace Physiologist, Vance AFB, OK
3. July 2001–June 2003, Student, Air Force Institute of Technology, University of Illinois at Urbana Champaign, IL
4. June 2003–June 2006, Human Performance Training Flight Commander, Aviano AB, Italy
5. June 2006–May 2008, Chief, Human Performance Enhancement, Whiteman AFB, MO
6. May 2008–May 2010, Aerospace Medicine Flight Commander, Whiteman AFB, MO
7. May 2010–July 2014, Chief, Human Factors Division, HQ AFGSC Safety Directorate, Barksdale AFB, LA
8. July 2014–July 2015, Principal Deputy, Air Force Human Systems Integration Office, HQ Air Force, The Pentagon
9. July 2015–present, Chief, Air Force Human Systems Integration, HQ Air Force, The Pentagon

MAJOR AWARDS AND DECORATIONS:

- Meritorious Service Medal with Oak Leaf Cluster
- Air Force Commendation Medal with Oak Leaf Cluster
- Air Force Achievement Medal with two Oak Leaf Clusters
- National Defense Service Medal
- Global War on Terrorism Service Medal
- Military Outstanding Volunteer Service Medal with two Oak Leaf Clusters

EFFECTIVE DATES OF PROMOTION:

Second Lieutenant	09 May 1998
First Lieutenant	26 May 2000
Captain	26 May 2002
Major	01 April 2008
Lieutenant Colonel	01 June 2014

Human M&S Workshop

9 May 2016 | 1130 – 1500

Room 265/266

Moderator: John Rice

Based on the feedback from the modeling and simulation pre-TAG workshop last year, the Human Modeling and Simulation SubTAG will conduct its 2nd workshop beginning PROMPTLY at 1130 Monday May 9th ending at 1500.

This year's course will be provided by facility and students from the Old Dominion University M&S (BS/MS/PhD) program & the Virginia Modeling, Analysis & Simulation Center (VMASC). It will provide a brief overview of some M&S basics and then use small team hands on experience creating and presenting for comparison, the working models that incorporate human factors effecting the outcomes. Each group will be provided with a problem, a computer preloaded with an open source M&S software package and supporting staff members.

LEARNING OBJECTIVES:

1. Recognition of different types of models and their usefulness and limitations for HF modeling.
2. Gain an awareness of the many and growing number of commercial and open source M&S tools that can be used to build and maintain specific models at relatively low cost.
3. Experience the thrill of building a model to answer a work related question, while learning more about what models are and how they can be used in HF related applications.
4. Gain an appreciation for the challenging task of defending a model and its output.

These objectives are translatable to the work and decisions required by Government HF program managers whose programs include the development or use of models and/or simulations to achieve cost beneficial returns on capital investments.

SESSION AGENDAS

Autonomy Special Session

9 May 2016 | 1515 – 1745
Room 262/263

Welcome to NASA LaRC Introduction to the Autonomy Session
Cynthia Null, NASA

Autonomy Incubator
Danette Allen, NASA Langley Research Center (LaRC)

Integrated Vehicle Health Management
Lorraine Fesq, Jet Propulsion Laboratory/California Institute of Technology

New Technologies in Air Traffic Management
Jessica Nowinski, Airspace Operations and Safety Program Office at NASA HQ.

HRI: Achieving the Vision of Effective Soldier-Intelligent Systems Teaming
Susan Hill, US Army Research Laboratory (ARL)

Rapid Global Mobility in Both Ground and Flight Operations
Donna Senft, Air Mobility Command, Scott Air Force Base, IL

Assessing Human-Machine Trust
Svyatoslav Guznov, Air Force Research Laboratory (AFRL), Wright-Patterson Air Force Base

TBD
Marc Steinberg, ONR

SESSION AGENDAS

HFE/HSI Session I

10 May 2016 | 1300 - 1500
Room 262/263

1300 – 1305	**Setup and Welcome** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect
1305 – 1330	**Equipping the Warfighter: Diggerworks and Adaptive Acquisition** Alistair Furnell, Defense Science and Technology Group
1335 – 1440	Air Force Life Cycle Management Center HSI Implementation William Mueller, USAF
1405 – 1430	**The Human Systems Integration Framework (HSIF): Updates to pre-Acquisition activities; Use cases for flexible Acquisition models.** Frank Lacson, Pacific Science & Engineering Group, Inc.
1435 – 1500	**Analytical and Visualization Methods for Understanding Unstructured Text Data** Stephen Dorton, Sonalysts

HFE/HSI Session II

12 May 2016 | 1030 - 1230
Room 262/263

1030 – 1035	**Setup and Welcome** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect
1030 – 1145	**Combat Information Center (CIC) Current and Future Capabilities** Sean Driscoll, Jon Dachos, Araya Semhar, Lorena De Los Santos, Hope Tuner,NSWCDD John Winters, Basic Commerce and Industries, Inc. Sazanne Hanna, Defence Science Technology Group- Australian Defence Force
1150 – 1215	**Graduate Education Opportunities in Human Systems Integration** Nita Shattuck, Naval Postgraduate School
1220 – 1230	**HFE/HSI subTAG Business** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect

SESSION AGENDAS

Training Session I

10 May 2016 | 1300 - 1500
Room 265/266

1300 – 1305	**Introductory Remarks and Admin**
1305 – 1355	**Maintenance Training: The Value of Coupling the Seven Step Troubleshooting Process to Simulation** Michael Cummings, NAWCTSD
1355 – 1415	**Towards Performance Based Assessment for a Portable Landing Signal Officer Virtual Reality Training System** Lee Sciarini, NPS
1415 – 1440	**Essential Attributes of Augmented Reality in Training Environment** Room 265/266 Nathan Jones, MARCORSYSCOM
1440 – 1445	**Final Admin/Resolutions**

Training Session I

11 May 2016 | 1500 - 1700
Room 265/266

1500 – 1505	**Introductory Remarks and Admin** Room 265/266
1505 – 1530	**Significance and Applications of an Autonomous Synthetic Teammate** Erin Hanson, Cognitive Models and Agents Branch, Air Force Research Laboratory
1530 – 1555	**Deployable LVC Training Technology for Pararescue** Aerial Camden, Air Force Research Laboratory
1555 – 1620	**Tactical Combat Casualty Care (TC3) Training and Learning in the Squad Overmatch (SOvM)-TC3 Project** Hank Phillips, Naval Air Warfare Center Training Systems Division
1620 – 1645	**Acquisition Workforce Development: DHS HSI Training and Certification Program** Thomas Malone, DHS/S&T/Office of Systems Engineering/HSI
1645 – 1650	**Final Admin/Resolutions**

SESSION AGENDAS

Modeling & Simulation Session I

10 May 2016 | 1530 – 1730
Room 262/263

1530 – 1555	Life Is Complicated: Synthetic Population Modeling in Computational Biology and Potential in Human Factors Engineering Christopher Conow, NUZHDIN Labs, Univ of Southern CA
1555 – 1620	Neuromusculoskeletal Modeling of Soldier Load Carriage Gives Insight into Underlying Indicators of Injury Risk John Ramsay, Natick Soldier Research, Development, and Engineering Center
1620 – 1645	Leveraging Healthcare Training Infrastructures for Human Factors Assessment of Prototype Medical Devices Danial McFarlane, Philips Medical
1645 – 1710	Simulation as a Tool for Human Factors Related to Patient Safety in Veterans Health Administration Medical Centers. Tandi Bagian, VHA NPSC
1710 – 1730	**HM&S SubTAG Meeting** Tandi Bagian, VHA NPSC

Modeling & Simulation Session II

11 May 2016 | 0800 – 1000
Room 262/263

0800 – 0815	Modeling of Human-System Interactive Effects in Systems of Systems Matthew Hoffman, Sandia National Laboratories
0815 – 0830	Human Performance Fusion in the Executable Architecture Management System (ExAMS) Ira Minor, SPAWAR SYSCOM HQ
0830 – 0845	Applying SysML, IMPRINT, and Human Experimentation to Better Design Human-Machine Interaction Michael Miller, Air Force Institute of Technology
0845 – 0900	Gaining insight from models of complex human/computer systems Robert Abbott, Sandia National Laboratories
0900 – 0915	Adapting mission recordings as examples for semi-automated forces Robert Abbott, Sandia National Laboratories
0915 – 0930	The Task Map Analysis Process Gail Nicholson, NSWC Crane

SESSION AGENDAS

Test & Evaluation

10 May 2016 | 1530 – 1730
Room 201/202

1530 – 1545	**Welcome - Vote for new Chair** Darren Cole
1545 – 1610	**Spatial Orientation in Flight with Helmet Mounted Displays** Tom Schnell, University of Iowa
1610 – 1635	**Research and Development of Helmet Mounted Display Symbology for the Air Soldier System** Bradley Davis, Army Research Laboratory, Human Research & Engineering Directorate
1635 – 1700	**Evaluation of Synthetic Vision Display Concepts for Improved Awareness in Unusual Attitude Recovery Scenarios** Stephanie Nicholas, National Aeronautics and Space Administration
1700 – 1725	**Combining eye tracking with traditional approaches for a system-level performance evaluation.** Yevgeniy Sirotin, Scitor, an SAIC company
1725 – 1730	**Closing Remarks** Darren Cole

Unmanned Systems Session I

10 May 2016 | 1530 – 1730
Room 265/266

Supporting Manned-Unmanned Teaming Operations with Dynamic Multi-vehicle Autonomy and Interface Design
Grant Taylor, U.S. Army AMRDEC Aviation Development Directorate

Decision Making Support for Human-Machine Collaboration in Complex Environments: Determining Design Requirements
Jen Pagan, SubTAG Chair

Can Autonomous Systems be Teammates?
James Walliser, George Mason University

Designing for Autonomous Cargo Operations
Brian Moon, Perigean Technologies LLC

SESSION AGENDAS

Unmanned Systems Session II

10 May 2016 | 0800 – 1000
Room 265/266

Supervisory and Executive Control of Unmanned Systems: Conceptual Framework and User Interface Impacts
Dennis Folds, Georgia Tech Research Institute

Pilot critical incident reports as a means to identify human factors in the operation of Remotely Piloted Aircraft
Alan Hobbs, San Jose State University Research Foundation/NASA Ames

SPECTRE: A Sensor Management Workstation leveraging Human-Automation Teaming
Terry Stanard, 711 Human Performance Wing, Air Force Research Laboratory (711 HPW/RHCI)

Using Simulation to Assess UAS Detect and Avoid Acceptability for Air Traffic Controllers and Ground Control Station Pilots
James Comstock, NASA Langley Research Center

Human-UAV Hybrid Team in Real-Time Environment Exploration
Zhuming Ai, Naval Research Laboratory, Code 55841

Tech Society/Industry Meeting

11 May 2016 | 0700 - 0800
Room 262/263

Aesop's Fable of the Cat and the Fox: What HSI Could Glean from Lean UX
Julie Naga, Booz Allen Hamilton

DoD HSI Standards Working Group – Update
Owen Seely, NSWC Dahgren

How the Air Force Executes HSI
William Kosnik, Air Force Research Laboratory

AF Human Systems Integration Capabilities and Requirements Tool
Roger Spondike, 711 HPW / Directorate Human Systems Integration

Formal Methods in Human Systems Integration
Jennifer Narkevicius, TBD
Steve Harris, Rational, LLC

SESSION AGENDAS

Controls & Displays

11 May 2016 | 0800 - 1000
Room 201/202

Now you see it and your hands don't: Using eye-tracking to enhance performance of gross-motor gestural controls
Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration

An Investigation of Loss of Well-Clear Incidences from the Collision Avoidance, Self-Separation, and Alerting Times (CASSAT) Human in the Loop Experiment.
Michael Vincent, NASA Langley

Electro Optic / Infrared Sensor Standardization for Surface Ships: Methodology and Techniques for Human Based Ship Board Data Collection
Marc Keller, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration

Agile Design & Section 804: A Human Factors Engineering Best Practice to support SCRUM
Alan Lemon, Space and Naval Warfare Systems Center, Pacific

Tablets in the Cockpit: Human Factors Issues in Military Aviation
Dennis Folds, Georgia Tech Research Institute

Mixed Reality

11 May 2016 | 1230 – 1430
Room 265/266

1230 – 1245	**Mixed Reality SubTag Introduction**
1245 – 1320	**Naval Workspace Prototype Evaluation using Projection Augmented Models and Tangible User Interfaces** Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration
1320 – 1355	**A Mixed-Reality Simulation for Tank Platoon Leader Communication Training** Peter Khooshabeh, US Army Research Laboratory, Human Research and Engineering Directorate
1355 – 1430	**Towards a Single Software Service for Multimodal Human Computer Interaction: Laying the Foundation for Intuitive Interfaces in the Next Generation of DoD Systems** Daniel Yaeger, US Army

SESSION AGENDAS

Sustained Operations

11 May 2016 | 1230 – 1430
Room 201/202

Introductions: "Welcome back Kotter..."
Thomas Nesthus and Nancy Wesensten

Sustained Operations Research at the Naval Aeromedical Research Unit Dayton
Richard Arnold, Naval Medical Research Unit Dayton

The NASA Fatigue Countermeasures Laboratory: Report of Current Activities
Erin Flynn-Evans, NASA

Work and sleep patterns in military shift workers: promoting health and wellness through informed shift schedules
Nita Shattuck, Naval Postgraduate School

An Individiualizable Model to Predict Sleep/Wake and Caffeine Effects on Cognitive Performance
Jaques Reifman, US Army

Trust in Autonomy Special Interest Group

11 May 2016 | 1230 – 1430
Room 262/263

My Co-Pilot is a Time Machine
Tamara Chelette, US Air Force Research Lab

Trust of an Automated Collision Avoidance System within the Air Force
William Fergueson, Air Force Research Laboratory

Tracking Fatigue and Reliance on Automation in Multi-UAV Operation
Gerald Matthews, University of Central Florida

Monitoring Operator State Through Psychophysiological Indices in Military Aircraft
David Boudreaux, U.S. Army Aeromedical Research Laboratory

Factors Affecting Performance of Human-Automation Teams
Anthony Baker, Embry-Riddle Aeronautical University

Using Natural Language to Enhance Mission Effectiveness
Anna Trujillo, NASA Langley Research Center

SESSION AGENDAS

Design: Tools & Techniques Session I

11 May 2016 | 1500 – 1700
Room 201/202

1500 – 1515	Welcome and SubTAG Business - Chelsey Lever
1520 – 1550	Using Model Based Tools to Support Human Automation Interaction Angelia Sebok, Alion Science and Technology
1555 – 1624	AF Human Systems Integration Capabilities and Requirements Tool (HSI-CRT) Roger Spondike, Booz Allen Hamilton
1630 – 1700	Making Software a Human Sensor for Integration and Performance Joshua Poore, Draper

Design: Tools & Techniques Session II

12 May 2016 | 1330 – 1530
Room 201/202

1330 – 1335	Welcome and SubTAG Business Chelsey Lever
1340 – 1410	The Military Anthropometry Resource Companion (MARC): A Tool for Accessing & Analyzing Anthropometry for Physical Accommodation Christopher Garneau, ARL-HRED
1415 – 1445	User Centered Design Applied to USAF Civil Engineering Explosive Ordinance Disposal Tools and Jigs Michael Miller, Air Force Institute of Technology
1450 – 1520	Developing Emprically-Derived Quantitative Human Systems Integration Guidelines for Systems Engineering Hunter Kopald, The MITRE Corporation

SESSION AGENDAS

Human Performance Measurement

11 May 2016 | 1500 – 1700
Room 262/263

1500 – 1505	**Introduction / Overview** Co-Chairs
1505 – 1530	**Performance in Noise: Impact of Degraded Speech Intelligibility on Sailor Performance in a Navy Command Environment** Marc Keller, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration
1535 – 1600	**Effects of normobaric hypoxia on task performance, psychophysiological measures of performance, and self-reported workload.** Chad L. Stephens, NASA
1600 – 1625	**Automation and Visual Attention Failure in a Simulated Flight Task** Kellie Kennedy, NASA
1630 – 1655	**Rapid Development of Precise Metrics for Human Performance Assessment** Stephen James, Washington State University
1655 – 1700	**Wrap-Up & Presentations - Co-Chairs**

SESSION AGENDAS

Cyber Security Special Interest Group Session I

12 May 2016 | 0800 – 1000
Room 265/266

A Functional and Organizational Cyber Unification Space (FOCUS)
Gina Thomas, Air Force Research Lab 711HPW/RHCV

Standardization in Cyber
Lisa Billman, AFLCMC/HNCY MITRE

Cyber Security Visualization – State of Practice
Anita D'Amico, Secure Decisions

Collaborative Data Analysis and Discovery for Cyber Security
Diane Staheli, MIT Lincoln Laboratory

Internalizing and Integrating Cybersecurity Approaches
John Valencia, City of San Diego - Office of Homeland Security,

Cyber Security Special Interest Group Session II

12 May 2016 | 1330 – 1530
Room 265/266

Analytic Questions and Visualization Objectives to Orient Network Defense Visualization Design
Laurin Buchanan, Secure Decisions

Cyber-cognitive Situation Awareness (CCSA)
Robert Gutzwiller, Space and Naval Warfare Systems Center Pacific

Simulation Methodology for Investigating Biometric Markers for Insider Threat
Gerald Matthews, University of Central Florida

The Role of Autonomous Agents in a Cyber Security Instruction Environment
Denise Nicholson, Soar Technology, Inc.

SESSION AGENDAS

Human Factors Standardization

12 May 2016 | 1330 – 1530
Room 265/266

Introduction of Attendees

Status Reports and Presentations

MIL-STD 1472H Working Group Team Meeting
Alan Poston, DoD HFE TAG Member Emeritus / Consultant
Daniel Wallace, Naval Sea Systems Command

Occupant-Centric Platform

Managing MIL-STD-1474E Software
Bruce Amrein, Army Research Laboratory: Human Research & Engineering Directorate
Paul Fedele, Army Research Laboratory: Human Research & Engineering Directorate
Charles Kennedy, Army Research Laboratory: Survivability/Lethality Analysis Directorate

NASA HIDH Update; HSI Practitioner Guide

G-45 Human Systems Integration Committee

Flight Symbology Working Group – MIL-STD-1787

Development of a Human-Systems Integration Standard

Development of a Human-Systems Integration Handbook

Human Factors Standardization Activities at the USCG

Development and application of a process standard to improve safety and efficiency of powered hand tools
Ghazi Hourani, Navy and Marine Corps Public Health Center

Recent Data Item Description Activity

Charter Changes

Election

New Business and Second Thoughts

SESSION AGENDAS

Extreme Environments / Cognitive Readiness

13 May 2016 | 0830 – 1030
Room: 265/266

Increasing Crew Autonomy for Future Human Spaceflight Missions
Kerry McGuire, NASA

Measuring Stress from Behavioral, Biological, and Psychological Perspectives during Simulated Mars Missions in Hawaii
Jocelyn Dunn, Purdue University

Investigating Hypoxia: Challenges and Lessons Learned
Brenda Crook, 711 Human Performance Wing/HPIF

Coast Guard Arctic Operations
Christian Kijora, U.S. Coast Guard

EEG-based Artificial Neural Network classification of intuition and analysis cognition
Joseph Nuamah, Seeung Oh, Marcia Nealy, Younho Seong, North Carolina A&T State University

SESSION AGENDAS

Personnel

13 May 2016 | 0830 – 1030
Room: 201/202

8:30 – 8:40	**Administrative tasks/discussion**
0840 – 0910	**Non-Cognitive Methods to Improve Military Personnel Classification: Interest and Job Previews** James Johnson, HQ Air Force Personnel Center, Randolph AFB, TX
0910 – 1010	**The Aviation Selection Test Battery - E: Preliminary Results and Discussion** Mike Natali, USN
0940 – 1010	**UAS Pilot Person-Job Match Optimization using Aptitude and Personality** Hector Acosta, HQ Air Force Recruiting Service
1010 – 1030	**Additional remarks, review, closing**

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Unmanned Systems	Laura Milham	laura.milham@navy.mil
User Computer Interaction	John Taylor	john.k.taylor3@navy.mil

ABSTRACTS

Human M&S Workshop

9 May 2016 | 1130 – 1500
Room 265/266

Moderator: John Rice

Based on the feedback from the modeling and simulation pre-TAG workshop last year, the Human Modeling and Simulation SubTAG will conduct its 2nd workshop beginning PROMPTLY at 1130 Monday May 9th ending at 1500.

This year's course will be provided by facility and students from the Old Dominion University M&S (BS/MS/PhD) program & the Virginia Modeling, Analysis & Simulation Center (VMASC). It will provide a brief overview of some M&S basics and then use small team hands on experience creating and presenting for comparison, the working models that incorporate human factors effecting the outcomes. Each group will be provided with a problem, a computer preloaded with an open source M&S software package and supporting staff members.

LEARNING OBJECTIVES:

1. Recognition of different types of models and their usefulness and limitations for HF modeling.
2. Gain an awareness of the many and growing number of commercial and open source M&S tools that can be used to build and maintain specific models at relatively low cost.
3. Experience the thrill of building a model to answer a work related question, while learning more about what models are and how they can be used in HF related applications.
4. Gain an appreciation for the challenging task of defending a model and its output.

These objectives are translatable to the work and decisions required by Government HF program managers whose programs include the development or use of models and/or simulations to achieve cost beneficial returns on capital investments.

ABSTRACTS

Autonomy Special Session

9 May 2016 | 1515 – 1745
Room 262/263

Organizer: Faith Chandler
Moderator: Cynthia Null

Welcome to NASA LaRC Introduction to the Autonomy Session
Cynthia Null, NASA

Autonomy Incubator
Danette Allen, NASA Langley Research Center (LaRC)

Integrated Vehicle Health Management
Lorraine Fesq, Jet Propulsion Laboratory/California Institute of Technology

New Technologies in Air Traffic Management
Jessica Nowinski, Airspace Operations and Safety Program Office at NASA HQ.

HRI: Achieving the Vision of Effective Soldier-Intelligent Systems Teaming
Susan Hill, US Army Research Laboratory (ARL)

Rapid Global Mobility in Both Ground and Flight Operations
Donna Senft, Air Mobility Command, Scott Air Force Base, IL

Assessing Human-Machine Trust
Svyatoslav Guznov, Air Force Research Laboratory (AFRL), Wright-Patterson Air Force Base

TBD
Marc Steinberg, ONR

ABSTRACTS

Autonomy Incubator*

Danette Allen, NASA Langley Research Center (LaRC)

As we seek to bridge the gap between highly automated and autonomous systems, we are rethinking the roles and responsibilities played by humans and machines in our missions. Shifting from the relegation of tasks to the delegation of responsibility means regarding machine systems as teammates rather than thralls. With delegation comes the expectation that assigned responsibilities will be executed with minimal or no oversight based on a shared understanding of intent. Effectively communicating intent between teammates is critical to overcoming unexpected hurdles in a way that achieves mission success.

Integrated Vehicle Health Management*

Lorraine Fesq, Jet Propulsion Laboratory/California Institute of Technology

JPL has been developing autonomy capabilities since the early days of space exploration, starting with the Mariner mission to Venus in the early 1960s. Over the past 50 years, JPL has developed capabilities such as autonomous entry, decent and landing onto the surface of Mars, autonomous orbital insertions around other planets, and autonomous surface navigation. In 2014, JPL identified Autonomy as one of the top areas that is critical to its future, and chartered the development of a strategic plan to provide coordination across the diverse disciplines that make up Autonomy, and to establish a roadmap for guidance in internal funding decisions and partnership/collaboration opportunities. This talk will provide an overview of JPL's Autonomy capabilities, identify the challenges that the Lab is facing, and identify current and future collaboration opportunities.

New Technologies in Air Traffic Management

Jessica Nowinski, Airspace Operations and Safety Program Office, NASA HQ.

As flight deck and air traffic management systems become increasingly intelligent, better interfaces with the remaining humans in the system will become critically important to safety and mission assurance. The human and system roles will need to adjust to incorporate the strengths of each. Human operators will primarily serve to make these increasingly autonomous systems more adaptive to non-deterministic elements in the environment. The system will need to provide timely and accurate information in order to engage these humans in real-time problem solving. In addition, intelligent systems can serve to monitor human operators to ensure their performance.

ABSTRACTS

HRI: Achieving the Vision of Effective Soldier-Intelligent Systems Teaming

Susan Hill, US Army Research Laboratory (ARL)

A U.S. Army Research Laboratory (ARL) vision for the future is effective Soldier-intelligent system teaming—having Soldiers team with autonomous, intelligent unmanned systems much as they team with fellow Soldiers. Examining how humans interact with such technology and understanding the inherent issues of these interactions is critical to that vision.

We have primarily, but not exclusively, considered interaction with embodied, mobile intelligent systems, which we will call “robots.” In our effort to better understand the issues related to Soldiers-robot teaming, ARL supports an on-going line of basic and applied research in human-robot interaction (HRI). We have completed experimental research into human interaction with increasing autonomous capabilities. Currently, our research program focuses on three areas: Soldier-Machine Communications, Intra-team Behavior (including teaming and trust), and Societal Interaction. Each of these areas will be discussed briefly, and examples of research being conducted within each area will be presented. We will review the organization of our research program, including our internal research, collaborative alliances among government, industry and academia, and identify opportunities for collaboration. Finally, challenges for the future will be addressed.

Rapid Global Mobility in Both Ground and Flight Operations

Donna Senft, Air Mobility Command, Scott Air Force Base, IL

The Air Mobility Command (AMC) recognizes the potential of autonomous systems to utilize manpower more effectively and improve flight and ground safety. AMC is actively supporting efforts to develop autonomous systems for Rapid Global Mobility in both ground and flight operations. At the same time, there is recognition of the barriers to introducing autonomous systems into a command with a high operational tempo. Last year, AMC flew more than 28,266 airlift and 13,841 air refueling sorties, transporting 224,229 tons of cargo and 1.3 billion pounds of fuel. The introduction of new technologies to produce long-term efficiencies cannot impact near-term operations, and human factors must be carefully integrated into technology development efforts for AMC autonomous systems.

ABSTRACTS

Assessing Human-Machine Trust

Svyatoslav Guznov, Air Force Research Laboratory (AFRL), Wright-Patterson Air Force Base

The Human Insight and Trust (HIT) team is part of the Air Force Research Laboratory (AFRL) performing a wide array of research in the area of human-machine trust, teaming, and suspicion. Appropriate trust in human-machine systems is a critical component to successful military missions. Multiple factors affect trust including system performance, interface transparency, training, and individual differences. Due to its multi-dimensional nature, trust is a difficult construct to measure. For example, measuring trust by using only a reliance metric might be insufficient: an individual might rely on the system, but not necessarily trust it. The HIT team is currently developing and validating self-report and psychophysiological metrics to assess trust, suspicion, and related constructs. We are collaborating with several directorates within the AFRL, NASA Ames, the Army Flight Development Directorate (AFDD), and academic institutions including Wright State University, Gettysburg College, Syracuse University, and Yale University.

TBD

Marc Steinberg, ONR

[Not cleared for release]

ABSTRACTS

HFE/HSI

SubTAG: HFE/HSI
Chair: Ms. Pamelyn Maynard   Chair Elect: Dr. Rebecca Iden

HFE/HSI Session I

10 May 2016 | 1300 - 1500
Room 262/263

1300 – 1305	**Setup and Welcome** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect
1305 – 1330	**Equipping the Warfighter: Diggerworks and Adaptive Acquisition** Alistair Furnell, Defense Science and Technology Group
1335 – 1440	Air Force Life Cycle Management Center HSI Implementation William Mueller, USAF
1405 – 1430	**The Human Systems Integration Framework (HSIF): Updates to pre-Acquisition activities; Use cases for flexible Acquisition models.** Frank Lacson, Pacific Science & Engineering Group, Inc.
1435 – 1500	**Analytical and Visualization Methods for Understanding Unstructured Text Data** Stephen Dorton, Sonalysts

HFE/HSI Session II

12 May 2016 | 1030 - 1230
Room 262/263

1030 – 1035	**Setup and Welcome** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect
1030 – 1145	**Combat Information Center (CIC) Current and Future Capabilities** Sean Driscoll, Jon Dachos, Araya Semhar, Lorena De Los Santos, Hope Tuner,NSWCDD Mr. John Winters, Basic Commerce and Industries, Inc. Ms. Sazanne Hanna, Defence Science Technology Group- Australian Defence Force
1150 – 1215	**Graduate Education Opportunities in Human Systems Integration** Nita Shattuck, Naval Postgraduate School
1220 – 1230	**HFE/HSI subTAG Business** Ms. Pamelyn Maynard, Session Chair; Dr. Rebecca Iden, Chair Elect

ABSTRACTS

Equipping the Warfighter: Diggerworks and Adaptive Acquisition

Alistair Furnell, Defence Science and Technology Group

Background: Diggerworks was formed in 2011 through a Memorandum of Understanding between the heads of the Australian Army, Capability and Sustainment Group, Capability Development Group and Defence Science and Technology Group (DSTG); with its remit being to address the procurement process shortcomings that often resulted in poor fitting equipment that did not integrate well on the dismounted soldier. Working in partnership, the lead organisations have been able to coordinate the application of an adaptive approach to modernising capability, based on harnessing user feedback, developing innovative solutions and delivering highly functional equipment.

Methods/Results: DSTG provides Human Factors support to the design and evaluation of Soldier Systems within the Diggerworks organisation and more widely to other programs. Frequently this involves the planning, conduct and reporting of user trials. In all cases, evidence is required concerning the effectiveness of the new piece of equipment coupled with an assessment of any impacts that it makes on other aspects of a soldier's ability to carry out his core tasks. In the last 5 years the range of equipment addressed has ranged from personal weapons, to protective equipment such as body armour or helmets, and boots and combat uniforms. This paper will:

1. Provide an overview of the Diggerworks organisation and its facilities;
2. Provide an overview of the Adaptive Acquisition process, comparing and contrasting with more traditional procurement methods;
3. Demonstrate the impact of Human Factors activities for end users of equipment through reference to a number of specific examples;
4. Present challenges and opportunities going forward.

Conclusion: In conclusion, it is the primary aim of this paper to demonstrate the practical application and impact of Human Factors within a novel organisational structure and secondly, to give host nation delegates an appreciation of the breadth of activities undertaken with the objective of promoting further discussion during the conference.

Potential impact to mission/warfighter (if applicable): An equipment procurement and development function within Australian Defence that delivers dismounted equipment that has the functionality required by frontline soldiers in a timely manner.

ABSTRACTS

Air Force Life Cycle Management Center HSI Implementation

William Mueller, USAF

In 2013, the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering took steps to establish Human Systems Integration into the Air Force's Engineering Enterprise. Since that time, the Air Force Life Cycle Management Center has identified HSI as a technical competency within the Systems Engineering field and has established a framework for executing HSI within its program office directorates. This presentation will summarize AFLCMC's HSI accomplishments and the plan for establishing HSI capability at AFLCMC by 2020.

The Human Systems Integration Framework (HSIF): Updates to pre-Acquisition activities; Use cases for flexible Acquisition models.

Frank Lacson, Pacific Science & Engineering Group, Inc.; John Gwynne, Pacific Science & Engineering Group, Inc.; Matthew Risser, Pacific Science & Engineering Group, Inc.; William Kosnik, USAF HSI Directorate, 711th Human Performance Wing

The HSI Framework (HSIF) is an interactive process diagram that visualizes and aligns the technical activities, collaborations, and products of all HSI Domains across the DoD Acquisition Life Cycle. Activities originate from relevant HSI-related guidance, standards, and best practices across DoD Services and non-DoD organizations. A timeline display references activities to Systems Engineering Technical Reviews and Acquisition milestones. The HSIF provides technical value to HSI Practitioners, Program Managers, MAJCOM/SYSCOM Technical Authorities, System Engineers, and Prime Contractors.

This presentation provides an update to the pre-Acquisition activities, based on the Air Force Development Planning (DP) process. Policy, standards, guidance, and best practices were collected to generate a series of activities related to Capabilities Based Assessment (CBA), Concept Characterization and Technical Description (CCTD), and the Analysis of Alternative (AoA) Study Plan Guidance. Also presented are updates to content on Modeling & Simulation (M&S) and Science & Technology (S&T) downselect efforts for systems in early-Acquisition.

Also featured are end-to-end use cases on how HSI practitioners can utilize the following HSIF software capabilities: Save/Retrieve models, edit activities, generate reports, and manage document and product repositories. These capabilities provide the flexibility for HSI practitioners to plan, conduct, and execute effective HSI in various Acquisition models, as specified in DoDI 5000.02 (07 JAN 2015).

For HSI Practitioners and Systems Engineers, access to pre-Acquisition guidance and capabilities to create custom HSI Framework models provides way to effectively adapt to different types of System Development. In turn, Program Managers are given the information needed to accurately assess human-related program risks, leading to relevant and scoped HSI plans. At the Service level, conducting HSI activities during pre-acquisition can also provide technical insight to the user-related components of non-materiel solutions: doctrine, organization, training, leadership and education, personnel and facilities.

Analytical and Visualization Methods for Understanding Unstructured Text Data

Stephen Dorton, Sonalysts

To better understand the nature of human-system interactions, a variety of Human Factors Engineering (HFE) methods and metrics to collect, analyze, and make sense of data are used. Increasingly prevalent mixed-methods approaches call for incorporation of qualitative data to contextualize and further make sense of quantitative analyses. Furthermore, practical and logistical issues often inhibit HFE practitioners from collecting quantitative data (e.g. performance metrics), meaning that surveys and questionnaires can often be the only source of data available to measure the mental model or perceptions of the Warfighter. To this end, methods are needed to enable standardized processing, analysis, and visualization of unstructured survey data (i.e. responses to open-ended questions).

This presentation will discuss the history and theoretical aspects of multiple related methods that were used, including thematic text analysis and applied concept mapping, as well as related theories on Shared Mental Models (SMM) and organizational cognition. These methods were employed to identify themes in a sample of expository narratives, in which key words and concepts could be binned into. By aggregating the data and applying numerical values, descriptive statistics and visualizations to represent a SMM of an organization were generated.

An example of how these concepts were used in an end-to-end use case will be discussed, showing how sample survey data was processed, analyzed, and visualized to glean understanding of the SMM of a diverse organization. Novel metrics were employed to measure the size and composition of individual mental models. By using these metrics, along with metadata to describe the organizational role and training status of the respondents, differences and commonalities amongst different subgroups became apparent.

While these methods greatly enabled understanding of disparate responses on a topic, Analyses of Variance showed no statistical significance across groups (organizational roles and pre-/post- training). This highlights the limitation of using thematic text analysis to drive statistical methods beyond descriptive statistics. Challenges and areas for future research will be shared and open for discussion with the audience. The aim is to

refine these methods to maximize the utility of interviews and questionnaires, enabling HFE/HSI practitioners to effectively capture and represent expert knowledge from the Warfighter, which can then be propagated into system design.

Combat Information Center (CIC) Current and Future Capabilities

Jon Dachos, NSWCDD

The HFE TAG Command Center Space Design presentation explores a process developed by Human Systems Integration engineers over the past several years to optimize operations and workflow within Command and Control spaces. Space analyses are performed to determine the most efficient use of space while taking into consideration personnel and equipment in the operating environment and allowing for the effective execution of tasks by users to support Platform Mission Areas, ROC/POE and Navy Tasks for warfare success. The presentation will cover the well-established and approved Government Five Phase Design Process and provide a high level overview of these phases to include prep work through the final layout design. The brief will cover key resources required, collaborations across branches and commands, challenges, and lessons learned. Since 2007, the Dahlgren HSI engineers have greatly assisted the Navy Ship Design Managers, Program Managers, and Fleet, in optimizing space design for afloat and ashore commands in over 50 projects.

Graduate Education Opportunities in Human Systems Integration

Nita Shattuck, Naval Postgraduate School

Abstract not provided

ABSTRACTS

SubTAG: Training

Co-Chairs: Kelly Hale, Joshua Kvavle, Jen Pagan

Training Session I

10 May 2016 | 1300 - 1500
Room 265/266

1300 – 1305	**Introductory Remarks and Admin**
1305 – 1355	**Maintenance Training: The Value of Coupling the Seven Step Troubleshooting Process to Simulation** Michael Cummings, NAWCTSD
1355 – 1415	**Towards Performance Based Assessment for a Portable Landing Signal Officer Virtual Reality Training System** Lee Sciarini, NPS
1415 – 1440	**Essential Attributes of Augmented Reality in Training Environment** Room 265/266 Nathan Jones, MARCORSYSCOM
1440 – 1445	**Final Admin/Resolutions**

Training Session I

11 May 2016 | 1500 - 1700
Room 265/266

1500 – 1505	**Introductory Remarks and Admin** Room 265/266
1505 – 1530	**Significance and Applications of an Autonomous Synthetic Teammate** Room 265/266 Erin Hanson, Cognitive Models and Agents Branch, Air Force Research Laboratory
1530 – 1555	**Deployable LVC Training Technology for Pararescue** Aerial Camden, Air Force Research Laboratory
1555 – 1620	**Tactical Combat Casualty Care (TC3) Training and Learning in the Squad Overmatch (SOvM)-TC3 Project** Room 265/266 Hank Phillips, Naval Air Warfare Center Training Systems Division
1620 – 1645	**Acquisition Workforce Development: DHS HSI Training and Certification Program** Room 265/266 Thomas Malone, DHS/S&T/Office of Systems Engineering/HSI
1645 – 1650	**Final Admin/Resolutions** Room 265/266

ABSTRACTS

TRAINING SESSION I, 1

Maintenance Training: The Value of Coupling the Seven Step Troubleshooting Process to Simulation

Michael Cummings, NAWCTSD; John Burns, NAWCTSD; In Ha, NAWCTSD; Brian VanVolkenburg, Sonalysts Corporation

1. What topic is to be addressed and why it is important

Topic: Demonstration of the AN/BLQ-10A(V)2 Maintenance training solution using the Seven Step Troubleshooting Process

The US Navy's performance in Electronic Warfare (EW) is critical in its ability to maintain awareness in the current geo-political/military environment. Submarine EW continues to grow in importance as our use of the electro-magnetic spectrum evolves. For the submarine force to perform at the highest levels in the electro-magnetic spectrum, it needs to maintain the AN/BLQ-10 at peak performance and the highest level of readiness. High fidelity training, focused on maintaining on-board EW systems, is vital in ensuring the submarine crews have the knowledge to sustain optimal equipment conditions to satisfy their assigned tasking when called upon.

2. How the topic relates to the conference theme

Warfighting influence starts with our people. When empowered with knowledge, reinforced through continuous learning and practice, our people will be able to effectively operate and maintain on board EW systems. When these systems are maintained properly, they will reliably achieve the desired combat outcomes. Since the AN/BLQ-10A(V)2 Maintenance Simulation System improves the readiness of the AN/BLQ-10 and the personnel who maintain it, this system directly impacts the ability of the Warfighter to perform missions such as ISR, I&W, and counter-A2AD.

3. How the method/approach addresses the topic

By demonstrating the product and discussing its advantages, conference attendees will be able to directly see this technology in action and understand its benefits.

The simulation was integrated into the NETC Advanced Electronic Classroom (AEC) used during the instructor-led portion of the curriculum at Naval Submarine School. Although the simulation itself can be run in a standalone environment, another powerful part of this simulation system is the Courseware Management Website, which communicates with the simulation to capture and log student actions and inputs, providing the instructor with a real-time method of monitoring student scenario progress, as well as the historical student performance for use in conducting end of course evaluations.

The Courseware Management Website provides portals for Administrators, Instructors, and Students to access the simulation. In addition to configuring server parameters, Administrators can create user accounts, assign applicable roles, and link the account to the network Active Directory, providing Single Sign-On functionality.

Scenarios developed to utilize the simulation include initialization commands, faults to be inserted, indications that the student must check, controls the student must operate, associated feedback, and the desired display mode (freeplay, training, or examination). As the student progresses through a particular scenario, the simulation logs the actions taken and evaluates performance.

4. The type, significance and importance of the results

As the submarine force aggressively expands its electro-magnetic warfighting influence, through the systems and future capabilities it procures, this simulation can be affordably adapted to meet the new training needs.

TRAINING SESSION I, 2

Towards Performance Based Assessment for a Portable Landing Signal Officer Virtual Reality Training System

Lee Sciarini, NPS

This effort to explore the range of expertise and examines how current breakthroughs in low-cost virtual reality displays might enable us to develop innovative training concepts for Naval Landing Signal Officers (LSOs). LSOs are responsible for helping naval aircrews land their aircraft safely and efficiently on aircraft carriers. The task is a demanding one which requires a team of LSOs to observe and understand critical cues in relation to a dynamic environment allowing them to make split second decisions on landing or waiving off for another attempt. Every carrier landing can be viewed as a unique event which is handled on the basis of an intuitive process that relies on an LSO recalling similar, previous landings. This being the case, it is inherently difficult for an expert to precisely describe, analytic rules and facts that encompass the complete set knowledge, skills, and abilities required to perform their challenging task. Considering the potential consequences to personnel and equipment of poor performance, it is imperative that LSO training systems not only provide appropriate cues and environment, any such system must be designed to accurately assess a trainee based on their expected level of expertise.

Recently, a proof-of-concept, light-weight, portable Virtual reality (VR) LSO simulation was developed at the Naval Postgraduate School (Greunke, 2015). Designed using the Unity game engine, the prototype LSO training system was designed for use with a low-cost, commercially available VR head mounted display (HMD). An initial investigation comparing the capabilities of the prototype and the large, fixed simulator which is currently used to train LSOs revealed that the newly developed system possessed the appropriate elements and capabilities for training LSO tasks (Greunke & Sadagic, 2016). Greunke's prototype LSO system is an exceptional example of how recent advances in technology can be rapidly used to create virtual environments that rival, and in many ways, surpass larger legacy systems. However, while impressive, the prototype is not a training system.

LSOs visualize the recovery of an aircraft by its location during the segments of its approach to the aircraft carrier. Following the Dreyfus and Dreyfus (1982) model of skill acquisition, this effort presents critical information requirements and identifies differences in understanding and skills specific to varying LSO skill levels for each of these segments. The results will be used to create performance based measures which can be collected and evaluated in real-time for application in Greunke's (2015) VR LSO prototype. Sensitive to specific skill levels, these performance measures can be used to evaluate and record a trainee's strengths, weaknesses, and progression through a training plan.

TRAINING SESSION I, 3

Deployable LVC Training Technology for Pararescue

Aerial Camden, Air Force Research Laboratory; Sharon Conwell, Air Force Research Laboratory; Jonathan Diemunsch, Air Force Research Laboratory

Live, virtual, and constructive (LVC) training methods have been implemented in a variety of military applications, such as fast jet and Joint Terminal Attack Controller (JTAC) training. Although traditional LVC works well for these environments that tend to have a relatively small geographic footprint, LVC methods have been difficult to apply to many ground-based forces, such as the Air Force Pararescue, due to the training space requirements. Further, Pararescue often trains at multiple sites to accommodate a range of training requirements and scenarios. To begin implementing LVC for Pararescue and other ground forces, the Warfighter Readiness Research Division of the Air Force Research Laboratory is developing a deployable LVC capability. This enables any exercise site, including those in remote or austere environments, to be networked, allowing for sensor data to be streamed from the field into a central server location for command and control. This data is synchronized in real-time to produce situational awareness of the live environment and a visual after-action-review capability. Additionally, commercial game engines are utilized to produce a virtual environment, enabling simulated UAS camera feeds. The deployable LVC capability was demonstrated in 2015 at Angel Thunder, the world's largest personnel recovery exercise. The Angel Thunder exercises took place in Playas, NM, a ghost town with no training technology infrastructure. Although the area was remote, the network was successfully deployed and received positive feedback from Pararescue trainees, leadership, and white force operators. A key advantage of the deployable LVC technology is the ability to provide infrastructure on demand to an exercise site, eliminating the costs associated with purchasing and

maintaining stationary infrastructure and training equipment. Future research efforts will focus on increasing the use of virtual elements and constructive characters. By providing LVC training and visual after-action-review capabilities, this research effort seeks to improve tactical and medical readiness for Pararescue forces.

TRAINING SESSION II, 1

Significance and Applications of an Autonomous Synthetic Teammate

Erin Hanson, Cognitive Models and Agents Branch, Air Force Research Laboratory;
Christopher Myers, Cognitive Models and Agents Branch, Air Force Research Laboratory

Training is integral to social and technological progress. For decades, scientists have sought to improve training and mitigate associated costs through instructional sciences and simulation. Autonomous Synthetic Teammates (ASTs) may serve as fully-independent members of a team in support of airmen training.

In collaboration with the Office of Naval Research and Dr. Nancy Cooke of Arizona State University, a high-cognitive-fidelity AST was developed in the ACT-R cognitive architecture. It operated as a pilot, and full-fledged teammate, within the context of a remotely piloted aerial system (RPAS) reconnaissance task. The RPAS task was composed of a three-person team (pilot, navigator, and photographer) carrying out five, forty-minute reconnaissance missions. Pilots were randomly assigned to teams as the synthetic agent, or human, and collaborated with teammates over text-to-text communication.

The AST was integrated with the RPAS simulated task environment (STE) through the use of an emulation, which the agent directly interacted with to complete its piloting goals. Events from the interaction (e.g., changing airspeed, altitude, etc.) were passed to the STE over TCP/IP and incorporated into the environment as if the AST were sitting at the STE console. In addition, the AST used the same chat-communication software as human participants.

Through the use of established metrics (Cooke, Gorman, Myers, & Duran, 2013), both team and individual performance scores indicated that, while the AST's actions deviated from those of the human pilot in some measures, team performance was not negatively impacted. Importantly, human teammates interacting with the AST performed as well as those on all-human teams.

Moving forward, these results confirm both the plausibility and considerable potential for ASTs operating as confederates during team training. Though, despite the AST's success, many areas for improvement arose out of the development. Most notably, the design decisions, need for cognitive fidelity, and generality of the agent must be addressed. The ACT-R cognitive architecture functions quite well for interacting with external interfaces, but is also built around a very low level of analysis (50 ms) to ensure high-cognitive fidelity. By sacrificing cognitive fidelity in some aspects of the agent and implementing a higher-order language/architecture, it would allow for more rapid development, adjustments, and maintenance. Additionally, though it would be unrealistic to generalize the whole agent, certain components could be generalized to maximize the AST's benefits and reusability.

Currently, the applications of this research have already been extended into the realm of development for synthetic agents within an Air Support Operations Center (ASOC) environment. By implementing these agents in training roles, such as the Procedural Controller or Air Tasking Order Manager, more experienced airmen will be able to stay committed to the mission and continue fulfilling key roles - confident that the next generation of warfighter is receiving superior, authentic training through the use of autonomous synthetic agents.

TRAINING SESSION II, 2

Essential Attributes of Augmented Reality in Training Environment

Nathan Jones, MARCORSYSCOM

Augmented Reality (AR) is quickly becoming all the rage. The race to take front on implementing AR in training environments is in full swing. AR technology has been demonstrated to provide realistic visuals of virtual and/or constructive entities and engagements on the live range. However, is the technology ready and able to support effective training?

To ensure the Augmented Immersive Team Trainer (AITT) is ready for use, an assessment was conducted to determine how well it meets the capability requirements to support specified training objectives. The AITT system was developed by Office of Naval Research (ONR) and is currently in the technology transition process at Program Manager Training Systems (PM TRASYS). The assessment team utilized a task- and attribute-based approach that enabled assessing the simulator on both the activities an individual is required to do in the performance of a specific job (i.e., tasks) and the elements the device is required to provide to support that performance (i.e., attributes). This method also provided an ability to compare the AITT to other training systems that are currently utilized for the same training objectives.

This presentation presents the attribute strengths and deficiencies identified in the AITT technology to support training objectives. The presentation will also address issues with AR technology interdependencies and research that is needed for acquisition and operations communities regarding the human effects in order to ensure safe use of AR technologies in the training environment.

ABSTRACTS

TRAINING SESSION II, 3

Tactical Combat Casualty Care (TC3) Training and Learning in the Squad Overmatch (SOvM)-TC3 Project

Hank Phillips, Naval Air Warfare Center Training Systems Division

Tactical medical situations require infantry squads to balance achieving tactical mission objectives with providing competent medical treatment. To do this, squad leadership must be able to assess both tactical and medical situations, and adaptively make decisions to accomplish mission objectives while treating their wounded in a fluid tactical environment. This requires squad leader management of the tactical medical situation coordinated with medical personnel (e.g. Army Combat Medics and Navy Corpsmen). Failure to manage the tactical situation can lead to additional casualties or mission failure. The challenge that military medical instructors face is how to develop tactics, techniques, and procedures (TTPs) that enable both mission completion and life-saving without warfighters becoming so focused on one task that they are unable to manage and balance the other. Becoming distracted in a combat casualty situation can impair decision-making, information processing, attention, and situational awareness, resulting in potentially catastrophic consequences.

The TC3 curriculum, one of four developed for the Squad Overmatch project, targeted learning objectives focused on the communication, decision-making, and team performance components of casualty care in tactical scenarios, including:

- Understanding the correct administration of three individual medical skills required to reduce preventable deaths on the battlefield – using a combat action tourniquet (CAT), nasopharyngeal airway (NPA), and chest decompression needle (CDN), found in the Improved First Aid Kit (IFAK II)
- Knowing when the tactical situation allows for specific medical interventions and who should (and importantly should not) be administering those interventions – the right treatment at the right time by the right person.
- Knowing what, when, how, and with whom to communicate in order to make effective tactical-medical decisions. Clear, concise and standardized communication is not only critical to patient care (e.g., documenting casualty collection cards to indicate patient status and treatment history) but also to managing resources and team activities once a casualty has occurred.
- Knowing how to establish and manage a casualty collection point (CCP).

This presentation will focus on the content, development process, and knowledge gains yielded by squad trainees using the TC3 curriculum. It will also include a brief introduction to and overview of the Squad Overmatch Tactical Combat Casualty Care (SOvM-TC3) project.

ABSTRACTS

TRAINING SESSION II, 4

Acquisition Workforce Development: DHS HSI Training and Certification Program

Janae Lockett-Reynolds, DHS/S&T/Office of Systems Engineering/HSI; Mark Rutherford, DHS/USCG CG 1B3; Thomas Malone, DHS/S&T/Office of Systems Engineering/HSI; Michele Simms-Burton, DHS/S&T/Office of Systems Engineering/HSI

The Department of Homeland Security is faced with the problem that, while the majority of technological solutions and systems being developed by DHS Components (Coast Guard, FEMA, ICE, etc.) rely on effective human performance for their successful operation, the Coast Guard is the only Component that has a viable Human Systems Integration (HSI) organization. The HSI Branch in the DHS Office of Systems Engineering, in cooperation with the HSI Office in the Coast Guard, has developed a strategic plan for ensuring that all DHS Components will have the personnel, policy, resources and support needed to ensure that emerging systems and technology adequately address human performance. One of the Goals described in this strategic plan is to develop and maintain a professional HSI workforce.

Critical to the development of any training and certification program is the development of core competencies that will drive the structure and content of training courses as well as personnel recruiting and hiring. The Department of Homeland Security is in the process of standing up a new Technical Management career field. This career field represents an Acquisition certification program for personnel who perform significant systems engineering tasks to support acquisition and pre-acquisition programs. It is designed to support training and development of acquisition workforce personnel who conduct, and/or monitor or manage systems engineering activities or science and technology activities including requirements development, basic research, applied research and/or advanced technology development. Human Systems Integration will be designated as one of the specialty areas identified under this career field. As a part of a larger front-end analysis to identify key stakeholders and address the needs and requirements for an HSI training and certification program, HSI competencies and skill requirements are being identified. The HSI core competencies for HSI practitioners will consist of three competency levels (entry-level, mid-level, and advanced-level) and will be aligned with the various areas identified in Departments core competency areas for Systems Engineering (i.e., Total Systems View, Systems Engineering Technical Management Processes, Systems Engineering Technical Processes, Systems Engineering by Stages, Systems Engineering Tools and Techniques, and Design Considerations). The competencies will comprise the basis for developing knowledge, skills and abilities (KSAs) which will support the development of training course content. Training will be directed at HSI practitioners and other DHS stakeholders who will require an understanding of HSI.

ABSTRACTS

SubTAG: Modeling & Simulation

Chair: Ranjeev Mittu, John Rice, Lee Sciarini

Modeling & Simulation Session I

10 May 2016 | 1530 – 1730
Room 262/263

1530 –1555	**Life Is Complicated: Synthetic Population Modeling in Computational Biology and Potential in Human Factors Engineering** Christopher Conow, NUZHDIN Labs, Univ of Southern CA
1555 –1620	**Neuromusculoskeletal Modeling of Soldier Load Carriage Gives Insight into Underlying Indicators of Injury Risk** John Ramsay, Natick Soldier Research, Development, and Engineering Center
1620 –1645	**Leveraging Healthcare Training Infrastructures for Human Factors Assessment of Prototype Medical Devices** Danial McFarlane, Philips Medical
1645 –1710	**Simulation as a Tool for Human Factors Related to Patient Safety in Veterns Health Administration Medical Centers. Tandi Bagian** Tandi Bagian, VHA NPSC
1710 –1730	**HM&S SubTAG Meeting** Tandi Bagian, VHA NPSC

Modeling & Simulation Session II

11 May 2016 | 0800 – 1000
Room 262/263

0800 – 0815	**Modeling of Human-System Interactive Effects in Systems of Systems** Matthew Hoffman, Sandia National Laboratories
0815 – 0830	**Human Performance Fusion in the Executable Architecture Management System (ExAMS)** Ira Minor, SPAWAR SYSCOM HQ
0830 – 0845	**Applying SysML, IMPRINT, and Human Experimentation to Better Design Human-Machine Interaction** Michael Miller, Air Force Institute of Technology
0845 – 0900	**Gaining insight from models of complex human/computer systems** Robert Abbott, Sandia National Laboratories

0900 – 0915	Adapting mission recordings as examples for semi-automated forces Robert Abbott, Sandia National Laboratories
0915 – 0930	The Task Map Analysis Process Gail Nicholson, NSWC Crane

MODELING & SIMULATION SESSION I, 1

Life Is Complicated: Synthetic Population Modeling in Computational Biology and Potential in Human Factors Engineering

Christopher Conow, NUZHDIN Labs, Univ of Southern CA

Synthetic population based modeling provides a powerful tool to examine the behavior of a given system in a way in which analytic and statistical models cannot. Analytic models tend to be concerned with finding strictly optimal solutions which exist at some sort of equilibrium in state space, while statistical models provide aggregate trends. They are less useful for studying how the system behaves over time when such equilibrium do not exist, or where more detailed information about how individuals interact with the given system is desired. It can additionally be extremely difficult or impossible to define an accurate analytic or statistical model to describe some complex systems.

Synthetic population models are comprised of a population of "agents" each of which acts according to a set of rules given an environmental context, and the actions of these agents may then modify their environment. In this way, the state of the model is updated iteratively for a given number of time steps or until some desired outcome has been obtained. These models are comparatively easy to define, and, since they simulate the individual components of the system in question, yield more nuanced information about the behavior of those systems than other models typically do. Two major downsides of agent based modeling are that the results can be more difficult to rigorously characterize, and they tend to be time consuming to execute from a computational standpoint when compared to other types of modeling.

Many problems in human factors engineering can be quite naturally expressed through synthetic population models. People and equipment can be represented by individuals in the model, each with their own internal state representing functional characteristics. Populations of these agents can then be simulated interacting with one another to obtain explicit information about how people of varying characteristics are, or are not, able to interact with a system. This approach has benefits over sampling real populations in that a synthetic population can be arbitrarily large and comprehensive in terms of diversity, and can be used repeatedly to test the outcome of changing the systems with which they interact.

ABSTRACTS

MODELING & SIMULATION SESSION I, 3

Neuromusculoskeletal Modeling of Soldier Load Carriage Gives Insight into Underlying Indicators of Injury Risk

John Ramsay, Natick Soldier Research, Development, and Engineering Center

Background: During military operations, Soldiers don heavy loads that overburden the musculoskeletal system, increasing the risk of injury and costing the armed forces millions of dollars in lost productivity and medical treatment each year. Traditional analysis of Soldier movement patterns is useful in quantifying Soldier performance. However, these techniques often overlook the extent of which the external loads transfer to the internal tissues of the body. Modeling and simulation of Soldier load carriage gives an additional lens to observe load-induced effects and underlying indicators or mechanisms of injury. Presented here is an example of modeling and simulation of Soldier load carriage during a run-to-stop (RTS) task.

Methods: Seven males had lower limb biomechanics recorded during both planned and reactive RTS tasks with three military-relevant load conditions: unloaded (UL; 6.2 kg), fighting load (FL; 20.0 kg) and approach load (AL; 40.0 kg). During the RTS, partic-ipants ran down a walkway and stopped their dominant limb on a force platform. Biomechanical data were recorded and imported into OpenSim to estimate knee flexion moments, muscle forces and peak knee joint contact force (PKJCF) during the stopping phase of each RTS. The subject based mean for each dependent variable was submitted to a repeated measures ANOVA to test the main effects of and possible interactions between body borne load (NL, FL and AL) and movement type (AN and UN).

Results: During the RTS, adding body borne load increased the PKJCF (p0.05) in peak muscle force were not evident during pre-planned RTS. No significant increase ($p>0.05$) in peak knee flexor muscle force was evident with the addition of load, or between the pre-planned and reactive RTS.

Conclusions: Increased body borne load likely increases the risk of musculoskeletal injury as a result of greater compressive force on the knee joint that may be attributed to the increased knee flexion moment. Performing reactive RTS may require larger

muscle forces to successfully complete the maneuver, resulting in greater injury risk compared to pre-planned maneuvers. Due to muscle redundancy, it's possible that little to no external differences will be observed using traditional performance techniques. Yet, internally, there may be significant changes in joint loading, muscle forces, and soft tissue stresses and strains that are directly related to musculoskeletal injury. Modeling and simulating Soldier load carriage provides insight into underlying indicators of injury risk that may not have been historically understood.

Potential impact to Warfighter: By understanding how load alters muscle forces and joint contact forces during dynamic tasks, training interventions can be used to optimize Soldier performance while reducing the debilitating effects load has on a Soldier's body.

MODELING & SIMULATION SESSION I, 4

Leveraging Healthcare Training Infrastructures for Human Factors Assessment of Prototype Medical Devices.

Danial McFarlane, Philips Medical

A repeated-measures clinical trial in patient simulation was conducted in a high-fidelity patient simulation facility that replicates a full-scale 20-bed hospital acute care unit. Four teams of four registered nurses participated in a 180 minute clinical scenario. Each nurse cared for five simulated patients and received 20 alarms per hour of which only 10% were clinically actionable. This hospital unit simulation supported high external validity for clinical evaluation while also enabling powerful control over many sources of variability for internal validity. A rich set of complex realistic behaviors were observed. Results show that when wearing a prototype smartwatch aid, nurses respond to important alarms three times faster.

Field experience shows that developing human-systems integration (HSI) solutions for health surveillance operations is problematic. Front-line operators must simultaneously: (1) track the progress of activities, people, or groups previously marked as "interesting;" (2) scan high-volume multi-source data for new things of interest; and (3) manage the dynamic allocation of limited surveillance resources, including their own cognitive attention. Managing this "track-while-scan" meta-activity puts heavy demands on operators' metacognition load and can cause information overload and human errors.

In clinical monitoring of patients in hospital (one type of health surveillance operation), medical device alarms currently create an information overload situation for nurses. Consequently, alarms are often missed or ignored, and emerging adverse events are not recognized or prevented. A proven HSI innovation from US Navy combat systems is leveraged to address this problem. Human Alerting and Interruption Logistics (HAIL) delivers metacognitive HSI services that empower end-users to quickly triage interruptions and dynamically manage their multitasking. HAIL informed the design and development of a prototype smartwatch attention aid for hospital nurses with metacognitive services to support alarm/alert triage.

MODELING & SIMULATION SESSION I, 5

Simulation as a Tool for Human Factors Related to Patient Safety in Veterns Health Administration Medical Centers. Tandi Bagian

Tandi Bagian, VHA NPSC

Not provided at this time.

MODELING & SIMULATION SESSION II, 1

Modeling of Human-System Interactive Effects in Systems of Systems

Matthew Hoffman, Sandia National Laboratories; Craig Lawton, Sandia National Laboratories; Ann Speed, Sandia National Laboratories; Amanda Wachtel, Sandia National Laboratories; Robert Kittinger, Sandia National Laboratories; John Gauthier, Sandia National Laboratories; Karina Munoz, Sandia National Laboratories

Considerable research has been performed regarding Human Systems Integration (HSI) at the individual system level, but very little has been done considering the interdependencies at a Systems of Systems (SoS) level. Similarly, traditional SoS modeling and simulation has done a good job of capturing interdependencies between systems, but usually assumes away the human element (or treats it very simplistically). In reality, most SoS are actually complex sociotechnical systems designed with humans interacting with technologies and occupying critical functional areas, and often humans introduce the greatest uncertainties and opportunities for failure. Humans and human-system interactions are thus critical to model properly within SoS. Automation is a promising avenue for reducing human error, but is not a silver bullet; it brings with it new failure modes, and it changes the burden on the humans—from being focused on direct task execution, to monitoring and assessing performance of automated systems, performing maintenance/sustainment of automated systems, diagnosis of unusual operating conditions, and recovery from automation failures.

To better understand the performance of sociotechnical SoS (including SoS-level impacts of automation issues), we are creating a modeling framework which can accept information from more detailed system-level HSI studies and evaluate how the effects of human-system interactions propagate through a SoS and impact its functionality.

Leveraging HSI literature and job analysis techniques from Industrial-Organizational psychology, we are creating a general process for distilling the key elements and structure of a SoS with respect to its functions, and modeling the dynamics as systems and humans perform tasks to fulfill these functions. Critically, our approach is designed to properly capture human performance, system performance, and human-system interactions, as well as the various interdependencies (e.g., communications, logistics supply) between entities within SoS.

We have been applying and refining our process to a use case analyzing how human-technology interactions affect force protection performance in small Forward Operating Bases (FOBs), e.g., Patrol Bases and Command Outposts. While model development is still ongoing, the framework appears general enough to accept a wide variety of possible human-system interactive effects at various functional areas throughout a SoS. When complete, we believe our modeling process will enable far richer assessment of SoS performance and a more systemic view of human performance than is currently possible. The resulting model(s) will allow us to assess potential changes to SoS design, such as improved human-system integration, new technologies and interfaces, revised training or operating procedures, introduction of technologies that augment or automate human tasks, etc.

By allowing us to assess the performance of complex sociotechnical systems (including those with autonomous components) and weigh the benefits of different potential function allocations between humans and systems, such a framework will enable design of SoS that take human and HSI effects into account "from birth." This will enable better use of humans' skills and adaptiveness while reducing repetitive workload, cognitive and physical fatigue, the number of human operators needed (e.g. reducing troop-to-task ratio and therefore reducing costs, logistics burdens and vulnerability) and ultimately, the likelihood of catastrophic human error.

MODELING & SIMULATION SESSION II, 2

Human Performance Fusion in the Executable Architecture Management System (ExAMS)

Ira Minor, SPAWAR SYSCOM HQ

The ExAMS effort was initiated in support of Navy Single Tech Authority for Information Warfare, and represents a model-based systems engineering (MBSE) and simulation success story at SPAWAR. This GOTS capability began in 2012, and has replaced tools previously used in analysis by SPAWAR 5.0.

ExAMS is designed as a black-box, scalable MBSE capability. In MBSE, the model must accurately represent component relationships to ensure traceability and the consistent description of boundary conditions across domains. ExAMS structures are decomposable into a set of black boxes that address the inputs and outputs to each component, including their sequencing and timing.

Because ExAMS is built upon Black Box theory, it introduces a unique paradigm for creating Executable Architecture. The application of black boxes to systems engineering facilitates discussion of complex systems at an abstract level, with a focus on inputs, output, and interactions, rather than on the details of how these inputs are transformed into outputs.

Human Performance Fusion was introduced into ExAMS to enable analysis of the emergent variance to System of Systems (SoS) performance caused by human cognitive and behavioral limitations, and to assess the impact of human performance on mission effectiveness through model execution.

MODELING & SIMULATION SESSION II, 3

Applying SysML, IMPRINT, and Human Experimentation to Better Design Human-Machine Interaction

Michael Miller, Air Force Institute of Technology; Christina Rusnock, Air Force Institute of Technology; John Colombi, Air Force Institute of Technology

BACKGROUND: The design of systems employing teams of humans and autonomous agents can be complex, as humans are likely to adapt their behavior in response to the performance attributes of the automated agents.

METHOD: A process, useful in the designing and understanding this type of environment, is discussed. This process employs a combination of Systems Modeling Language (SysML), discrete event simulation in the Improved Performance Research Integration Tool (IMPRINT), and human-in-the-loop experiments. Within this process, SysML is applied to describe anticipated human-system interaction. The SysML artifacts are then applied to inform the construction of discrete event simulations of human-machine teams in IMPRINT. Finally, these models are both informed by and used to improve our understanding of system behavior through human-in-the-loop experiments.

RESULT: This process will be illustrated through three recent projects which explored human interaction with automation in separate application environments. In one example, directional sound is used to simplify the operator's recognition of multiple call signs for each of several UAVs under control from among a number of distractive call signs. In the second environment, the models were used to explore the effect of agent timing on system performance within a human-agent teaming environment. In the third environment, models were used to anticipate the impact of automation speed and

accuracy tradeoffs on system performance. In each system, this approach illustrates utility in projecting and understanding human-agent interaction.

CONCLUSIONS: The proposed method was useful to better design the human-machine interaction in each environment. The benefits of this method and future development efforts will be discussed.

IMPACT: This method may aid the robust design of human-agent interaction in future systems, potentially permitting a robust understanding of interaction under a large range of environmental conditions.

MODELING & SIMULATION SESSION II, 4

Gaining insight from models of complex human/computer systems

Robert Abbott, Sandia National Laboratories

Anticipating and preparing for malfunctions of critical systems (such as power generation and distribution) is important for enhancing reliability, developing backup systems and procedures, and training system administrators and users. Since it is usually infeasible to disable or damage the system repeatedly for training and studies, system simulations are developed and analyzed. The systems are comprised of both machines (including computers) and the people who operate them, so the simulations must incorporate realistic models of human behavior, which introduce wide variability in the outputs. Assuming a realistic simulation can be developed, analyzing and understanding the output of thousands of runs to gain insight remains a sizable task. Within the Department of Energy nuclear complex, we have developed government-owned software tools to explore simulation parameters (e.g. DAKOTA) and analyze/visualize the outputs (e.g. SlyCat). Though the tools were developed primarily for physics-based finite element simulations, we are exploring applications to agent-based and discrete event simulations. Potential applications include simulations for system reliability, physical security, cyber security, and developing tactics, techniques, and procedures.

MODELING & SIMULATION SESSION II, 5

Adapting mission recordings as examples for semi-automated forces

Robert Abbott, Sandia National Laboratories

For an automated system to be useful, it must achieve a delicate balance between autonomy and human control. Without adequate autonomy, the system will not achieve a reduction in workload, nor even survive in a harsh adversarial environment. Without

adequate control, the system seems to have a “mind of its own” and cannot be trusted to achieve mission objectives without violating expectations. How can a commander’s intent be communicated to an autonomous asset, so it is both constrained and empowered in appropriate ways? We are researching approaches to these challenges in the context of semi-automated forces which serve as role-players in tactical flight training exercises. Using programming by Demonstration, the user specifies a mission for an automated asset using a sketch, or a recording of a previous mission. Our software recognizes actions and interactions of entities in the scenario (such as maneuvers in air-to-air engagements) and outputs a scenario for the Next Generation Threat System that captures defining aspects of the demonstration scenario, but also allows the semi-automated forces to alter their behavior in response to human actions or other sources of scenario variability. This is done by composing a new high-level behavior from re-usable sub-behaviors that encapsulate complex internal logic. Importantly, the resulting behaviors are represented in a graphical decision-tree so they can be reviewed and modified by end users without writing source code.

MODELING & SIMULATION SESSION II, 7

The Task Map Analysis Process

Gail Nicholson, NSWC Crane

The development of systems for Warfighters is complex. Even with many people working to provide the best solution possible for their tasks, numerous examples exist where the final deployed system missed its objectives. The Task Map Analysis Process (TMAP) provides a robust tool that defines a solution space connecting individual objective tasks in a specified environment to the requirements for equipment. By defining this solution space, the capability of a system to meet the end users requirements is illuminated. This process brings together inputs from the end users; system developers; science and technology personnel; and logistics and sustainment practitioners. The process eliminates many of the assumptions and misunderstandings between research scientists, product developers, and support activities who bring products to the end users. Providing better end products by capturing the tasks performed by the Warfighter, connecting those tasks to system requirements, evaluating performance based on Warfighter decisions and actions, and quantifying each system’s efficacy in meeting those requirements is the outcome of the process discussed in this presentation. TMAP is a powerful tool that connects and benefits all communities of interest, harnessing the power of technology to provide the Warfighter with improved mission accomplishment and lowered risk to self and mission. This presentation will explore examples and demonstrate TMAP’s ability to assure better products are deployed.

ABSTRACTS

SubTAG: Test & Evaluation

Chair: Daren Cole

Test & Evaluation

10 May 2016 | 1530 – 1730
Room 201/202

1530 – 1545	**Welcome - Vote for new Chair** Darren Cole
1545 – 1610	**Spatial Orientation in Flight with Helmet Mounted Displays** Tom Schnell, University of Iowa
1610 – 1635	**Research and Development of Helmet Mounted Display Symbology for the Air Soldier System** Bradley Davis, Army Research Laboratory, Human Research & Engineering Directorate
1635 – 1700	**Evaluation of Synthetic Vision Display Concepts for Improved Awareness in Unusual Attitude Recovery Scenarios** Stephanie Nicholas, National Aeronautics and Space Administration
1700 – 1725	**Combining eye tracking with traditional approaches for a system-level performance evaluation.** Yevgeniy Sirotin, Scitor, an SAIC company
1725 – 1730	**Closing Remarks** Darren Cole

ABSTRACTS

TEST & EVALUATION SESSION I, 1

Spatial Orientation in Flight with Helmet Mounted Displays

Tom Schnell, University of Iowa; Eric Geiselman, USAD AFMC 711 HPW/RHCV; Henry Williams, USN AFMC NAMRU/Dayton; Jonathan Knox, USAF AFMC 711 HPW/RHCV; Bill Ercoline, University of Iowa

Historically, the objective of new technology development has been to enhance pilot performance (such as situation awareness) without causing problems such as Spatial Disorientation (SD). However, when improperly designed or poorly integrated, such technologies may actually reduce performance and increase the likelihood of unintended consequences. SD continues to be a serious problem in the military flight domain and it is critical that both the potential to cause problems as well as support effective defensive mitigation strategies be considered early during the development of new technologies.

Past research has shown that new technologies change operator behaviors, e.g., the availability of visual information provided via Helmet-Mounted Displays (HMDs) results in pilots looking farther off-axis for longer duration than when the information is not provided. In addition, many recent accident investigations have attributed the cause of the mishap to SD where the pilot at the controls failed to execute a proper instrument crosscheck. Given the above information and the statistical fact that SD accounts for approximately 20% to 25% of all Class A accidents, across all services, it makes good sense to consider how the HMD, and its integration within the fighter community, will impact a pilot's instrument crosscheck BEFORE the first accident

A flight test is ongoing at the University of Iowa Operator Performance Laboratory (OPL) to identify problematic HMD interface issues and design adequate mitigation strategies (avoid SD and unusual attitude condition) into HMD systems representative of the technology presently aboard the multi-role F-35 platform. This will be accomplished so that intended human performance and system capability is maintained while unintended consequences are avoided. A major potential unintended consequence of HMD functionality and human operator interaction is the production of debilitating SD. The aim of this effort includes the development and flight testing of scenarios that have the potential to cause spatial disorientation (in the operational context) in the F-35 using a HMD and development of a symbology set that will help with the prevention of SD. The test involves the assessment of the Helmet-Mounted symbology utility including Virtual Head-Up Display (VHUD) mechanization, off-axis ownship status information portrayal, and possibly off-axis ownship attitude information interacting with targeting symbology.

ABSTRACTS

TEST & EVALUATION SESSION I, 2

Research and Development of Helmet Mounted Display Symbology for the Air Soldier System

Bradley Davis, Army Research Laboratory, Human Research & Engineering Directorate

BACKGROUND: Degraded visual environment (DVE) is a major problem for rotary wing pilots. According to NATO, DVE is responsible for approximately 75% of coalition helicopter mishaps. DVE is so problematic due to the spatial disorientation induced from the reduced and conflicting sensory information pilots experience with the horizon obscured and overall visibility reduced. Perceptual issues are further compounded by aggravating factors experienced by pilots such as fatigue, high workload, unexpected mission changes, and inexperience.

The typical Army helicopter cockpit provides little useful information for safe operations in DVE. Traditional, analog cockpit displays depict current aircraft state and attitude information but provide little to no information with respect to drift while maneuvering the aircraft. Current helmet mounted display technology also does little to help the situation.

Advanced 2D visual cueing has been researched and developed to aid pilots in a DVE, namely the Brown-out Symbology Set (BOSS). BOSS has been refined through a series of simulator and flight test events and includes several key advancements for operations in DVE including horizontal and vertical guidance, an integrated radar altimeter and vertical speed indicator, and a flight path marker.

Another approach to supplementing the missing external visual cues due to DVE is to use 3-dimensional (3D) conformal symbology, meaning the graphics align with or conform to the Earth's surface and appear to the visual system as being 3D. With these virtual references, we could expect to reduce spatial disorientation during DVE and allow for safe maneuvering.

The UK MoD and AgustaWestland conducted and accelerated research program called Low Visibility Landing (LVL) to identify, assess, and develop 3D conformal symbology. Through their investigation, they demonstrated the feasibility of the hardware required and utility of 3D conformal symbology to aid DVE operation.

The US Army has leveraged the technology developed for LVL and continued to evolve the 3D conformal symbology, and importantly, combined the 3D conformal symbology with advanced 2D hover symbology (similar to BOSS) for a hybrid solution with redundant cueing as part of the Army's Air Soldier System program.

METHODS: A series of user-centered design and evaluation activities were conducted for the Air Soldier System HMD symbology. The investigation began with an early user demonstration and comparison of the vendor created HMD symbology versus

the current HMD symbology in a UH-60L cockpit. The next activity centered on the detailed design and evaluation of improved 2D flight symbology (i.e. BOSS-like) and 3D conformal symbology in both the CH-47F and UH-60L cockpits. Lastly, user evaluations were conducted on the finalized design, again in both the CH-47F and UH-60L cockpits. In each of these events, operationally realistic scenarios were flown over desert terrain which included multiple takeoffs, hovering maneuvers, and landings with very challenging DVE conditions. Human factors measures administered by ARL-HRED included aircraft performance, situation awareness, mental workload, and usability.

RESULTS & CONCLUSIONS: The investigation indicated that advanced 2D hover symbology significantly improved crew situation awareness, reduced pilot workload, improved usability, and improved takeoff and landing performance over legacy 2D symbology. Likewise, but to a greater magnitude, the presence 3D conformal symbology significantly improved crew situation awareness, reduced pilot workload, improved usability, and improved takeoff and landing performance over the absence of 3D symbology. Furthermore, the combination of the advanced 2D hover symbology with the presence of 3D conformal symbology proved to be the optimal combination with the greatest effect on performance, situation awareness, workload, and usability.

TEST & EVALUATION SESSION I, 3

Evaluation of Synthetic Vision Display Concepts for Improved Awareness in Unusual Attitude Recovery Scenarios

Stephanie Nicholas, National Aeronautics and Space Administration

A recent study conducted by the Commercial Aviation Safety Team (CAST) determined 40 percent of all fixed-wing fatal accidents, between 2001 and 2011, were caused by Loss-of-Control (LOC) in flight (National Transportation Safety Board, 2015). Based on their findings, CAST recommended manufacturers develop and implement virtual day-visual meteorological conditions (VMC) display systems, such as synthetic vision or equivalent systems (CAST, 2016). In a 2015 simulation study conducted at NASA Langley Research Center (LaRC), researchers gathered to test and evaluate virtual day-VMC displays under realistic flight operation scenarios capable of inducing reduced attention states in pilots. Each display concept was evaluated to determine its efficacy to improve attitude awareness. During the experiment, Evaluation Pilots (EPs) were shown the following three display concepts on the Primary Flight Display (PFD): Baseline, Synthetic Vision (SV) with color gradient, and SV with texture. The baseline configuration was a standard, conventional 'blue over brown' display. Experiment scenarios were simulated over water to evaluate Unusual Attitude (UA) recovery over 'featureless terrain' environments. Thus, the SV with color gradient configuration presented a 'blue over blue' display with a linear blue color progression, to differentiate attitude changes between sky and ocean. The SV with texture configuration presented a 'blue over blue' display with a black checkerboard texture atop a synthetic ocean. These displays were paired with a Background Attitude Indicator (BAI) concept. The BAI was presented across all four Head-Down Displays (HDDs), displaying a wide field-of-view blue-over-blue attitude indicator. The BAI aligned with the PFD and showed through the background of the navigation displays with opaque transparency. Each EP participated in a two-part experiment series with a total seventy-five trial runs: Part I included a set of twenty-five Unusual Attitude Recovery (UAR) scenarios; Part II included a set of fifty Attitude Memory Recall Tasks (AMRT). At the conclusion of each trial, EPs were asked to complete a set post-run questionnaires. Quantitative results showed that there were no significant statistical effects on UA recovery times when utilizing SV with or without the presence of a BAI. Qualitative results show the SV displays (color, texture) with BAI On are most preferred for both UA recognition and recovery when compared with the baseline display. When only comparing SV display concepts, EPs performed better when using the SV with texture, BAI On, than any other display configuration. This is an interesting find considering most EPs noted their preference towards the SV with color gradient when the BAI was on.

TEST & EVALUATION SESSION I, 4

Combining eye tracking with traditional approaches for a system-level performance evaluation.

Yevgeniy Sirotin, Scitor, an SAIC company; Ellie Bair, Scitor, an SAIC Company

The Department of Homeland Security Science and Technology Directorate Air Entry-Exit Re-Engineering project is exploring how novel biometric technologies and processes can augment the ability of U.S. Customs and Border Protection (CBP) officers to identify travelers entering the United States. A major goal is to reduce reliance on fixed booth infrastructure so as to increase system mobility and flexibility, and reduce the required footprint at Federal Inspection Service locations.

Entry processing is a system composed of several distinct components including a computer terminal, biometric devices, and document scanners. To process foreign international travelers, CBP officers interact with each of these system components while interviewing the traveler to assess admissibility into the U.S.

Using analysis of CBP officer job tasks and usability evaluations, we have identified a podium-based entry system as a viable candidate for meeting CBP entry processing needs. However, it is not clear how the podium impacts officer performance, especially the balance between interaction with system components and situational awareness and traveler focus. This cannot be easily captured by simple time and use-error based metrics.

ABSTRACTS

To understand how CBP officers allocate attention while performing their job task, we are using eye tracking glasses technology in conjunction with scenario testing to compare the traditional booth entry process with the new podium system. To characterize system performance, we have developed a comprehensive set of system-level metrics combining eye tracking, timing, use-errors, and user feedback.

Here we demonstrate our approach for incorporating eye tracking into design, testing, and evaluation with a focus on the podium entry system. This may make it easier to identify problematic system components and to identify the impact of different technologies and procedures from the user's perspective. Our approach may be applicable to other human systems integration efforts where operator attentional allocation across system components drives performance.

The research for this paper was fully funded by the Department of Homeland Security Science and Technology Directorate on contract number W911NF-13-D-0006-0003. The views presented here are those of the authors and do not represent those of the Department of Homeland Security or of the U.S. Government.

ABSTRACTS

SubTAG: Unmanned Systems

Co-Chairs: Thomas Alicia & Laura Milham

Unmanned Systems Session I

10 May 2016 | 1530 – 1730
Room 265/266

Supporting Manned-Unmanned Teaming Operations with Dynamic Multi-vehicle Autonomy and Interface Design
Grant Taylor, U.S. Army AMRDEC Aviation Development Directorate

Decision Making Support for Human-Machine Collaboration in Complex Environments: Determining Design Requirements
Jen Pagan, SubTAG Chair

Can Autonomous Systems be Teammates?
James Walliser, George Mason University

Designing for Autonomous Cargo Operations
Brian Moon, Perigean Technologies LLC

Unmanned Systems Session II

10 May 2016 | 0800 – 1000
Room 265/266

Supervisory and Executive Control of Unmanned Systems: Conceptual Framework and User Interface Impacts
Dennis Folds, Georgia Tech Research Institute

Pilot critical incident reports as a means to identify human factors in the operation of Remotely Piloted Aircraft
Alan Hobbs, San Jose State University Research Foundation/NASA Ames

SPECTRE: A Sensor Management Workstation leveraging Human-Automation Teaming
Terry Stanard, 711 Human Performance Wing, Air Force Research Laboratory (711 HPW/RHCI)

Using Simulation to Assess UAS Detect and Avoid Acceptability for Air Traffic Controllers and Ground Control Station Pilots
James Comstock, NASA Langley Research Center

Human-UAV Hybrid Team in Real-Time Environment Exploration
Zhuming Ai, Naval Research Laboratory, Code 55841

UNMANNED SYSTEMS SESSION I, 1

Supporting Manned-Unmanned Teaming Operations with Dynamic Multi-vehicle Autonomy and Interface Design

Grant Taylor, U.S. Army AMRDEC Aviation Development Directorate; Terry Turpin, U.S. Army AMRDEC Aviation Development Directorate

Background. The Army is leading the development of an aviation employment concept called Manned-Unmanned Teaming (MUM-T), which teams manned aircraft with unmanned aerial system(s) (UAS). The intent is to increase situational awareness (SA) and survivability by positioning UAS down range while the manned aircraft remains in a relatively safe position. Recent fielding of the AH-64E Apache brings MUM-T from concept to reality, allowing Apache crewmembers to receive information from, and even control supporting UAS. The current teaming ratio of manned to unmanned aircraft is one to one, with a goal to expand this ratio by 2035. Interviews with pilots that attempted MUM-T in theater indicate that excessive workload associated with UAS management prevents them from taking full advantage of the existing capabilities, and an alternative approach is necessary to accommodate the added responsibility of additional UAS.

Problem Statement. Find the optimal combination of cockpit technology enhancements and autonomous UAS behaviors that will accommodate additional UAS assets in the MUM team without driving pilot workload to an unmanageable level.

Methodology. The goal of this research is to develop and evaluate advanced crewstation design concepts and autonomous UAS behaviors that will enable the warfighter to effectively command teams of advanced UAS in support of a wide variety of MUM-T mission profiles. This piloted simulation experiment will attempt to expand the ratio of UAS control from one to three.

Crewstation design. The interface design concepts include a complete side-to-side glass cockpit with multi-touchscreen interaction, a movable game-type hand controller with buttons, triggers, joystick controllers, and touchscreen display, aided target recognition, radar-enhanced target tracking, and other advanced features. Voice activated systems, spatial audio, and an eye tracker as an input device will be added in phase two of the experiment. The cockpit includes a large out-the-window display, multi-sensor display, interactive digital map display, and sensor/autonomy management through the hand controller.

Autonomous UAS behaviors. Autonomous UAS behaviors have been designed around an operational concept called Delegation of Control (DELCON), in which the air mission commander calls a “play” like a team quarterback, and each UAS under his control executes a set of complex behaviors with minimal pilot input. The “plays” that SCORCH

will execute include area reconnaissance, route reconnaissance, points of interest reconnaissance, safe air volume determination, and cooperative engagement of enemy targets.

Experiment execution. The experiment will be carried out over a two day period per subject pilot. Twelve military pilots will each execute eight MUM-T missions, teamed with either one or three UAS with or without autonomy support. Objective measures of performance will be recorded for each mission. Subjective ratings will capture pilot workload, SA, trust in automation, and opinions of the interface. Eye tracker data will be recorded and evaluated to better understand pilot-interface interaction.

Experiment results. Experimental data has not yet been collected and will be presented at the HFE-TAG meeting. Results are expected to demonstrate that access to additional UAS assets only improves SA and mission performance if workload is managed through advanced autonomy and interface design.

UNMANNED SYSTEMS SESSION I, 2

Decision Making Support for Human-Machine Collaboration in Complex Environments: Determining Design Requirements

Jen Pagan, SubTAG Chair; Katherine Tucker, NAWCTSD; Andrea Postlewate, Stracon; Betsir Zemen, Stracon

In order for autonomous systems to navigate from waypoint to waypoint, they must employ a multitude of sensor combinations (e.g., Light Detection and Ranging, Millimeter Wave Radar, Stereovision, Electro-Optical/Infrared, Sonar) that allow for perception of the environment, and aid sensor uncertainty (Chao & Chen, 2012). While research has identified the most effective sensor combinations for various platforms, the most effective way to translate this myriad of disparate sensor data sources into actionable operator information remains an area for research (e.g., Jang & Liccardo, 2007). Consequently, the need exists to investigate how to effectively combine large amounts of disparate data into a manageable format that enhances operator performance. This format must support the quick synthesis and transformation of data into actionable information that aids operator DM in complex environments. To understand how to combine this type of data, it is important to first understand DM strategies used by existing expert operators, mission specific information processing requirements, task demands, and other characteristics associated with interpreting such data. This presentation will discuss preliminary findings from the first study in a three part study series aimed at determining such requirements.

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UNMANNED SYSTEMS SESSION I, 3

Can Autonomous Systems be Teammates?

James Walliser, George Mason University; Patrick Mead, Naval Surface Warfare Center Dahlgren Division; Tyler Shaw, George Mason University

The developing capabilities of automated systems have provided for the transfer of tasks away from humans and effectively changed the human's role from hands-on operator to supervisor. Ostensibly, automation supports more efficient operations though a reduction in operator workload (Farrell & Lewandowsky, 2000). In practice, however, the offloading of some tasks onto automation merely places new supervisory demands on the human and creates unforeseen opportunities for errors (Parasuraman & Riley, 1997). One potential solution is to restructure the master-slave, supervisory control relationship in favor of a teamwork model, fundamentally changing the way groups of humans and autonomous systems interact. There are a number of ways in which groups organize, but teams have been shown to be the most effective structure to accomplish work (Groom & Nass, 2007). Research has shown that humans affiliate with computers as teammates but we do not yet know how they will accept and interact with autonomous systems as teammates (Nass, Fogg, & Moon, 1996; Groom & Nass, 2007). A study is currently underway to explore human-autonomous system teams using a serious game, Strike Group Defender (SGD). The SGD platform is under development as a tool to train sailors in missile defense techniques. In this study, participants complete two missile defense scenarios while interacting with a human or autonomous agent which controls separate assets in the same battlespace. Team structure is manipulated by creating a scenario in which performance of the player and the agent are either independent (non-team structure) or interdependent (team structure). Both the human and autonomous agents are operated by a human confederate. In the autonomous condition this is known as a Wizard of OZ design, and allows for a more effective teamwork manipulation. Outcomes are measured with regard to teamwork processes: affect, behavior, and performance (Salas, Cooke, & Rosen, 2008). Measures of affect include trust and perceptions of teamwork, cooperation, communication, and performance. Teamwork behaviors captured include adaptation, communication, coordination, monitoring, and backup. Performance is measured by a composite of missiles defended, efficiency, and target tracking. We predict that interdependence will lead to improved teamwork outcomes relative to the non-team condition. Furthermore, we expect to observe similar results whether the interaction partner is a human or autonomous systems. These findings will support future work exploring interactions with an autonomous aid that relies on a machine learning algorithm. Results will also support efforts to develop

human-robot teams for the Department of Defense. One such example is the Air Force's Loyal Wingman concept, which will team a human pilot with one or more autonomous wingmen (Dept. of Air Force RPA Vector, 2013).

UNMANNED SYSTEMS SESSION I, 4

Designing for Autonomous Cargo Operations

Brian Moon, Perigean Technologies LLC; James Bona, Kutta Technologies, Inc.

Objective: The objective of this paper will be to describe how our team is meeting the design challenges inherent in cargo operations using a full-size autonomous helicopter.

Significance: As autonomous systems reach greater levels of autonomy, new questions emerge about how humans can and should bring autonomous systems into the fold of routine operations. While challenges for making automation a team player have been known for some time (Klein et al., 2004), the degree of autonomy has reached a level such that envisioned mission complexity can be realistically explored. As the exploration goes deeper, the challenges become more acute, requiring design thinking to work out the implications.

Our team is designing interfaces for use by a humans interacting with a full size helicopter capable of autonomous planning and mission execution of cargo operations. We encountered previously unforeseen design challenges as we conceived modules for pre-planning tasks, mission monitoring, and dynamic replanning, and as we considered the range of interactions between humans and systems that would need to be enabled through the interfaces. The significance of the paper is that it is one of the first to consider design challenges in the context of complex mission planning and execution with a full-size autonomous helicopter. The significance will be realized through a description of the emergent design challenges, our proposed design hypotheses, and the results of our formative evaluations.

Description of methods: The work builds upon prior work (Papautsky et al, in press; Dominguez et al., in press) in which an extensive Cognitive Task Analysis (Crandall et al., 2006) was conducted with military personnel who will request supplies that can be delivered by the autonomous helicopter, as well as personnel who will manage the mission. The current effort is advancing a user-centered design by engaging in iterative design/develop/evaluation cycles with active duty personnel who are envisioned to team with the autonomous helicopter.

Discussion of results: Tentative design hypotheses were developed in the form of wireframes that address the emergent design challenges. They were subjected to a round of formative evaluation. The improved design was then instantiated in software, used in several flight tests, and subjected to a design checkout with Marines. The paper will present the design rationale, resulting software, and findings from the design checkout.

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UNMANNED SYSTEMS SESSION II, 1

Supervisory and Executive Control of Unmanned Systems: Conceptual Framework and User Interface Impacts

Dennis Folds, Georgia Tech Research Institute

Supervisory control refers to a human role in a system function in which some machine component, typically computer software, makes decisions that are subject to override by a human operator. Manual control, in contrast, relegates all the decision making to a human operator. The notion of executive control, as distinct from supervisory control, is traceable to a conceptual framework I developed for characterizing human operator roles in Soviet air defense systems. This general conceptual framework, known as Operator Role Theory, was later generalized to encompass all types of human machine systems. These are generic operator roles along a continuum, and therefore there is no clear delineation between supervisory and executive control. The fundamental distinction, however, is that under supervisory control, the human operator has the capability to monitor machine performance, override decisions as needed, and adjust the parameters used by the machine in making those decisions, whereas in executive control, the interventions available to the human are simply to control whether the machine executes the function, and otherwise cannot intervene in how it executes. More succinctly, in executive control, the human controls whether the machine executes the function, not now how. In the most extreme case, the machine executes a function automatically, and the only human role is to "pull the plug" on the machine if something goes awry. To implement a system function under executive control implies that machine performance is expected to be sufficient to require no operator intervention, even in unusual circumstances. Supervisory control is more appropriate if machine performance is expected to be sufficient under most circumstances, but may require some degree of adjustment

from time to time. If the need for intervention becomes too frequent, it might be better to implement the function under manual control, and just let the human do it. For human operators to monitor and control multiple unmanned systems simultaneously, especially for N > ~2, it will be necessary for a large number of the system functions to be performed under executive control. Note that the operator role designation is made at the function level, not the overall system level. For example, an unmanned system may perform all its vehicle control, navigation, and communications functions under executive control, but the weapons employment functions might be under supervisory control or manual control. User interface implications are significant: For executive control functions, the information requirements for the operator are to be able to monitor overall function performance at the top level, and to have access to controls that allow the function to be started or stopped easily. In contrast, functions performed under supervisory control need a user interface that allow a much more detailed view of machine performance, and controls that allow adjustment of parameters being used by the machine to make decisions, and of course, the means to override them.

UNMANNED SYSTEMS SESSION II, 2

Pilot critical incident reports as a means to identify human factors in the operation of Remotely Piloted Aircraft

Alan Hobbs, San Jose State University Research Foundation/NASA Ames; Cynthia Null, NASA; Colleen Cardoza, San Jose State University/NASA Ames

Background: It has been estimated that aviation accidents are typically preceded by numerous minor incidents arising from the same causal factors that ultimately produced the accident. Accident databases provide in-depth information on a relatively small number of occurrences, however incident databases have the potential to provide insights into the human factors of Remotely Piloted Aircraft System (RPAS) operations based on a larger volume of less-detailed reports. Currently, there is a lack of incident data dealing with the human factors of unmanned aircraft systems. An exploratory study is being conducted to examine the feasibility of collecting voluntary critical incident reports from RPAS pilots.

Method: Twenty-seven experienced RPAS pilots volunteered to participate in focus groups in which they described critical incidents from their own experience. Participants were asked to recall (1) incidents that revealed a system flaw, or (2) highlighted a case where the human operator contributed to system resilience or mission success. Participants were asked to only report incidents that could be included in a public document. During each focus group session, a note taker produced a de-identified written record of the incident narratives. At the end of the session, participants reviewed each written incident report, and made edits and corrections as necessary. The incidents were later

analyzed to identify contributing factors, with a focus on design issues that either hindered or assisted the pilot during the events.

Results: A total of 140 incidents were reported. Human factor issues included the impact of reduced sensory cues, traffic separation in the absence of an out-the-window view, control latencies, vigilance during monotonous and ultra-long endurance flights, control station design considerations, transfer of control between control stations, the management of lost link procedures, and decision-making during emergencies.

Conclusions: Pilots participated willingly and enthusiastically in the study, and generally had little difficulty recalling critical incidents. The results suggest that pilot interviews can be a productive method of gathering information on incidents that might not otherwise be reported. Some of the issues described in the reports have received significant attention in the literature, or are analogous to human factors of manned aircraft. In other cases, incident reports involved human factors that are poorly understood, and have not yet been the subject of extensive study. Although many of the reported incidents were related to pilot error, the participants also provided.

UNMANNED SYSTEMS SESSION II, 3

SPECTRE: A Sensor Management Workstation leveraging Human-Automation Teaming

Terry Stanard, 711 Human Performance Wing, Air Force Research Laboratory (711 HPW/RHCI); Jason Roll, 711 Human Performance Wing, Air Force Research Laboratory (711 HPW/RHCI); Antonio Ayala, 711 Human Performance Wing, Air Force Research Laboratory (711 HPW/RHCI); Mike Bowman, Infoscitex Corporation; Taleri Hammack, Wright State University

Visually tracking a moving object – particularly a vehicle – is a difficult task performed during remote Intelligence, surveillance, and reconnaissance (ISR) missions. Moving vehicles or pedestrians can be confused with others nearby, or lost within the terrain. Within UAV operations this challenge is overcome by having many people watch the same single sensor feed. However, target losses still occur. Within an USAF UAV operations center, a sign was seen which listed the number of days since the last time a vehicle was lost. It would appear robust tracking performance is not guaranteed even with many observers involved.

Another challenge with ISR missions is coordinated use of the increasing variety of sensors and sensor platforms which can provide additional data about moving targets. In addition to UAVs, manned and unmanned ground vehicles and also sea-going vehicles are now equipped with sensors which can serve ISR goals. Stationary security cameras are also very common around military installations, urban centers, and building complexes. Unfortunately, although the use of additional sensors and platforms can enrich the data collected about moving objects of interest, any additional monitored sensors compound the manning problems described above.

The Supervisory Control and Interfaces Branch (711 HPW/RHCI) within the Air Force Research Laboratory is conducting research to address both challenges. The goal is to enable a single operator to leverage heterogeneous sensors to visually follow multiple moving objects of interest. This goal may be achieved by leveraging the latent power of human-automation teaming. This approach is described by Deputy Defense Secretary Robert Work as a "Third Offset" strategy which will set apart U.S. forces from the rest of the world.

SPECTRE (Sensor Planning and Exploitation Collaboration for Target Reconnaissance and Engagement) is a sensor management workstation and test bed that is designed for flexible interaction of a human operator with automation in the management of sensors on UxV platforms during target tracking tasks. Automation technologies are integrated into SPECTRE, and human factors design principles are applied to produce effective interaction with the automation.

Using SPECTRE we have developed and experimentally validated joint human-automation sensor selection and steering to keep a target in view as it moves through an urban environment. We are now integrating optical object trackers into SPECTRE, which can perform automated target following under limited conditions. We are designing methods for an operator to supervise object trackers as they follow multiple moving targets, providing assistance or taking over the tracking when the object tracker reports reduced confidence.

SPECTRE is transitioning to a tri-service Autonomy Research Pilot Initiative (ARPI). The APRI IMPACT project has designed a workstation for joint human-automation ISR mission planning and execution using collaborating UAVs, UGVs, and USVs. The workstation supports vehicle movement plans but not sensor management. A version of SPECTRE workstation was created to manage the sensors on the UxVs while IMPACT controls their movements.

The proposed presentation will describe progress to date with technology development, experimental evaluations, and future plans for SPECTRE. We believe the TAG will find this project very interesting and informative.

ABSTRACTS

UNMANNED SYSTEMS SESSION II, 4

Using Simulation to Assess UAS Detect and Avoid Acceptability for Air Traffic Controllers and Ground Control Station Pilots

James Comstock, NASA Langley Research Center; Michael Vincent, NASA Langley Research Center; Rania Ghatas, NASA Langley Research Center

Background: Routine operations of Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) will require new equipage, standards, rules and regulations, and procedures. To obtain information in these areas, NASA established a multi-center "UAS Integration in the NAS" project in cooperation with the FAA and industry. Methods of maintaining safe separation between UAS and manned aircraft operating in the NAS are of major interest to the project. To address relevant issues, a series of simulation studies were conducted to evaluate parameters of a candidate Detect and Avoid (DAA) system, especially with regard to Air Traffic Controller (ATC) acceptability of self-separation capable aircraft, and usability of the DAA interface for the Ground Control Station pilots.

Methodology: For the series of ATC acceptability evaluations, a simulation of the East-side of the Dallas-Ft. Worth (KDFW) airspace was used with retired and active controllers maintaining traffic separation in the airspace. Traffic density approximated actual traffic in the sector with 14 UAS per hour having traffic "encounters" with manned aircraft which typically required communications with ATC and a maneuver on the part of the UAS. In the part of the study in which Ground Control Station pilots were test subjects, the focus was on the way in which the pilot used the DAA guidance information. Guidance information was presented on a "track-up" Navigation display and showed an amber band across headings that if flown would result in a loss of "well-clear" with the nearby traffic.

Results: One of the variables under test was the Horizontal Miss Distance (HMD) programmed in the DAA guidance that the UAS pilot based a maneuver on. The results showed that ATC test subjects preferred certain miss distances on their radar screens. UAS pilots using the guidance were not as sensitive to HMD as were the controllers but did appear to introduce a "buffer" beyond the HMD which varied depending on the geometry of the traffic encounter.

Conclusions: DAA systems, as tested in this simulation, can provide guidance information that results in separation distances and timing of maneuvers acceptable to ATC. UAS pilots could successfully use the guidance information to maintain separation from the encounter traffic. The importance of the series of studies are that once separation standards are established, then work on developing, refining, and evaluating candidate sensors for traffic detection can be conducted.

ABSTRACTS

UNMANNED SYSTEMS SESSION II, 5

Human-UAV Hybrid Team in Real-Time Environment Exploration

Zhuming Ai, Naval Research Laboratory, Code 55841; Ira S. Moskowitz, Information Management and Decision Architectures, U.S. Naval Research Laboratory, 4555 Overlook Ave. SW, Washington, DC 20375; Mark A. Livingston, Information Management and Decision Architectures, U.S. Naval Research Laboratory, 4555 Overlook Ave. SW, Washington, DC 20375

We are presenting a human robot interaction system that can be used for real-time 3D environment exploration with an unmanned aerial vehicle (UAV). This is our ongoing effort of building a human-UAV hybrid team that allows a robot and human to work together. The method creates an immersive environment, in which a user can interactively adjust the behavior of an otherwise autonomous UAV and visualize the exploration data in real-time. While much research has emphasized on developing fully autonomous UAVs, human interaction may be needed since it provides an option for correcting autonomous UAV mistakes while the mission is ongoing. Adjustable autonomy is a smart cooperation of human and robot that allows a robot and human to work together as a hybrid team. The autonomous technology eases the connection between humans and robots, instead of replacing humans altogether.

SubTAG: Tech Society/Industry Meeting

Co-Chairs: Steve Merriman & Barbara Palmer

Tech Society/Industry Meeting

11 May 2016 | 0700 - 0800
Room 262/263

Aesop's Fable of the Cat and the Fox: What HSI Could Glean from Lean UX
Julie Naga, Booz Allen Hamilton

DoD HSI Standards Working Group – Update
Owen Seely, NSWC Dahgren

How the Air Force Executes HSI
William Kosnik, Air Force Research Laboratory

AF Human Systems Integration Capabilities and Requirements Tool
Roger Spondike, 711 HPW / Directorate Human Systems Integration

Formal Methods in Human Systems Integration
Jennifer Narkevicius, TBD
Steve Harris, Rational, LLC

TECH SOCIETY/INDUSTRY SESSION I, 1

Aesop's Fable of the Cat and the Fox: What HSI Could Glean from Lean UX

Julie Naga, Booz Allen Hamilton

This comparative discussion provides insight into the successful methodologies Lean User Experience (UX) applies to agile product development that Human Systems Integration (HSI) could potentially benefit from. As in Aesop's fable of the Cat and the Fox, the user centered approaches of Lean UX and HSI may also illustrate the difference between resourceful expendiency and master strategem.

While both Lean UX and HSI advocate the user, champion the human in the system and its ultimate impact on the end user, the differences in application have driven the methodologies they use. DoD HSI typically practices the Waterfall and Incremental Commitment Model (ICM) of risk-driven spiral model developmental approaches. In contrast to these traditional models, Lean UX operates in an agile product design environment. In agile, development teams collaborate closely with little step-by-step

procedure or upfront planning—decisions are made and solutions are implemented on the fly, in a highly iterative and flexible manner.

Lean UX research methods bring a strategic perspective into development, helping a product team figure out priorities and focus on the right things to work on based on user insight. Due to the iterative nature of the agile process, UX research can be conducted during all phases of development. Lean UX focuses on the quality of the product and the kind of user experience it offers in the end rather than polished report research deliverables and presentation graphics. High quality is provided by effectively influencing product teams to produce great products based on UX research. With its nimble nature based on iterative design and requirements definition, the methods employed by Lean UX offer techniques for consideration in HSI. The resourceful expediency of Lean UX offers possibilities to provide the warfighter with a positive perception and resulting response from the use of a product, system or service for their mission, as well as, save time and money in development.

TECH SOCIETY/INDUSTRY SESSION I, 2

DoD HSI Standards Working Group - Update

Owen Seely, NSWC Dahgren

The Department of Defense (DoD) Human Systems Integration (HSI) Standards Working Group was chartered in 2014 and completed a gap analysis in 2015 that served as the basis for documenting the gap in HSI standards. Following a series of technical discussions and decision meetings with the Defense Standards Program Office (DSPO) and Defense Standardization Council (DSC), the WG is pursuing the development of a non-government standard (NGS) that will be adopted by the DoD for use on contracts as a process standard. After two years of preparations and analysis, in 2016 the DoD HSI Standards WG selected SAE International to develop the DoD HSI Standard Practice. The SAE G45 HSI Technical Committee will lead the industry team with government participation from all the services and Joint HSI community. During the next 24 months as the HSI Standard Practice is being developed, the DoD HSI Standards WG will also be developing an accompanying and complimentary HSI Military Handbook (MIL-HDBK). While the HSI Standard Practice will discuss the HSI programmatic requirements and process for contractors, the MIL-HDBK will provide guidance to Program Managers on how to use/tailor the HSI Standard Practice and cover additional HSI tasks unique to the government. The presentation on this topic at the TAG will provide an update on the overall efforts of the DoD HSI Standards WG.

ABSTRACTS

TECH SOCIETY/INDUSTRY SESSION I, 3

How the Air Force Executes HSI

William Kosnik, Air Force Research Laboratory

Human Systems Integration (HSI) is a process designed to optimize human performance and enhance mission capability across a system's life cycle. Since system effectiveness, reliability, and performance are affected by proper consideration of HSI, it is both justified and essential during system development, modifications, and sustainment. The Air Force Human Systems Integration Directorate (711 HPW/HP) continues to make progress in building HSI capability for the Air Force. This presentation will discuss how HP conducts HSI for the larger Air Force and will highlight several recent efforts including the establishment of full-time positions at two MAJCOMs, support for cyber security operations, and revamping operational procedures at AF operational medical clinics.

TECH SOCIETY/INDUSTRY SESSION I, 4

AF Human Systems Integration Capabilities and Requirements Tool

Roger Spondike, 711 HPW / Directorate Human Systems Integration

Establishing human-centered requirements early in the system design, development and acquisition process is key to delivering effective and useable systems to the warfighter. The Human Systems Integration Capabilities and Requirements Tool (HSI – CRT) was created to help achieve this goal. The HSI-CRT analyzes human related risks in the Capabilities-Based Assessment (CBA), Analysis of Alternatives (AoA), and Concept Development (CD) process. The questions, pertaining to all nine domains, were developed by leveraging DoD and AF requirements guides, and subject matter expert feedback. Using yes/no answers and a tradeoff matrix, the tool will provide a report documenting the human performance risks (in the form of risk matrices) associated with the analysis being performed.

A usability study has been performed using both HSI practitioners and those outside of the field. Results of this study aided in the final design, interface, and functionality of the tool. HSI-CRT has been certified for installation on USAF networks and is currently able to be utilized. In addition to presenting basic information on the tool and the methods/results behind question development and the usability study, a demo of the tool will be given. The tool will be available to interested parties.

TECH SOCIETY/INDUSTRY SESSION I, 5

Formal Methods in Human Systems Integration

Jennifer Narkevicius, and Steve Harris, Rational, LLC

This presentation outlines ongoing work that arose out of attempts to solve practical problems for military, aviation, aerospace and national infrastructure applications. It extends a briefing that was provided to the HFE TAG Tech Society / Industry Subgroup at its Dayton 67th Meeting in May, 2012 and updates that information with more recent results in both aviation and infrastructure applications.

Human-System Integration (HSI) encompasses many aspects of the problem of integrating human and machine components into a coherent system. Most of the methods and tools used in the practice of HSI have evolved from practical experience. While these tools are invaluable, there little doubt they would benefit from increased rigor and precision.

The approach outlined in this presentation focuses on low probability, high consequence events that are routinely missed in conventional Failure Modes and Effects Analysis (FMEA) and other systems engineering techniques. The presentation provides an introduction to a formal mathematical approach that served to identify a new phenomenon called emergent failure modes (EFM). EFM were first identified in response to a failure in the Air Traffic Control (ATC) system in August, 2015. In that event, the ATC center in Leesburg, VA, responsible for a major swath of the northeast corridor, failed catastrophically and without warning. Very quickly, operational managers determined that a recently installed software update had failed due largely to an unanticipated interaction with human operators. The immediate solution was to disable the recent modification and restart the software. The system recovered, but not until after some 400 flights were canceled, affecting people as far away as Chicago and Dallas.

Conventional analysis would suggest that additional testing was required prior to deployment of the software update. However, analysis shows that approach to be essentially unworkable, as it would require a high fidelity simulation involving numerous operational controllers be available and used for every relatively minor patch to be deployed. This example underscores the need for more formal methods for analyzing such events, and to provide a framework for the resolution of such low probability events when they (inevitably) occur.

The approach outlined in this presentation has roots in work by the Navy on multisensory integration, and has been refined in work by other agencies, including, most recently, the FAA in work on maintenance requirements for NextGen and for the New York City Transit (NYCT) authority as it confronts the need to upgrade the subway control center to prepare for increased ridership and technology insertion that may entail substantial automation.

ABSTRACTS

The mathematical object called a sequential dynamical system (SDS) is introduced. The emergence of unpredictable modes in a complex system are examined from the perspective of SDS. Highway traffic congestion is examined as a metaphor to understand the processes that underlie EFM. An approach called intelligent control theory is presented as the only viable approach to mitigate the effects of EFM. Implications of the work for DOD policy for the specification and acquisition of automation and autonomous weapons are discussed, with particular focus on DODDIR 3000.09, dated Nov, 2012.

ABSTRACTS

SubTAG: Controls & Displays

Co-Chairs: Marianne Paulsen & Allison Mead

Controls & Displays

11 May 2016 | 0800 - 1000
Room 201/202

Now you see it and your hands don't: Using eye-tracking to enhance performance of gross-motor gestural controls
Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration

An Investigation of Loss of Well-Clear Incidences from the Collision Avoidance, Self-Separation, and Alerting Times (CASSAT) Human in the Loop Experiment.
Michael Vincent, NASA Langley

Electro Optic / Infrared Sensor Standardization for Surface Ships: Methodology and Techniques for Human Based Ship Board Data Collection
Marc Keller, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration

Agile Design & Section 804: A Human Factors Engineering Best Practice to support SCRUM
Alan Lemon, Space and Naval Warfare Systems Center, Pacific

Tablets in the Cockpit: Human Factors Issues in Military Aviation
Dennis Folds, Georgia Tech Research Institute

CONTROLS & DISPLAYS SESSION I, 1

Now you see it and your hands don't: Using eye-tracking to enhance performance of gross-motor gestural controls

Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration

The emergence of gesture based controls like the Microsoft Kinect provides new opportunities for creative and innovative methods of human computer interaction. However, such devices are not without their limitations. The gross-motor movements of gestural interaction present physical limitations that may negatively affect interaction speed, accuracy, and workload, and subsequently affect the design of system interfaces and inputs. Conversely, interaction methods such as eye tracking require little physical effort, leveraging the unconscious and natural behaviors of human eye-movements as inputs. Unfortunately, eye tracking, in most cases, is limited to a simple pointing device.

However, this research shows by combining these interactions into gaze-based gestural controls it is possible to overcome the limitations of each method, improving interaction performance by associating gestural commands to interface elements within a user's field of view. Participants completed four basic modified Fitts' tasks, to include point and click, click and drag, menu selection, and visual search. The system consisted of a large format display, Eye-tech VT2-XL long distance eye-tracker, and Microsoft Kinect version 2.0, allowing participants to control the interface from a distance of six feet. In addition to integration of the hardware and impacts of gesture and gaze-based gestural controls on performance, this research addresses issues related to appropriate information design criteria for implementing effective gestural interactions.

CONTROLS & DISPLAYS SESSION I, 2

An Investigation of Loss of Well-Clear Incidences from the Collision Avoidance, Self-Separation, and Alerting Times (CASSAT) Human in the Loop Experiment

Michael Vincent, NASA Langley

Background: NASA's Unmanned Aerial Systems Integration in to the National Air Space (UAS in the NAS) project conducted the Collision Avoidance Self Separation Alerting Times (CASSAT) human in the loop experiment to investigate the effects of self-separation alerting parameters on pilot acceptability and performance. The Detect and Avoid Alerting Logic for Unmanned Systems (DAIDALUS) algorithm was used to provide maneuver guidance to pilots to remain well-clear from simulated manned aircraft. Distance and time alerting thresholds were varied during the experiment. The present research investigates incidences of subject pilots penetrating the well-clear volume during the CASSAT experiment.

Methods: Output data from the experiment were analyzed to determine when pilots flew inside the well-clear volume. Flight state data, controller-pilot communications, user inputs to the control station, and videos of the loss of well-clear incidents were then reviewed to create a factual account of each encounter. The timeline of events for each encounter were reviewed by experimenters to determine which events lead to the loss of well-clear during the encounter.

Results: In total 13 losses of well-clear were observed during the CASSAT experiment. All but one loss of well clear occurred in the smallest distance alerting threshold condition while loss of well clear incidents were evenly distributed across alerting time conditions. Two primary causal factors for losing well-clear were observed: late initiation of avoidance maneuver and early initiation of a return to course maneuver. Use of lateral navigation (LNAV) mode, radio congestion, and traffic display limitations were found to contribute to initiating a maneuver late or returning to course too early.

Conclusions: Overall, DAIDALUS and the bands based display concept were effective in helping pilots remain well-clear. Pilot induced loss of well clear appear to occur at a higher rate when the distance alerting threshold is nearer to the well-clear definition distance threshold while alerting time does not appear to increase or decrease loss of well-clear incidences. Display and user interaction improvements alongside training to the concept of detect and avoid would have likely prevented the losses of well-clear observed during CASSAT.

CONTROLS & DISPLAYS SESSION I, 3

Electro Optic / Infrared Sensor Standardization for Surface Ships: Methodology and Techniques for Human Based Ship Board Data Collection

Marc Keller, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration; Gail Nicholson, Naval Surface Warfare Center Crane Division; Daniel Wallace, Naval Sea Systems Command 05W; Erin Calhoun, Naval Surface Warfare Center Crane Division; Richard Woodruff, Naval Surface Warfare Center Crane Division; Keith Lannan, Naval Sea Systems Command 05W

Background: Electro-Optical/Infrared (EO/IR) technology is used by the Navy for several critical ship based tasks including navigation, target identification, threat assessment, and weapon systems. The current Naval EO/IR capability includes several vendor systems each with unique controls and user interfaces. Operators face challenges as they move from one EO/IR system to another as each system can include different visual overlay information, different menu structures and different control layouts. Operators are then required to apply different operating procedures that correspond with each specific EO/IR system which can be confusing especially during periods of stress.

As new EO/IR systems are developed, operators can benefit from a consistent and familiar layout that meets basic human factors principles and operator expectations. To assure consistent and practical designs for future EO/IR systems, the current project is developing interface standards for future EO/IR systems using operator feedback and human factors design principles as the primary basis for the recommendations. The recommended standards will serve to provide decision makers and system designers needed information as future systems are developed. While specific results cannot be shown here, the current presentation discusses methodology and techniques used after considering the complexity and challenges of ship board testing. The current project is funded through the Naval Sea Systems Command Cross Platform System Development program.

Methods: To date the EO/IR Standardization team has visited several Navy Ships and interviewed several Active Duty Navy EO/IR operators to collect data regarding current system use, how the systems are used, Pros and Cons of different systems, and missing capabilities. Data collection includes the use of questionnaires, interviews, recorded observations and functionality prioritization activities.

Results: The final product from this effort will be a recommended standards document that will serve to populate requirements, specifications, and capability documents for future EO/IR systems as needed. The results will also provide insight into future efforts that should be conducted as future capabilities are considered.

Conclusion: Given the complexity and variety of EO/IR systems, standardization becomes ever increasingly more important. The urgency is driven primarily from the increased demand for EO/IR capability aboard Navy ships given the need for better situational awareness. Using a variety of research methods and techniques, investigators have been able to successfully elicit relevant feedback from active duty Navy EO/IR operators. The operator feedback combined with human factors design principles will be used to establish a set of recommended human centered design standards for use by EO/IR stakeholders and designers in the development of future EO/IR systems.

Potential impact to mission/warfighter: EO/IR systems provide ships with unique and often new capabilities that enhance the ability for a ship to complete its mission. Whether used for navigation, targeting, or even man overboard, EO/IR systems have become a critical asset for Navy Ships. A consistent user centered EO/IR design will allow operators efficient use of EO/IR systems while minimizing confusion, error rates and training requirements while satisfying the needs of the mission.

CONTROLS & DISPLAYS SESSION I, 4

Agile Design & Section 804: A Human Factors Engineering Best Practice to support SCRUM

Alan Lemon, Space and Naval Warfare Systems Center, Pacific; Karl Van Orden, Space and Naval Warfare Systems Center Pacific; Michael Cowen, Space and Naval Warfare Systems Center, Pacific (ret.); Hanae Hara, Space and Naval Warfare Systems Center, Pacific

Since 2010 the Department of Defense (DoD) has been directed to develop and implement a new acquisition and development process for information technology (IT) systems based on commercial “agile” practices.

Agile Design methodologies have been developed to compliment Agile IT processes in order to achieve the speed required of software development to rapidly produce and deploy military IT systems. The goal of user interface design in industry is to improve the customer’s user experience (Ux), satisfaction and brand loyalty through the simplicity, utility, gratification and ease of use provided by the products design. Within DoD the focus on the development of the full range of command and control systems is to achieve tactical primacy and mission assurance.

In this presentation, we argue for the broader adaptation of an Agile operator interface design approach capable of achieving the objectives of DoD directives and the inherent challenges of functional allocation between humans and autonomy.

Agile design allows human factors professionals to define the users tasking, workflows, and further refine the predetermined warfighter requirements established by Joint Capabilities Integration and Development System (JCIDS). It will also identify new interdependencies and relationships required of increased autonomy to ensure that such objectives Agile IT and advanced autonomy can be achieved.

In an Agile development environment it is necessary for software archetypes in advance of the software development efforts. The artifacts of the Agile design methodology align with those of the SCRUM process (Epics to Stories to task to sub tasks) providing UI prototypes and architecture templates required achieving such acceleration.

By employing an Agile design methodology, we compliment the Agile IT process by rapidly implementing effective and efficient software development and advance the continuous improvement objectives of SCRUM.

CONTROLS & DISPLAYS SESSION I, 5

Tablets in the Cockpit: Human Factors Issues in Military Aviation

Dennis Folds, Georgia Tech Research Institute; Courtney Crooks, Georgia Tech Research Institute

Tablets (iPads, Android Tablets, and possible Surface tablets) are already being used in military aircraft operations. Widespread use in general aviation and in some commercial aviation has led to Federal Aviation Administration (FAA) concerns. The relative ease of developing applications for tablets, and the low expense of acquiring and distributing tablets, is leading to increasing use of tablets in military aviation. Some uses are supported by the military aviation community; others are being handled mode informally by individuals and squadrons. The Georgia Tech Research Institute (GTRI) conducted a human systems integration (HSI) assessment of uses of tablets in military cockpits, with focus on the electronic kneeboard (EKB) for US Navy aircraft. The evaluation included identification of the functions implemented on, or envisioned for, the EKB. We compiled lists of relevant guidelines (mostly human factors guideline), findings from FAA assessments and associated accident investigations in civil aviation, and results from our own task analysis of envisioned EKB applications. We developed a computational model of human performance using these envisioned applications, with emphasis on estimating total heads-down time and frequency of transition of visual gaze to and from the tablet. We also conducted an assessment of task performance using a low-fidelity mockup of the tasks. Results indicate that (a) location of the tablet on the knee is a bad idea for most applications, (b) applications that induce a lot of visual gaze transitions increase the likelihood of nausea or "aviator vertigo", and © poor choice of fonts, low visual contrast, and complicated user interface design exacerbates these problems. Recommendations are to move tablet locations to higher places (other than the knee) in the cockpit, require better user interface design, and to evaluate applications in higher fidelity simulation environments.

ABSTRACTS

SubTAG: Mixed Reality

Chair: Daniel Walker

Mixed Reality

11 May 2016 | 1230 – 1430
Room 265/266

1230 – 1245	**Mixed Reality SubTag Introduction**
1245 – 1320	**Naval Workspace Prototype Evaluation using Projection Augmented Models and Tangible User Interfaces** Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration
1320 – 1355	**A Mixed-Reality Simulation for Tank Platoon Leader Communication Training** Peter Khooshabeh, US Army Research Laboratory, Human Research and Engineering Directorate
1355 – 1430	**Towards a Single Software Service for Multimodal Human Computer Interaction: Laying the Foundation for Intuitive Interfaces in the Next Generation of DoD Systems** Daniel Yaeger, US Army

MIXED REALITY SESSION I, 1

Naval Workspace Prototype Evaluation using Projection Augmented Models and Tangible User Interfaces

Patrick Mead, Naval Surface Warfare Center Dahlgren Division - Human Systems Integration

This research seeks to utilize projection augmented models, tangible user interfaces, and computer vision technology to develop a cost effective prototyping tool for creating augmented reality (AR) prototyping environments for designing, simulating, and evaluating the impact of future naval work spaces on human performance. Naval workspace mock-ups made of foam core or other construction materials, while relatively inexpensive, lack immersive and interactive capabilities, relying on methods like cognitive walkthroughs to evaluate human performance characteristics. Simulators provide the ability to capture more realistic human performance data, but are more costly, require hardware and software designs to be more mature, and are less capable of accepting rapid design changes. With recent advances in AR it is becoming increasingly possible

to bridge the gap between low fidelity mock-ups and high fidelity simulators, providing prototyping capabilities with higher levels of immersion and interaction, at lower cost, while remaining flexible to real time design changes. The goal of this research is to create a cost effective, highly adaptable, and reusable projection based immersive prototyping tool for designing, simulating, and evaluating human performance characteristics of future naval workspaces and systems.

MIXED REALITY SESSION I, 2

A Mixed-Reality Simulation for Tank Platoon Leader Communication Training

Peter Khooshabeh, US Army Research Laboratory, Human Research and Engineering Directorate; Julia Campbell, USC Institute for Creative Technologies; David M. Krum, USC Institute for Creative Technologies, Mixed Reality Lab; Brett T. Wright, US Army Maneuver Center of Excellence; Andrew P. Jenkins, US Army Maneuver Center of Excellence; Igor Choromanski, USC Institute for Creative Technologies; Ryan Spicer, USC Institute for Creative Technologies

It is often assumed that the highest possible fidelity and realism in simulation-based training environments is always desirable. For example, Army doctrine requires enhanced realism such that the physical hardware, visual graphics, as well as the functional and social realism will be at the highest level possible so as to “train like you fight” (Brown, 2016)—which requires significantly more time and financial resources. Research from the cognitive sciences and educational psychology, however, offers a more nuanced approach to tailoring realism and fidelity to the needs of the individual trainee and the task (Andre & Wickens, 1995; Cummings & Bailenson, 2015; Moreno & Mayer, 2002). In order to address this dilemma, our project within the TE-STO (Training-Effectiveness Science & Technology Objective) at ARL-West focuses on the question of “how much fidelity is enough” in order to improve training effectiveness for critical-thinking tasks. We have conducted literature reviews, field studies, and interviews with SMEs in order to gather a class of tasks and individuals for whom a mixed-reality (MxR) simulation provides sufficient fidelity cues. Our work has resulted in an innovative MxR prototype-simulation that is intended to assess critical-thinking skills for communication tasks to improve Cognitive Readiness (another subTAG to which this effort is related), thereby incorporating training effectiveness in the front-end analysis of the project.

The MxR environment we have prototyped is intended to emulate functional characteristics of the Close-Combat Tactical-Trainer (CCTT), which is a precise replication of the interior and controls of a combat vehicle, intended for collective-crew training. One domain in which the CCTT is employed is training decision-making and communication skills for armor platoon leaders. The Maneuver Center of Excellence

(MCoE) has developed one such cognitive assessment exercise for Second Lieutenants (2LTs) in the Armor Basic Officer Leadership Course designed to be conducted in the CCTT. Based on literature reviews and observational field studies, we hypothesize that platoon-leader critical thinking skills involved in radio and intercom communication, such as deciding when to relay information to higher command, do not require a precise physical replication of the combat-vehicle interior controls. For that reason, our MxR simulation uses a head-mounted display (HMD) to render the combat-vehicle interior, and represents the other tank crew members (loader and gunner) as virtual humans. The primary physical controls that we implement are the push-to-talk (PTT) capability in the combat-vehicle-crewman (CVC) helmet as well as a switch to determine whether the radio broadcasts should be directed to the vehicle intercom, platoon-net or the company-net. We have also implemented a joystick control similar to that in the CCTT, which allows the platoon-leader to operate the Commander's Independent Thermal Viewer (CITV) in the simulated combat vehicle.

Using an MxR virtual environment to emulate key functionality of the CCTT has potential benefits in terms of training effectiveness. First, eye-tracking capability can be integrated into the HMD and this can provide training effectiveness data that could be visualized for the Company Commander After-Action-Review. Additionally, because the representation of the crew compartment is part of the virtual environment, updating the training tool to reflect the appearance and systems of a particular combat vehicle can be accomplished less expensively in the MxR simulation, compared to a refresh of hardware across all the physical modules of the CCTT. Finally, because this MxR prototype-simulation uses COTS hardware (laptop and HMD), it can enable a desired capability for training at the point of need (TRADOC PAM 525-8-2, 2011).

MIXED REALITY SESSION I, 3

Towards a Single Software Service for Multimodal Human Computer Interaction: Laying the Foundation for Intuitive Interfaces in the Next Generation of DoD Systems

Daniel Yaeger, US Army

As the next generation of Army hardware and software systems emerge, advancements in computing architectures and communications technologies will allow the volume of information available to soldiers at every echelon, including at the tactical edge, to increase exponentially. As system designers introduce new approaches to delivering this data to the soldier more efficiently (Heads-up Augmented Reality displays, haptic feedback, multiple wearable displays, virtual displays, etc.), traditional modes of interacting with our software systems become less and less practical. In order to take advantage of increasingly robust data sets made available via displays that move with us,

and that can be viewed without the use of our hands, it is important to employ Human Computer Interaction (HCI) input modalities that are flexible enough to maintain the advantages of hands-free information delivery.

Previous efforts to integrate advanced HCI modalities within DoD software systems have been limited in scope, and remain out of reach for the majority of users. Stove-piped integration, focusing on one application at a time, has resulted in capabilities that are both costly and difficult to extend to additional applications. As the DoD moves toward the next generation of software systems, there is an opportunity for the DoD R&D community to lay the groundwork for the implementation of advanced HCI technologies at the system level by providing a single software interface for integration with advanced multimodal HCI input. This will allow integration with multiple applications through well-defined software design guidelines and a single API set.

ABSTRACTS

SubTAG: Sustained Operations

Chair: Thomas Nesthus and Nancy Wesensten

Sustained Operations

11 May 2016 | 1230 – 1430
Room 201/202

Introductions: "Welcome back Kotter…"
Thomas Nesthus and Nancy Wesensten

Sustained Operations Research at the Naval Aeromedical Research Unit Dayton
Richard Arnold, Naval Medical Research Unit Dayton

The NASA Fatigue Countermeasures Laboratory: Report of Current Activities
Erin Flynn-Evans, NASA

Work and sleep patterns in military shift workers: promoting health and wellness through informed shift schedules
Nita Shattuck, Naval Postgraduate School

An Individiualizable Model to Predict Sleep/Wake and Caffeine Effects on Cognitive Performance
Jaques Reifman, US Army

SUSTAINED OPERATIONS SESSION I, 1

Sustained Operations Research at the Naval Aeromedical Research Unit Dayton

Richard Arnold, Naval Medical Research Unit Dayton

In modern aerospace settings, unpredictable and long work hours, circadian disruptions, and disturbed or restricted sleep are common. These factors often result in personnel reporting for duty in a fatigued state, leading to mistakes, cognitive difficulties, and mood disturbances that can lead to performance problems and safety hazards. In the U.S. Navy and Marine Corps, fatigue was identified as the leading aeromedical factor contributing to a mishap between 1990 and 2011.

To address the problem of fatigue, scientists at the Naval Aeromedical Research Unit Dayton (NAMR-D) are conducting research aimed at finding ways to reduce the impact of inadequate sleep on alertness and performance. Countermeasures to combat the effects of sleep loss on performance have been investigated at NAMRU-D for several years, including behavioral and pharmacological countermeasures. Investigations into the effects of combining countermeasures (e.g., napping with modafinil) are the current focus of research. Also, in collaboration with other scientists, investigators are examining the effects of combined stressors on performance (e.g., hypoxia combined with inadequate sleep). In addition, identification of individual characteristics and the response to sleep deprivation have led to investigation of the way countermeasures may benefit individuals differently based on their response to sleep loss. For example, identification of fatigue vulnerable individuals could allow tailored implementation of alertness aids, providing help to those who need it most while avoiding unnecessary dosing of those who do not.

It is possible to effectively reduce the effects of inadequate sleep on performance and alertness if scientifically-validated strategies are systematically applied. Scientists at NAMRU-D have addressed this threat to the operational community for many years and will continue to focus on resolving this problem and inform leaders of ways to improve safety and effectiveness while successfully completing the mission.

SUSTAINED OPERATIONS   SESSION I, 2

The NASA Fatigue Countermeasures Laboratory: Report of Current Activities

Erin Flynn-Evans, NASA

The Fatigue Countermeasures Laboratory at NASA Ames Research Center has a long history of investigating the causes and consequences of fatigue in aviation and spaceflight. After several years of quiescence, the laboratory was re-established in 2013. The current focus of the laboratory is fourfold, 1) we investigate the causes and consequences of fatigue arising from sleep loss and circadian desynchrony; 2) we develop tools and sensors that can be used to monitor and mitigate fatigue; 3) we evaluate commercial tools and biomathematical models aimed to predict fatigue in order to determine the effectiveness of such tools, and; 4) we develop fatigue risk management education programs for groups that have complicated or non-traditional work requirements. Some of the groups that we work with include commercial airlines, spaceflight personnel, harbor pilots, automobile companies and the US Navy. We provided Fatigue Risk Management training to individuals working on the SOFIA project, which required nighttime operations, and the New Horizons mission to Pluto, which required an intense, high-tempo workflow during the Pluto flyby in 2015. We have developed a Fatigue Risk Management App for handheld devices that we have tested in a commercial aviation environment and are currently preparing to deploy widely. We have many studies in progress and preliminary findings will be presented.

SUSTAINED OPERATIONS SESSION I, 3

Work and sleep patterns in military shift workers: promoting health and wellness through informed shift schedules

Nita Shattuck, Naval Postgraduate School; Panagiotis Matsangas, Naval Postgraduate School; Arlene Saitzyk, United States Navy

Background: Members of the military often get inadequate sleep for a variety of reasons. Cost-cutting measures that result in reduced manning, extended work hours, shiftwork schedules that result in circadian misalignment—all of these factors contribute to the sleep debt and degraded alertness observed in much of the military population. This study assessed subjective levels of reported fatigue and compared them to real time performance measures (e.g., reaction time, accuracy) of military shift workers.

Methods: Military shift workers (N=75) serving in various locations around the world participated in the study. Participants wore actigraphs over a two-week period, filled out daily activity logs, and took a three-minute Psychomotor Vigilance Task (PVT) before and after standing watch on their regular schedules. In addition, they filled out questionnaires about their sleep habits and their individual mood states at the beginning and end of the study period. Participants in the present study worked either 8-hour (daytime, evening, or overnight) or 12-hour (day vs. overnight) shifts.

Results: Participants slept 6.74 hours on a daily basis, with 19% sleeping on average less than 6 hours. At the outset of the study, approximately 62% of the participants reported symptoms of insomnia and were classified as poor sleepers. Although there were no significant differences in the sleep amounts for the two watch standing schedules (8-hour vs. 12-hour), participants on the 8-hour shifts made fewer errors and showed less variability in their reaction time performance (e.g., fewer lapses combined with false starts) compared to those individuals working on 12-hour shifts. Furthermore, those on 12-hour shifts were nearly twice as likely to be identified as poor sleepers compared to those on 8-hour shifts. Finally, many more participants reported personal preference of the 8-hour over the 12-hour shift schedule. The top three issues identified as interfering with sleep were temperature, light, and noise.

Conclusion: Results show that sleep quality, quantity, and sleeping conditions remain problems for these military shift workers. These preliminary findings suggest the 8-hour shift schedule is preferable to the 12-hour one, both in terms of personal preference and in performance. Extant research indicates that the “mids” shift (midnight to 6 a.m.) is generally the most problematic in terms of obtaining quality sleep due to the challenges of sleeping during daylight hours. Consequently, efforts are underway in this population to assess the use of High Energy Visible (HEV) blue light-blocking glasses to facilitate circadian entrainment and improve sleep during daytime hours.

ABSTRACTS

SUSTAINED OPERATIONS SESSION I, 4

An Individiualizable Model to Predict Sleep/Wake and Caffeine Effects on Cognitive Performance

Jaques Reifman, USMRMC/BHSAI/TATRC

Sridhar Ramakrishnan, Ph.D.1; Jianbo Liu, Ph.D.1; Maxim Khitrov1; Nancy J. Wesensten, Ph.D.2; Thomas J. Balkin, Ph.D.3; and Jaques Reifman, Ph.D.1*

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BACKGROUND: Biomathematical modeling of sleep/wake and circadian rhythm effects on cognitive performance comprises a critical component of most fatigue risk management systems, allowing for identification of periods during which individuals are at increased risk for committing fatigue-related errors. However, currently available models are not individualizable nor do they account for the effects of caffeine (one of the most widely used fatigue countermeasures). Here we describe a unified mathematical model of performance (UMP) that predicts (1) sleep/wake and time of day (circadian) effects on an individual's cognitive performance (i.e., model can be tailored to the individual) and (2) the temporary performance-restoring effects of caffeine.

METHODS: To determine UMP accuracy for predicting an individual's performance response to sleep/wake amounts and time of day, we utilized data from a study in which 15 subjects underwent both a 64 h total sleep deprivation (TSD) challenge and a chronic sleep restriction challenge [3 h time in bed (TIB) per night for 7 consecutive nights]. To determine UMP accuracy for predicting caffeine effects, we utilized data from a 29-h TSD study in which 48 subjects were administered three repeated doses (separated by 2 h) of 0, 50, 100, or 200 mg of caffeine (n = 12 per caffeine group).

RESULTS: Individual performance prediction accuracy. The UMP customized to an individual under one sleep/wake condition (either 64 h TSD or 3 h TIB/night for 7 nights)

predicted performance of the same individual under the other condition up to 50% more accurately than a non-individualized (i.e., group-average) model. Importantly, once the model had been customized to an individual for either of the two conditions, it could be directly applied to predict the same individual's performance under the other sleep/wake condition. Caffeine effect prediction accuracy. The UMP accurately predicted the effects of the range of caffeine doses, yielding up to 90% improvement over a model that did not account for caffeine.

CONCLUSIONS: Our UMP provides the means to tailor the cognitive performance predictions to an individual and to accurately predict the restorative effects of different dosages of caffeine, offering substantial gains in accuracy over currently available models.

POTENTIAL IMPACT TO MISSION/WARFIGHTER: The UMP can be used as a tool to accurately predict the impact of a given mission sleep/wake schedule on Warfighter operational performance and to plan in advance for countermeasure strategies such as appropriately time caffeine and/or naps to optimize performance at critical times.

DISCLAIMER: The opinions and assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the United States (U.S.) Army or of the U.S. Department of Defense. This abstract has been approved for public release with unlimited distribution.

ABSTRACTS

SubTAG: Trust in Autonomy Special Interest Group

Chair: Lauren Reinerman-Jones

Trust in Autonomy Special Interest Group

11 May 2016 | 1230 – 1430
Room 262/263

My Co-Pilot is a Time Machine Tamara Chelette, US Air Force Research Lab	
Trust of an Automated Collision Avoidance System within the Air Force William Fergueson, Air Force Research Laboratory	
Tracking Fatigue and Reliance on Automation in Multi-UAV Operation Gerald Matthews, University of Central Florida	
Monitoring Operator State Through Psychophysiological Indices in Military Aircraft David Boudreaux, U.S. Army Aeromedical Research Laboratory	
Factors Affecting Performance of Human-Automation Teams Anthony Baker, Embry-Riddle Aeronautical University	
Using Natural Language to Enhance Mission Effectiveness Anna Trujillo, NASA Langley Research Center	

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 1

My Co-Pilot is a Time Machine

Tamara Chelette, US Air Force Research Lab

Background: There I was….. within the distinctly confined cockpit of my 50 year old twin-turboprop, interacting rapidly with my A-grade copilot…who is a cyborg. It is not so much a cyborg, as a time machine. A collection of knowledge and abilities captured from dozens of intellects over decades. Many were pilots like me, but a lot were mechanical and software experts that would build this distributed cyber-aviator to observe, orient, decide, and act on par with any flyer – with minimal direction from me. They contributed their thoughts and skills several years ago, recorded in the design and software that now has this operation, and my life, in its 'hands'. One of the most intriguing realities is that this aircraft is twice my age and my co-pilot has been flying, learning, and adapting since before I got my wings. But right now, we have a critical humanitarian airdrop to make in a few moments and the fog just keeps getting thicker. Suddenly there is a jolt and my digital co-pilot reports that the cargo door is open and it is beginning the drop procedure. I am concerned about the rising terrain to the west but my co-pilot has already brought up overlays on its upgraded display with the terrain, our DZ, and our projected path. I am focused on confirming coordinates and studying the lidar-enhanced display to assure we don't drop this palate on a house, while the co-pilot has already corrected our approach for cross winds > 40 kts and is flying us in at precision slope. Once I confirm the drop, I turn my attention to air traffic and transmitting our mission status while the co-pilot navigates us toward home and finishes the entire post-drop checklist, including three cycles of closing the cargo door against the wind. I find myself breathing easier with the assurance that this veteran aircraft is being flown by one of the most skilled sets of aviator 'hands' ever.

Methods: The goal of the DARPA ALIAS program is to explore the use of machine perception, system knowledge acquisition, and novel actuators to non-invasively provide modular automation in legacy aircraft. Several industry and academic partners are investigating the complex design trade space and viability of a distributed, artificially intelligent crew member under this program. In addition to the traditional aviation design issues, there remain complexities of machine learning, dynamic task allocation, system transparency, fault tolerance, and formal verification & validation.

Results: Machines such as those developed under ALIAS will allow flexible upgrades to decades-old aircraft that are airworthy but lack modern avionics and automation. The distributed digital crew could go from novice, to journeyman, to expert adapting with the incorporated knowledge of each mission – and the collaborative learning of all its digital cohort's missions – literally learning in the clouds.

Conclusion: Autonomy and agency are granted to machines by humans; designers who build them and operators who chose to use them. ALIAS is exploring a new frontier where the pilot co-flies with a system that is the long-term product of both evolutionary and intelligent design – a machine that transcends time.

ABSTRACTS

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 2

Poster Presentation/Review 1: Poster Presentation Trust of an Automated Collision Avoidance System within the Air Force

William Fergueson, Air Force Research Laboratory; Joseph Lyons, Air Force Research Laboratory; Nhut Ho, California State University, Northridge; Garrett Sadler, NASA Ames Research Center; Samantha Cals, Air Force 412th Flight Test Squadron; Casey Richardson, Air Force 416th Flight Test Squadron; Mark Wilkins, Office of the Secretary of Defense

Background: This field study assessed pilot trust (i.e., willingness to accept vulnerabilities) of a recently fielded system—the Automatic Ground Collision Avoidance System (AGCAS) which in a short time frame is already credited with 3 operational saves. AGCAS is currently used on the Air Force's F-16 platform in order to reduce loss of life/equipment to Controlled Flight Into Terrain (CFIT) due to spatial disorientation or gravity-induced loss of consciousness. The AGCAS system uses a time-based algorithm that incorporates a digital terrain mapping technology as well as flight information to detect if an impact with the ground is imminent. When triggered, the system will take control of the aircraft and execute an aggressive automated recovery, thus this system represents a complex form of automation. Little field research has been done with trust in automation of fielded systems since this research is typically conducted in a lab-based setting. The AGCAS system implementation offered a rare opportunity to study the development of trust in automation by real operators in high-stake training as well as operational missions.

Method: Operational F-16 pilots (N = 168) were interviewed at 10 different Air Force or Air National Guard bases. The interviews looked at the AGCAS system in the following ways: initial perceptions, trust antecedents overtime, reason for trust changes (if applicable), performance perceptions, awareness of the psychological business case for why the system was implemented, reputation of the system, and awareness of operational performance.

Results: The main trust enablers found included: nuisance-free performance, dependable performance in operational situations and broad awareness of this operational performance, robust business case, high trustworthiness of the test community, transparency of the system (AGCAS chevrons, indicators) in the Head-up Display (HUD), and the knowledge that early system errors were thought as hardware limitations instead of AGCAS software issues. The main detractors of trust included: nuisance activations (i.e., false alarms), data limitations for system sensing capabilities, ambiguous error displays, and lack of system familiarity / understanding.

Conclusions: This research revealed the antecedents of trust and distrust of Air Force operational pilots towards the AGCAS system. The factors explored in the present study

reveal a complex pattern of interrelationships among psychological and operational dimensions as antecedents of trust in a complex military form of automation.

Potential Impact to Mission/Warfighter (if applicable): The study is currently supporting modifications to the F-16 AGCAS system as well as the pilot community by revealing pilots concerns and system issues to OSD, AF/ACC and the Air Force test community. This research is improving the current AGCAS system and forming the foundation for a successful implementation into the Air Force's F-35 program which will use the same AGCAS technology.

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 3

Tracking Fatigue and Reliance on Automation in Multi-UAV Operation

Gerald Matthews, University of Central Florida; Ryan Wohleber, University of Central Florida; Jinchao Lin, University of Central Florida; Gloria Calhoun, Air Force Research Laboratory; Gregory Funke, Air Force Research Laboratory

The capability for a single human operator to control multiple Unmanned Aerial Vehicles (UAVs) depends critically on automation of systems. Operators may be challenged both by the need to regulate workload adaptively and to correctly calibrate trust in automation, avoiding both over- and under-reliance on decision-aids. We are conducting simulator-based research in this area with support from the AFOSR Trust and Influence Program. This research focuses especially on automation of surveillance tasks, consistent with use of UAVs for Intelligence, Surveillance and Reconnaissance (ISR) missions. Following an initial study of the impact of cognitive overload, we are focusing on the issues of underload and fatigue that are common in the operational environment. We will review findings from a recent study that showed progressive deterioration in operator performance over a 2-hour simulated mission, especially with low-reliability automation. We will also evaluate the utility of eyetracking as a method for diagnostic monitoring of the monitor that may support adaptive automation.

ABSTRACTS

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 4
POSTER PRESENTATION/REVIEW 1: POSTER PRESENTATION

Monitoring Operator State Through Psychophysiological Indices in Military Aircraft

David Boudreaux, U.S. Army Aeromedical Research Laboratory; Kathryn Salomon, U.S. Army Aeromedical Research Laboratory

Background: The Army is currently in the process of developing a new generation of advanced rotary-wing aircraft, known as Future Vertical Lift (FVL) that will include increased automation capabilities. A key requirement is to maintain a pilot-centric system through a pilot-computer team design. One method to achieving this goal is the incorporation of adaptive automation that utilizes psychophysiological feedback from the pilot to determine operator state. Adaptive automation utilizing psychophysiological feedback has already shown promise in mitigating high cognitive workload conditions (Freeman et al., 1999; Pope et al., 1995; Matthews 2015), but currently lacks the fidelity to be used in direct application within aircraft. It is essential to first identify the most reliable psychophysiological indices for measuring operator states such as high workload, fatigue, and stress. This study aims to address these issues by empirically determining which psychophysiological indices best identify adverse operator state that can lead to performance degradation during specific aviation tasks.

Methods: A number of flight maneuvers essential to aviation will be selected for use in a full-motion, UH-60 Blackhawk simulator. Rated Army pilots will perform each maneuver under high and low workload conditions in a counter-balanced design. Psychophysiological data, including EEG, heart rate variability, blood pressure, core body temperature, eye tracking, and respiratory rate, will be collected during the flight. Flight performance data from the simulator such as air speed, altitude, attitude, heading, and flight path will be recorded and chronologically synched with the tasks and psychophysiological data. Pilots will also report on subjective workload following each maneuver and workload condition. Once baseline measures are established for each individual task, flight scenarios will be developed that mix multiple aviation tasks in a combinatorial test matrix.

Results: First, a manipulation check between the workload conditions will be done using a repeated-measures t-test to ensure the conditions have the desired effect on performance. Second, mixed-model ANOVAs will be completed to examine each of the dependent variables (flight performance measures, psychophysiological measures, subjective workload measures) as between-subjects factors, with the independent variables of workload conditions as the within-subjects factor.

Conclusions: The results of the study will be used to determine which psychophysiological measures best characterize workload changes in conjunction with the maneuvers assessed. The findings will also be used to determine the level of performance decrement

under high workload conditions. The combinatorial test matrix will be used to identify which task pairings produce deleterious performance effects and which tasks a pilot can successfully perform in conjunction. This research will guide the development of algorithms for detecting adverse operator states to inform automated systems when, and which, tasks should be controlled by the computer in FVL.

Potential impact to mission/warfighter: This research will contribute to the design of the automation system used in future Army airframes. By developing design guidelines from evidence-based studies specific to Army aviation with a focus on monitoring the operator's state, this study will have the potential to save millions of dollars and the lives of many military members through reduced mishaps and improved flight performance.

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 4

Factors Affecting Performance of Human-Automation Teams

Anthony Baker, Embry-Riddle Aeronautical University; Joseph Keebler, Embry-Riddle Aeronautical University

Automated systems continue to increase in both complexity and capacity. As such, there is an increasing need to understand the factors that make good human-automation (H-A) teams. This presentation will be a high-level review of several factors that affect the performance of H-A systems. We will begin by discussing the effects and implications of using different levels and degrees of automation. The impact of the automated system's reliability on the H-A team's performance will be discussed. The human side of the H-A team will also be considered, with specific emphasis on discussing factors that affect human trust of automated assets. We consider the consequences of failures in the H-A system, and we discuss factors that improve performance outcomes after automation failures. Finally, we draw conclusions about ways to improve the overall performance of H-A teams, and we provide directions for future research.

An automated system must have a level of automation appropriate to the task so as not to put the team at excessive risk when it fails. The system must be reliable, which will inspire calibrated trust of it by the human operators, which in turn will allow for better performance of the H-A team due to the congruence of their shared mental models. Steps must be taken in the design of the system to allow the operators, in the event of automation failures, to swiftly and accurately diagnose and manage faults. Some potential design steps involve improving transparency of the system (via improvements in display ecology), adding checklist support to the fault management step, and improving operator training on system repair and management.

The influence that each of these factors has on the H-A team dynamic must be more completely understood in order to ensure that the team can perform to its maximum potential. Thorough understanding of this dynamic is especially important to ensuring that H-A teams can succeed safely and effectively in critical contexts.

ABSTRACTS

TRUST IN AUTONOMY SPECIAL INTEREST GROUP SESSION I, 5

Using Natural Language to Enhance Mission Effectiveness

Anna Trujillo, NASA Langley Research Center; Erica Meszaros, Eastern Michigan University

The availability of highly capable, yet relatively cheap, unmanned aerial vehicles (UAVs) is opening up new areas of use for hobbyists and for commercial activities. The purpose of this research is allowing an operator, who is not a trained UAV pilot, to define and manage a mission. This paper describes the preliminary usability measures of an interface that allows an operator to define the mission using speech to make inputs.

An experiment was conducted to begin to measure the efficacy and user acceptance of using voice commands to define a multi-UAV mission and to provide high-level vehicle control commands such as “takeoff.” The primary independent variable was input type—voice or mouse. The primary dependent variables consisted of the correctness of the mission parameter inputs and the time needed to make all inputs. Other dependent variables included NASA-TLX workload ratings and subjective ratings on a final questionnaire.

The experiment required each subject to fill in an online form that contained comparable required information that would be needed for a package dispatcher to deliver packages. For each run, subjects typed in a simple numeric code for the package code. They then defined the initial starting position, the delivery location, and the return location using either pull-down menus or voice input. Voice input was accomplished using CMU Sphinx4-5prealpha for speech recognition. They then input the length of the package. These were the option fields. The subject had the system “Calculate Trajectory” and then “Takeoff” once the trajectory was calculated. Later, the subject used “Land” to finish the run. After the voice and mouse input blocked runs, subjects completed a NASA-TLX. At the conclusion of all runs, subjects completed a questionnaire asking them about their experience in inputting the mission parameters, and starting and stopping the mission using mouse and voice input.

In general, the usability of voice commands is acceptable. With a relatively well-defined and simple vocabulary, the operator can input the vast majority of the mission parameters using simple, intuitive voice commands. However, voice input may be more applicable to initial mission specification rather than for critical commands such as the need to land immediately due to time and feedback constraints.

It would also be convenient to retrieve relevant mission information using voice input. Therefore, further on-going research is looking at using intent from operator utterances to provide the relevant mission information to the operator. The information displayed will be inferred from the operator’s utterances just before key phrases are spoken. Linguistic analysis of the context of verbal communication provides insight into the intended meaning of commonly heard phrases such as “What’s it doing now?”

Analyzing the semantic sphere surrounding these common phrases enables us to predict the operator's intent and supply the operator's desired information to the interface. This paper also describes preliminary investigations into the generation of the semantic space of UAV operation and the success at providing information to the interface based on the operator's utterances.

ABSTRACTS

SubTAG: Design: Tools & Techniques

Chair: Michael Feary & Chelsey Lever

Design: Tools & Techniques Session I

11 May 2016 | 1500 – 1700
Room 201/202

1500 – 1515	**Welcome and SubTAG Business - Chelsey Lever**
1520 – 1550	**Using Model Based Tools to Support Human Automation Interaction** Angelia Sebok, Alion Science and Technology
1555 – 1624	**AF Human Systems Integration Capabilities and Requirements Tool (HSI-CRT)** Roger Spondike, Booz Allen Hamilton
1630 – 1700	**Making Software a Human Sensor for Integration and Performance** Joshua Poore, Draper

Design: Tools & Techniques Session II

12 May 2016 | 1330 – 1530
Room 201/202

1330 – 1335	**Welcome and SubTAG Business** Chelsey Lever
1340 – 1410	**The Military Anthropometry Resource Companion (MARC): A Tool for Accessing & Analyzing Anthropometry for Physical Accommodation** Christopher Garneau, ARL-HRED
1415 – 1445	**User Centered Design Applied to USAF Civil Engineering Explosive Ordinance Disposal Tools and Jigs** Jeffrey Parr, Air Force Institute of Technology Michael Miller, Air Force Institute of Technology
1450 – 1520	**Developing Emprically-Derived Quantitative Human Systems Integration Guidelines for Systems Engineering** Emily Stelzer, Hunter Kopald The MITRE Corporation

ABSTRACTS

DESIGN TOOLS & TECH I, 1

Using Model Based Tools to Support Human Automation Interaction

Angelia Sebok and Christopher Wickens, Alion Science and Technology

Background: As automation becomes more prevalent across industries, human automation interaction (HAI) is a topic of increasing importance. Designing systems to support operator performance has progressed in complexity far beyond Fitts' List. Many questions need to be answered regarding the roles of the operator and the automation, particularly with respect to allocation of responsibilities, the design of the interface, and the reliability of the automation. This presentation will summarize three projects to develop and validate model-based tools that predict operator performance in to-be-built automated systems. Human performance modeling provides a way to simulate systems and perform "what if" analyses and to examine in detail the effects of changes to design parameters on predicted performance before the systems are built.

Methods: Three projects were performed for NASA research agencies to evaluate operator performance in novel, automated situations. One project evaluated the effects of automation design changes to the Flight Management System (FMS) in aviation. A second project predicted operator performance while using a remotely controlled mechanical arm (robotic arm). A third project examined operator performance in a dual task scenario of environmental process monitoring / control and robotic arm control.

In the FMS project, the team developed a tool that a flight deck designer can use to identify potential HAI design issues. The tool consists of modules that address the layout of displays and controls, the complexity of the modes of operation, and procedures used for interacting with the FMS. The robotic arm control tool allows human performance specialists and robotic automation designers to evaluate the effects of various design factors (such as the allocation of trajectory control functions to automation versus humans, camera recommendations, and hazard alerting to humans or automation) on predicted performance (mission completion time, trajectory errors, collisions, operator workload). The dual task project allows human performance specialists and automation designers to evaluate the effects of level of robotic automation and automation failure types and indications on predicted operator performance.

Results: Each of the three projects included a validation effort in which model predictions were compared with empirically gathered human performance. The FMS tool validation compared predictions regarding layout and procedures. Two FMS designs were compared, and the model predictions agreed with the empirical findings regarding which design provided better pilot performance. The robotic arm model predictions for performance and automation-based complacency were compared with empirical results regarding operator detection of automation failures. Model results indicated good agreement ($r = 0.97$) with empirical findings regarding failure detection rates. An intermediate

degree of automation provided the best situation awareness and highest automation failure detection rate. Finally, the dual task model predictions were compared with targeted empirical results and identified good agreement ($r > 0.88$) in terms of task switching behaviors, time to detect faults, and time to repair faults. These studies indicate that model based tools provide a viable technique for predicting operator performance in novel HAI situations. These techniques can be used to support the warfighter by predicting performance in automated systems such as unmanned asset control.

DESIGN TOOLS & TECH SESSION I, 2

AF Human Systems Integration Capabilities and Requirements Tool

Roger Spondike, 711 HPW / Directorate Human Systems Integration

Establishing human-centered requirements early in the system design, development and acquisition process is key to delivering effective and useable systems to the warfighter. The Human Systems Integration Capabilities and Requirements Tool (HSI – CRT) was created to help achieve this goal. The HSI-CRT analyzes human related risks in the Capabilities-Based Assessment (CBA), Analysis of Alternatives (AoA), and Concept Development (CD) process. The questions, pertaining to all nine domains, were developed by leveraging DoD and AF requirements guides, and subject matter expert feedback. Using yes/no answers and a tradeoff matrix, the tool will provide a report documenting the human performance risks (in the form of risk matrices) associated with the analysis being performed.

A usability study has been performed using both HSI practitioners and those outside of the field. Results of this study aided in the final design, interface, and functionality of the tool. HSI-CRT has been certified for installation on USAF networks and is currently able to be utilized. In addition to presenting basic information on the tool and the methods/results behind question development and the usability study, a demo of the tool will be given. The tool will be available to interested parties.

Making Software a Human Sensor for Integration and Performance

Joshua Poore, Laura Mariano, Eric Jones, Draper

Outside of the commercial sector, the acquisition process for software isn't so different from the acquisition process for hardware. Traditionally, the process of development and testing is a highly sequenced, phasic process. Modern Agile software development practices, in contrast, allow for distributed and parallelized development in such a way that software can be constructed, tested, and deployed very quickly. IV&V practices have not similarly changed, resulting in an acquisition and verification process that is not as equally matched with software development in agility. This is especially true where products are tested for usability and end-user adoption, which generally involves laboratory or field testing methods that take time and resources to implement. Across a five year span, Draper has developed Software as a Sensor™ Assessment methods for collecting, modeling, and assessing software activity logs for usability analysis. Draper has recently developed a number of open source applications that when integrated allow for continuous, agile software evaluation that can match the cadence of modern software development practices.

Laboratory and traditional field assessment practices for usability analysis place a reliance on methods that produce well-labeled, interpretable data. With clear questioning, known stimulus content (and presentation), and comparisons with baselines, it becomes relatively easy to infer that users experienced cognitive load, for example, because they either report as much or some signal collected during test deviates from some baseline or benchmark. However, these methods require that development efforts cease while data is collected under special circumstances (e.g., in a laboratory or in the field). Translating findings from end-user interviews about the usability and usefulness of software products is somewhat of an art, not a science. Thus, to actually improve software products through testing, testing must be performed iteratively, or tested through larger scale experiments with a priori hypotheses about how to improve the product, which takes valuable time away from development.

To modernize software human systems integration analysis, Draper has developed methods for not only for continuously analyzing usability data and disseminating results to developers in agile ways, but utilizing opportunistic data that results in insights that are “developer readable”. Draper has developed open-source API to capture and restructure logs generated during software usage, and export them in real-time. The structure of Draper’s API (User ALE) provides granularity that commercial for website analytics do not currently achieve. Non-parametric modeling approaches can then be leveraged to provide insights into how users integrate the functionality of software applications and the workflows they learn to accomplish tasks with applications. Metrics extracted from these models describe key indicators of usability, workload, and proficiency. They predict well traditional measures, suggesting that we can capture similar information that might be captured in laboratory environments at greater speeds and with less invasive methods. Also, these models and metrics are ultimately traceable to software events; developers can use these findings to improve their software in actionable ways. Most importantly, software activity logs can be collected at end use and remotely collected and databased for analysis allowing for continuous evaluation and data collection.

ABSTRACTS

DESIGN TOOLS & TECH   SESSION II, 1

The Military Anthropometry Resource Companion (MARC): A Tool for Accessing and Analyzing Anthropometry for Physical Accommodation

Christopher Garneau, ARL-HRED; Lamar Garrett, ARL-HRED

Background: In the design of military vehicles, equipment, weapons, and other systems, the spatial requirements of the Soldier/warfighter must be considered to ensure fit, safety, and performance. Detailed databases of reference anthropometry (body dimensions) for the military have been made available to those involved with developing and evaluating military systems. These databases are used to determine or evaluate adjustability, reach, clearance, and other parameters; examples include ANSUR, the 1988 U.S. Army Anthropometric Survey, and the new ANSUR II 2012 update. While it is relatively easy to find references and summary statistics for the data, capabilities for interactively exploring the data and performing multivariate analysis for design or evaluation have been lacking in existing resources.

Methods: The Army Research Laboratory (ARL) has developed a web-based tool to address the aforementioned gap. The tool—called the Military Anthropometry Resource Companion (MARC)—has three core components: (1) an interface for exploring available datasets, (2) an interface for collecting and analyzing anthropometry for small-scale fit studies, and (3) an interface for determining multivariate accommodation given limits on various dimensions. There are also complementary features that support these three core components such as a tool for estimating the effect of clothing and equipment and visualizations of the distribution of the various measures. The MARC tool has been utilized recently in a Human Systems Integration (HSI) context to collect anthropometry for Joint Service Aircrew Mask Rotary Wing (JSAM-RW) and the Soldier Protection System (SPS), which serves as a case study for the data collection component of the tool.

Results: In the case study, anthropometry measurements were taken across 12 dimensions for the purpose of incorporating scientific data on human physical characteristics for system design. A total of 12 anthropometric dimension measures were recorded in centimeters (cm) and kilograms (kg): elbow-grip length (cm), hand breadth (cm), interpupillary breadth (cm), grip strength (kilogram), shoulder (bideltoid) breadth (cm), shoulder-elbow length (cm), shoulder-fingertip length (acromion-dactylion) (cm), strap length (cm), weight (kg), stature (cm), acromial height (cm), and trochanterion (cm). After inputting the dimensions in the MARC tool, built in statistical analyses indicated the mean, standard deviation, range, median, and variability for each measure, along with a graphical comparison of collected data points with the density curve for the reference distribution (e.g., ANSUR). These parameters were then readily incorporated into reports for the study sponsor. Data input and output for the MARC tool and its utility for data analysis and reporting will be demonstrated.

Conclusions: MARC can be a useful tool for working with anthropometry and performing preliminary analysis and can be useful for HSI practitioners. It is one step toward providing designers with the resources required to make appropriate trade-offs in the design of complex military systems. Future work will focus on making data collection in the tool more robust by performing real-time error checking for outliers, performing additional statistical analyses on the collected data, and allowing repeated inputs per measure/subject. Work is also planned to add range of motion data to the tool in addition to body dimensions.

DESIGN TOOLS & TECH   SESSION II, 2

User Centered Design Applied to USAF Civil Engineering Explosive Ordinance Disposal Tools and Jigs

Jeffrey Parr, Air Force Institute of Technology; Brad Shields, Air Force Institute of Technology; Michael Miller, Air Force Institute of Technology

Background: Additive manufacturing has been applied in early system prototyping for years and is now revolutionizing the manufacturing industry. By directly printing three-dimensional objects customized products can be quickly and cost effectively formed to meet unique user needs.

Methods: This research employed a User-Centered Design Process to examine the application of additive manufacturing (AM) to fabricate tools and jigs in United States Air Force civil engineering (CE) operations. Within this research, numerous parts were designed and printed for use within CE operations, rapidly evolving the design based upon user feedback.

Results: The results of the part testing and the resultant surveys indicate that AM can impact the daily operations of a CE unit, improving operational effectiveness. Further, the research determined that AM has reached a point that the integration of AM into strategically coordinated units, along with proper education and training, can be beneficial for the CE career field. Finally, the results indicate that 3D scanning technology will reach a point within the next 5 years where it can help foster the rapid build-up of 3D CE asset designs for printing applications. However, this research raises questions regarding the dissemination and rapid adoption of successful designs across DoD operations, without creating burdensome evaluation methods or proliferating an overwhelming number of less than ideal designs.

Conclusions/Warfighter Impact: AM has reached a point where introducing the technology into the operational environment is the only way to test for its true potential. Additionally, AM provides significant field based "just in time" capabilities for DoD applications.

ABSTRACTS

DESIGN TOOLS & TECH SESSION II, 3

Developing Emprically-Derived Quantitative Human Systems Integration Guidelines for Systems Engineering

Emily Stelzer, Hunter Kopald, The MITRE Corporation

The Federal Aviation Administration (FAA) is modernizing the procedures and automation systems used in air traffic facilities across the United States (US). The future operating environment (i.e., NextGen) is envisioned to provide transformative change to air traffic through the year 2025. Specifically, the new technologies and procedures are expected to reduce flight delays, save fuel, and maintain safety (FAA, 2013). NextGen technologies are already showing promise of benefits; however, there have been inefficiencies in the systems engineering and implementation processes associated with the deployment of these systems. The FAA projected that the acquisition and implementation of ERAM has taken more than four years and $500 million more than initially planned (FAA, 2012). The Government Accountability Office (GAO) has indicated that human systems considerations within the engineering and implementation process can provide significant impact in addressing these challenges (GAO, 2010).

The FAA has developed the Human Factors Design Standard (HFDS) to improve the design and development of air traffic systems (Department of Transportation, 2003). While the HFDS can inform improved system design, the standard is not intended to provide the level of detail necessary for requirements definition and validation. However, the HFDS is often directly used to define human systems integration requirements for NextGen systems. Using these standards as requirements can create ambiguity and inefficiencies within the systems engineering process (Stelzer et al., 2014).

In order to overcome these limitations, quantitative guidelines are needed to help inform the broader set of system requirements. These guidelines must be informed by empirical research and data, empowering human systems integration engineers in the system development process to ensure that human systems integration requirements have equivalent weight to other requirements and allowing the FAA to ensure that operational needs of air traffic controllers will be sufficiently met through the introduction of new NextGen systems.

To address this specific need, The MITRE Corporation's Center for Advanced Aviation System Development is conducting research that is designed to improve the design of advanced air traffic management systems through the development of quantitative human systems integration guidelines. These guidelines are expected to supplement the standards presented through the FAA's Human Factors Design Standard. The proposed guidelines have been defined through a set of air traffic management system case studies, quantified through a careful review and integration of empirical research, and defined and maintained within a framework database. The database can be used to

identify guidelines that are relevant to key system components, examine the relationship between guidelines, understand case study examples where the guidelines may have improved the design of the system, and view synthesized related research. In areas where sufficient empirical research does not exist to develop a quantitative guideline, gaps can been identified and classified for communication to the human systems integration research community. The resulting guidelines are envisioned to inform human systems integration requirements, improving the operational acceptability of future air traffic management systems.

ABSTRACTS

SubTAG: Human Performance Measurement

Chair: Jeff Grubb & Rahel Rudd

Human Performance Measurement

11 May 2016 | 1330 – 1530
Room 262/263

1500 – 1505	**Introduction / Overview** Co-Chairs
1505 – 1530	**Performance in Noise: Impact of Degraded Speech Intelligibility on Sailor Performance in a Navy Command Environment** Marc Keller, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration
1535 – 1600	**Effects of normobaric hypoxia on task performance, psychophysiological measures of performance, and self-reported workload.** Chad L. Stephens, NASA
1600 – 1625	**Automation and Visual Attention Failure in a Simulated Flight Task** Kellie Kennedy, NASA
1630 – 1655	**Rapid Development of Precise Metrics for Human Performance Assessment** Stephen James, Washington State University
1655 – 1700	**Wrap-Up & Presentations - Co-Chairs**

HUMAN PERFORMANCE MEASUREMENT SESSION I, 1

Performance in Noise: Impact of Degraded Speech Intelligibility on Sailor Performance in a Navy Command Environment

Marc Keller, John Ziriax, Naval Surface Warfare Center Dahlgren Division, Human Systems Integration; William Barns, Sonalysts; Benjamin Sheffield, Walter Reed National Military Medical Center

Background: Hearing is critical to the success of military operations. Yet warfighters are frequently called upon to perform their duties in noisy environments, while wearing hearing protection and suffering from temporary or permanent hearing loss. Unfortunately, there is very little quantitative data to characterize the impact of impaired verbal communication on Warfighter performance. To justify and guide the design and implementation of mitigation measures, data is needed to determine the extent to which military effectiveness is impaired when speech communication is compromised. The current study sets out to investigate these issues by utilizing a Combat Information Center (CIC) environment where multiple participants work together through a simulated combat scenario under different conditions of speech intelligibility. The results will help determine future hearing fitness for duty standards, accelerate the development of assistive technologies when hearing is challenged (i.e., noise or hearing loss) and demonstrate the benefits to overall crew performance of system designs that reduce noise and risk of hearing loss.

Methods: The experiment consists of a command and control task involving two participants and two research confederates during a simulated at-sea-mission scenario. Performance was measured using ratings from confederates, participant self-ratings, response accuracy on several mission tasks, situational awareness measures, speech analysis, and eye tracking. During the scenario, participants were exposed to four specific speech intelligibility levels twice in a quasi-random order. A pre-test using an adaptive Modified Rhyme Test was used to determine the noise levels required for each participant to experience the desired speech intelligibility levels (100% or normal hearing, 80%, 60%, and 40%).

Results: Results showed that what sailors can hear in realistic environments is likely to be less than might be expect based on simple noise measurements or from a speech intelligibility score (e.g., a 75% speech intelligibility score may not mean that participants understand 75% of the CIC communications). Rather, participants changed their behavior to compensate at all levels of reduce speech intelligibility. Specifically, they asked for more repeat communications, changed their visual scan behavior and changed their speech (e.g., spoke louder and slowed their speech). Nevertheless, the compensation behavioral changes did not overcome the effects of reduced hearing as participants communicated less often, responded less accurately, scored worse on

the situational awareness tests and were rated with lower performance scores by the confederates and themselves.

Conclusion: A study of operational performance in noise provided objective evidence of the negative impact reduced speech intelligibility has on Warfighter performance in an operational, communication intense environment. These data show evidence of improved operational performance from designing and maintaining environments and equipment for warfighters which support high levels of speech intelligibility.

Potential impact to mission/warfighter: Decision makers and system designers can improve operator performance metrics by protecting Warfighters' ability to hear. Not only will quieting spaces and providing adequate communication systems improve Warfighter performance, but since permanent hearing loss is cumulative over a warfighter's career, quieter environments and better hearing protection will allow Warfighters to have longer more productive careers benefiting not only the individual but the overall mission as well.

HUMAN PERFORMANCE MEASUREMENT SESSION I, 2

Effects of normobaric hypoxia on task performance, psychophysiological measures of performance, and self-reported workload

Chad Stephens, Kellie Kennedy, Brenda Crook, Ralph Williams, Paul Schutte, NASA

Background: A research team at NASA LaRC conducted an initial experiment involving normobaric hypoxia induction to study the impact on aircraft pilot performance. The purpose of this study was to investigate the use of hypoxia induction as a method of impairing human operators in future flight simulation studies to be conducted at Langley focused on human-autonomous systems integration.

Method: Human test subjects in the study experience simulated altitudes of Sea Level (21% O2) and 15,000 feet (11.2% O2) induced by an Environics, Inc. Reduced Oxygen Breathing Device (ROBD). During non-hypoxic and hypoxic exposures each test subject performed a battery of written/computer-based (Cognitive Function Test or CogScreen HE), multi-task computer application (NASA MATB-II) and flight simulation tasks each lasting 10-minutes. Task performance measures, NASA Task Load Index subjective self-report of workload, and physiological responses including: SPO2, EEG, EKG, respiration effort, and GSR were recorded.

Results: Preliminary analyses have revealed non-significant ($p>0.05$) differences in performance scores on the three types of tasks between the Sea Level and 15,000 feet simulated altitude conditions. Physiological responses including SPO2 and heart rate changes were significantly different between the Sea Level and simulated altitude conditions. Statistically significant ($p<0.05$) differences were found in the self-reported NASA-TLX overall workload and TLX subscales between the the Sea Level and 15,000 feet simulated altitude conditions during the various tasks completed by the test subjects.

Conclusion: Preliminary results indicated that the 15,000 feet simulated altitude was not sufficiently challenging to induce cognitive impairment such that task performance was affected. Further analyses are being conducted on the dataset and results will be presented at the conference. This study represents ongoing work at NASA LaRC intending to add to the current knowledge of psychophysiologically-based input to automation to increase aviation safety.

HUMAN PERFORMANCE MEASUREMENT SESSION I,3

Automation and Visual Attention Failure in a Simulated Flight Task

Kellie Kennedy, Chad Stephens, Ralph Williams, Paul Schutte, NASA

Background: Visual attention failures commonly occur during periods of high workload as the visual and cognitive systems approach structural limitations; however, these failures also occur under periods of low workload. Inattentional blindness (IB) is one kind of visual attention failure. IB occurs when observers fail to notice the presence of a clearly viewable but unexpected event when cognitive resources are diverted elsewhere. IB is not context-specific; researchers have attributed errors and accidents to this phenomenon in various task environments including aviation. This experiment was conducted to determine if low workload conditions could produce an IB occurrence rate similar to that observed during high workload conditions.

Method: The study reported herein was conducted in the Human and Autonomous Vehicle Systems (HAVS) Laboratory and used a fix-based, human-in-the-loop simulator. This was done as part of a larger investigation on the role of automation in the context of aviation operations. This portion of the study focused on the relationship between automation and in attentional blindness (IB) occurrences for a runway incursion. Sixty non-pilot participants performed the final five minutes of a simplified landing scenario in one of three automation conditions (autopilot, autothrottle, and manual).

Results: The runway incursion critical stimulus was directly relevant to primary task performance. Of these, 70% (42 of 60) failed to detect the runway incursion critical stimulus. Participants in the partial automation condition were significantly more likely to detect the runway incursion when compared to those in the full automation condition. The odds of participant detection in the full automation condition did not significantly differ from the manual condition. Participants that detected the runway incursion did not have significantly higher scores on any component of the NASA-TLX compared to those who failed to detect.

Conclusion: The low workload automation condition induced IB occurrences similar to those in the high workload condition. The relationship demonstrated between automation condition and IB occurrence indicates the potential impact of highly automated systems on operational attention detriment.

HUMAN PERFORMANCE MEASUREMENT SESSION I, 4

Rapid Development of Precise Metrics for Human Performance Assessment

Stephen James, Bryan Vila, Lois James, Washington State University

Background: The system dynamics of social encounters between warfighters and community members often make them evolve rapidly in ways that are complex and difficult to predict—or measure. How a warfighter behaves toward people each time he or she encounters them generates a cascade of responses, counter responses and interactions with active participants and bystanders. This dynamic system of interactions evolves as a network of interactions surges and wanes, each action spawning others, reinforcing some possibilities and missing or countering others. Each actor in this intimate social system tends to try—with more or less success—to assess the probable consequences of the actions they use to influence others in the encounter and guide its course toward a desired outcome. High-level performance in these encounters requires naturalistic decision making, and tools such as cognitive task analysis tend to be expensive and time consuming. As a consequence, metrics used to develop polices, practices, and training on performance in these high-risk/high-consequence encounters are often concept based and measured subjectively using ordinal measures. We addressed this gap by developing and testing a novel technique for rapidly prototyping interval-level metrics for measuring human performance at a granular level under the DARPA SSIM program. Because environmental variables strongly affect the likelihood of a desirable outcome in these encounters, we also used these novel techniques to develop situation-based difficulty metrics. They allow repeated exposure to scenario-based training that holds difficulty constant or varies it in a predicable direction.

Methods: A novel pairing of two well-established research techniques, reverse concept mapping and Thurstone scaling was used to develop measurement scales that substantially improve our ability to measure individual performance in three different types of dynamic encounters: a) a potentially deadly encounter, b) a routine warfighter-civilian encounter, and c) an encounter with a person in crisis.

Results: Metrics were successfully developed, tested and employed to score data from human subject experiments using both computerized deadly force judgment and decision making simulator scenarios and role-play training. They also have been successfully used to develop high-definition training scenarios and establish performance criteria, behavioral objectives, and training curricula that have been implemented and tested.

Conclusions: The methodology described here offers a rapid, cost effective, scientifically valid process for uncovering critical elements within the system dynamics of social encounters. This process allows for the predicable manipulation of training difficulty; and weighted, interval-level performance objectives.

Potential impact to mission/warfighter: The creation of detailed difficulty and performance metrics of warfighter/civilian interactions in a wide range of encounters will enable better evaluation of warfighter performance (both in training and operations), training curriculum, and training modality. These metrics can also be used to identify needs gaps in warfighter training and rapidly build behavioral learning objectives to fill these gaps.

ABSTRACTS

SubTAG: Cyber Security Special Interest Group

Chair: Marianne Paulsen & Ajoy Muralidhar

Cyber Security Special Interest Group Session I

12 May 2016 | 0800 – 1000
Room 265/266

A Functional and Organizational Cyber Unification Space (FOCUS)
Gina Thomas, Air Force Research Lab 711HPW/RHCV

Standardization in Cyber
Lisa Billman, AFLCMC/HNCY MITRE

Cyber Security Visualization – State of Practice
Anita D'Amico, Secure Decisions

Collaborative Data Analysis and Discovery for Cyber Security
Diane Staheli, MIT Lincoln Laboratory

Internalizing and Integrating Cybersecurity Approaches
John Valencia, City of San Diego - Office of Homeland Security,

Cyber Security Special Interest Group Session II

12 May 2016 | 1330 – 1530
Room 265/266

Analytic Questions and Visualization Objectives to Orient Network Defense Visualization Design
Laurin Buchanan, Secure Decisions

Cyber-cognitive Situation Awareness (CCSA)
Robert Gutzwiller, Space and Naval Warfare Systems Center Pacific

Simulation Methodology for Investigating Biometric Markers for Insider Threat
Gerald Matthews, University of Central Florida

The Role of Autonomous Agents in a Cyber Security Instruction Environment
Ryan O'Grady, Denise Nicholson, Soar Technology, Inc.

ABSTRACTS

CYBER SECURITY SPECIAL INTEREST GROUP SESSION I, 1

A Functional and Organizational Cyber Unification Space (FOCUS)

Gina Thomas, Air Force Research Lab 711HPW/RHCV; Kristen Liggett, Air Force Research Lab 711HPW/RHCV; Pete Venero, Camo LLC

Compared to the traditional domains of land, air and space, the cyber domain is young and not well defined. Common cyber definitions, although accurate, typically define cyber in an overly broad way. To discuss cyber in terms of either what needs to be accomplished, research that is needed, or information required by or tools that are useful to someone working in that domain, we need a way to more specifically define what is meant by "cyber" in a particular context. The authors propose the Functional and Organizational Cyber Unification Space (FOCUS) as a way for those working in, developing tools for, or doing research on various areas of the cyber domain to specify the particular area of cyber to which they are referring. FOCUS offers a way to organize one's research or development in the cyber domain by function, organization, and user type at varying levels of abstraction. The ability to map one's work onto this unification space allows for better communication and understanding of information requirements, goals, and constraints as they relate to "cyber" research and development. This presentation will define the concept of a unification space, provide examples of such a space in the air domain, and then transition into a detailed explanation of and argument for the concept as applied to the cyber domain.

Distribution A: Approved for public release. 88ABW Cleared 01/15/2016; 88ABW-2016-0143

CYBER SECURITY SPECIAL INTEREST GROUP SESSION I, 2

Standardization in Cyber

Lisa Billman, AFLCMC/HNCY MITRE

Cyber has been included by the Air Force as the fifth domain of warfare along with space, air, land and sea, elevating the significance of the domain and emphasizing the importance of human cyber systems integration. Cyber is experiencing some of the same challenges the air domain experienced years ago. There are a variety of platforms and tools that operators are required to use, and there is little consistency across these stovepipe systems in the way information is presented. A systematic process must be established to identify standard approaches to presenting information to operators in cyber, just like is done in the air domain: Think of it as the stand "T" cross-check for cyber. AFRL/RH has recently coined the term "cyber cockpit" to emphasize the similarity between the challenges faced by the air and cyber domains.

Just like the air domain, cyber involves the integration of humans with computer platforms and software that are extremely complex and can overwhelm operators with data. Transforming that data into a subset of information that is required by the operators and their commanders requires a careful analysis of the missions, tasks and decision processes engaged in by operators. Once the data for the analysis is collected, the information requirements for each task can be determined. Once the information is identified, the UI designers can work to present the information in a manner that will minimize operator workload and maximize human system performance. Ultimately, patterns will emerge across tasks and mission that will enable HSI practitioners to develop guidelines and standards for use in cyber. This process and the resultant products, are expected to evolve over years, just as they did in the air domain.

A number of efforts are underway to address the challenges found in cyber. USCYBERCOM is conducting an Analysis of Alternatives for the upcoming acquisition of the Unified Platform (UP) that states that UP will allow cyber mission forces operators to conduct full spectrum cyberspace operations including Offensive Cyberspace Operations (OCO), Defensive Cyberspace Operations (DCO), and Cyberspace Core Mission Services that include the conduct of Cyberspace ISR to support the design of common operating pictures, data sharing, data collection, and mission essential infrastructure. This is a significant challenge, since the tools and platform for OCO, DCO and ISR have largely been developed independently with little attempt to standardize their user interfaces, terminology or symbology.

There has been an attempt to develop an appendix L to MIL-STD 2525 for Cyber, but there is little correlation between current 2525 symbology and what is used by the cyber community and computer community as a whole. In addition, the AF acquisition community is developing style guides for some its efforts, and they have recently begun to integrate into the UI design.

This briefing will discuss these efforts in greater detail. In addition recommendations will be made for further expansion of these efforts to maximize human system efficiency, increase usability, increase situational awareness, reduce training time, and reduce the probability of operator errors.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION I, 3

Cyber Security Visualization – State of Practice

Anita D’Amico, Secure Decisions; Paul Walczak, Warrior LLC; Laurin Buchanan, Secure Decisions

The requirement to visualize cyber security data to augment cyber operator performance and commander situation awareness cuts across all DoD services and intelligence agencies. Vendors of security products have added data visualization and dashboards to the automated cyber security systems used by the US government. However, the types of visualizations added to cyber security systems are largely based on subjective assessment, with little foundation in scientific studies on the effects of visualization on cyber operator performance. In this presentation we review the state of the "art" or "craft" of designing and fielding cyber security visualizations within DoD, and identify research challenges that must be met to assure that future cyber security visualizations designed and implemented in DoD actually enhance the decision making of cyber operators.

We posit that the state of practice of cyber visualization has not changed significantly in the past ten years, even though the pace and nature of the threat and number of sensor data sources has increased exponentially. Among the evidence for this are the results of a survey we performed of network defense subject matter experts in which we verified that the cyber operator's cognitive work and the use of visualizations to support that work have not changed in a decade.

We discuss the limitations of current studies on the effectiveness of cyber security visualizations, and identify specific research needs that must be satisfied to address these limitations. We illustrate how already-fielded cyber security visualizations violate information visualization principles grounded in the science of perception and cognition. We review the differences in design requirements for "at-a-glance" visualizations vs exploratory visual analytics, and how each type of visualization fits into the DoD Cyber Incident Handling Life Cycle (CIHLC) (CJCSM 6510.01B).

The presentation will also describe how Goal Directed Task Analysis has been and can be used to identify the information requirements that must be met by cyber security visualizations. The GDTA discussion will include a list of key decisions that cyber operators in Stages 1 and 2 of the CIHLC make, the Analytic Questions that they must answer to make those decisions, and how cyber security visualization designers convert those Analytic Questions into Visualization Objectives to guide the visualization design. We will also address the necessity and challenges of transforming data from its raw sensor format into structured data that can be visualized and manipulated by the cyber operator. All the work presented in this session is based on prior studies conducted by the authors and funded by AFRL, IARPA and DHS.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION I, 4

Collaborative Data Analysis and Discovery for Cyber Security

Diane Staheli, MIT Lincoln Laboratory; Vincent Mancuso, MIT Lincoln Laboratory; Raul Harnasch, MIT Lincoln Laboratory; Cody Fulcher, MIT Lincoln Laboratory; Madeline Chmielinski, MIT Lincoln Laboratory; Stephen Kelley, MIT Lincoln Laboratory

Cyber has been identified as a key research trajectory for ensuring national security. Researchers have begun to assess the role of humans in cyber, focusing mainly on the analysis process, with limited attention to collaboration, information sharing, and team cognition. Cyber operators face challenges in accessing key information with little collaboration between analysts. Current generation analysts rely on their individual record keeping systems, which hinders their ability to reflect on their own work and transition analytic products to others. Research has demonstrated that online collaboration systems can encourage and facilitate distributed teams in information sharing and group decision-making, however, no such technology exists today for cyber defenders. In pursuit of this, we present the Cyber Analyst Real-Time Integrated Notebook Application (CARINA). CARINA is a collaborative investigation system that aids in decision making by co-locating the analysis environment with centralized cyber data sources, and providing analysts with increased visibility to the work of others. Using visualization and annotation, CARINA leverages conversation and ad hoc thought to coordinate decisions across an organization. CARINA incorporates features designed to incentivize positive information-sharing behaviors, and provides a framework for incorporating recommendation engines and other analytics to guide analysts in the discovery of related data or analyses. In this paper, we present the user research that informed the development of CARINA, discuss the functionality of the system, and outline potential use cases. We also discuss future research trajectories and implications for cyber researchers and practitioners.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION I, 5

Internalizing and Integrating Cybersecurity Approaches

John Valencia, City of San Diego - Office of Homeland Security,

In government and private sector, organizations are seeing a need to emphasize a technological approach to achieve maximum efficiency in services and asset delivery, many without full consideration of the cybersecurity implications. Leaders, families, and consumers have all made a decision long ago, likely without conscious deliberation, about cyber risks and security: the risks are worth it. The decision has been made to move quickly toward further integration of technology in all aspects of our society. This leads to great opportunity, but also great obligation to be proactive in cybersecurity measures. Greater system interdependencies create greater potential consequences, which could result in larger breaches, operation failures of one or more systems, and devastating economic impacts. However, systems users, generally, haven't internalized the notion of risk, but expect it to be safe, functional, and reliable without fail. It then becomes the obligation of cybersecurity professionals to seamlessly integrate cybersecurity into the routine of everyday users.

With the rise of smart cities and increased demand for open data, many overlook the criticality of an effective cybersecurity program. While some agencies struggle with simply defining cybersecurity, the City of San Diego leads the nation with its comprehensive, strategic cybersecurity program that aims to embed cybersecurity measures into the daily habits of network users. The success of the City's program begins with the acknowledgement that regardless of the technological strength of a cybersecurity system, if human factors result in variations from protocols, there could be major ramifications. This presentation discusses the concept of integrating human-centric security measures, both technological and environmental, to mitigate the risk of human error resulting in cyber attacks, hacks, and breaches.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION II, 1

Analytic Questions and Visualization Objectives to Orient Network Defense Visualization Design

Anita D'Amico, Secure Decisions; Laurin Buchanan, Secure Decisions; Paul Walczak, Warrior LLC; Drew Kirkpatrick, Secure Decisions

DoD security operations centers seek visualizations of network security data that will make the interpretation of that data by cyber operators faster and more immediately actionable compared to the alpha-numeric data that is the output of automated security sensor systems. However, there are few scientific studies on the effects of visualizations on cyber operator performance; these studies are needed to guide the design and selection of visualizations for network defense. We present the initial results of the first phase of a research project funded by AFRL to define visualization objectives and to design visualization concepts that have high potential for enhancing cyber operator performance during event detection and preliminary event analysis—the first two stages of the DoD Cyber Incident Handling Life Cycle (CIHLC) (CJCSM 6510.01B). The second phase of the research will measure the effectiveness of these visualization concepts.

Prior to defining visualization objectives for event detection and preliminary event analysis, we reviewed prior studies that described the cognitive work and decision making of cyber operators. We also reviewed the operator's task objectives as defined in DoD doctrine such as CJCSM 6510.01B.

We next reviewed prior work conducted on incident analysis decision making, including our own goal directed task analysis (GDTA) of defensive cyber operations for a DoD agency, and aligned these decisions and tasks with CJCSM. For the early stages of the CIHLC, we identified 40 "analytic questions" that an operator seeks to satisfy in order to make these decisions. A Knowledge Elicitation we conducted with subject matter experts verified that network defense operators regularly ask fundamental analytical questions (AQ) that cut across specific tasks and roles. Each of these AQs can be considered as a discrete "cognitive work unit."

We selected six AQs to address with visualizations; we will describe these in the TAG presentation. Before designing visualizations that would provide information needed to answer the AQs we specified a Visualization Objective that describes the data and relationships that must be accessible in the visualization (or through simple interactions such as mouse-overs). We will provide examples of these visualization objectives in the TAG presentation. We will also present a sample of the initial visualization concepts and transformations of raw data that would have to occur prior to rendering these visualizations.

We will describe the next steps we anticipate in this research including a study for measuring the effectiveness of each visualization concept on the performance of cyber operators.

The methods used for constructing analytic questions and visualization objectives, as well as the results presented, can be used by cyber security visualizations designers to provide requirements for their design concepts and by DoD cyber operators when assessing visualizations offered by security product vendors.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION II, 2

Cyber-cognitive Situation Awareness (CCSA)

Robert Gutzwiller, Space and Naval Warfare Systems Center Pacific

Objective/Rationale: Cyberspace situational awareness (CSA) is a distinct area of criticality for effective cyber defense. There is natural interest in forming a cyber representation which brings together all of the known pieces of information and data, and fuses them into a "common operational picture." The use case for this equipment is presumably to inform commander decision-making through data-to-knowledge transformation. However, as with all situation awareness displays, there remain challenges in creating a useful display that quantifiably improves human awareness. After all, simply presenting all of the possible information for users to sort through is not enough, nor is it truly informed design. We must be able to determine what information is needed, when, and how best to display it. Moreover, once doing so, we must measure with robust human-in-the-loop measurement, whether the display induces changes to performance and cyber-cognitive situation awareness (CCSA).

Methods: I report some of the progress made on the situation awareness of human cyber analysts as network defenders, as informed by ongoing cognitive task analyses and reviews of awareness.

Results: Often, as alluded to in the objective statement, cyber situation awareness is really a way of saying "present all needed information in the system", despite originally encompassing both system and user (Bass, 2000). A correction identified in (Gutzwiller, Fugate, Sawyer, & Hancock, 2015) and expanded on in (Gutzwiller, Hunt, & Lange, 2016; Gutzwiller, under review) suggests a human-centric focus is needed instead. The CCSA moniker refocus awareness on the human performing cyber tasks. CCSA is particularly important in cyber defense operations.

Second, as will be discussed, existing research on human operations in cyberspace defense suggests we are perilously behind in our efforts to build effective tools for, and analyze performance in, this environment. We must strive to create scenario-based experimentation methods for human performance measurement.

Third, and perhaps most importantly, the creation of visualizations for cyber appears to be divorced from the users. This is true in two ways: first, most tools may be created by non-analysts, whether academic, industrial or military. And these creators have alternative goals that do not always coincide with rigorous human performance analysis and human-systems integration. Second, a lack of analyst buy-in, and lack of user-centered design processes, creates situations in which tools go unused or have a fatally steep learning curve because a developer wanted to shove all possible functionality into the tool.

Conclusion & Potential Impact: A user-centric approach is vital if tools are to be valued and used by the operator. As we expect cyberspace will incorporate large amounts of automated systems, this need is similarly reflected in trust and transparency issues for human-automation interaction. As it is still a nascent field, the depth of existing human factors for cyberspace is understandably shallow. Our problem de jour is a lack of experimentation and measurement of analyst cognition. In addition to CCSA, other facets to consider include training and integration with automation (Gutzwiller et al., 2015).

CYBER SECURITY SPECIAL INTEREST GROUP SESSION II, 3

Simulation Methodology for Investigating Biometric Markers for Insider Threat

Gerald Matthews, University of Central Florida; Lauren Reinerman-Jones, University of Central Florida; Eric Ortiz, SoarTech

A countermeasure to insider threat (IT) is to perform continuous diagnostic monitoring of suspect individuals, especially in high-stakes settings. The methodological challenge is that while studies of deception identify promising several promising biometric responses, much of the evidence comes from highly-controlled experimental studies which differ from less structured work contexts. We will discuss the use of immersive simulator environments for validating potential biometric markers for deceptive intent. Environments sensitive to IT such as espionage and financial decision-making can be simulated with sufficient fidelity to motivate experimental participants to conceal their motivations to access illicit information. Use of multi-window displays allows participants' eye-movements to be analyzed as they view an information source that they are prohibited to access. Simulation paradigms also afford recording of additional implicit responses that may indicate IT behavior, via non-intrusive means. These include psychophysiological metrics such as the thermographic response of facial regions, and behavioral measures secured from sequences of mouse clicks. We will also discuss

methodological challenges including needs to induce awareness of monitoring, the role of emotion in deception, and the need to impose structure on work activities to facilitate meaningful analysis of biometric markers.

CYBER SECURITY SPECIAL INTEREST GROUP SESSION II, 4

The Role of Autonomous Agents in a Cyber Security Instruction Environment

Denise Nicholson, Soar Technology, Inc.; Ryan O'Grady, Soar Technology, Inc.; John Runge, AFRL 711 HPW/RHAS

Cyber vulnerabilities are continually emerging as a threat to our national and economic security and stability. Reports indicate a tremendous gap in skilled personnel capable of filling our growing need for Cyber Security workforce to operate, analyze, protect, and defend our critical infrastructure systems. In response, the Department of Homeland Security has developed a national strategic program and developed the National Cybersecurity Workforce Framework which "provides a blueprint to categorize, organize, and describe cybersecurity work into Specialty Areas, tasks, and knowledge, skills and abilities (KSAs)" (NICCS, 2015). There is a logical progression to turn to modeling and simulation based training systems to provide experiential learning to augment those KSAs being developed in classroom and e-learning cyber security certification and degree programs. By using a scenario based approach in a virtual simulation, trainees can practice higher order skills and have an opportunity to experience realistic stressors in dynamic situations. We propose to present the design, and initial prototype results, for a virtual Cyber Security Instruction Environment (CYSTINE) being developed under an Air Force Research Lab (AFRL) Small Business Research Initiative (SBIR). Targeting competencies from the NICCS framework within the competency of "Computer Network Defense", CYSTINE focuses on training objectives from the certified ethical hacker (CEH), e.g. penetration testing. A trainee practices their skills against autonomous cognitive agent defenders to understand defense from the cross-training perspective in the role of the attacker. Performance measurement and instructionally relevant adaptation of the training scenario is realized by our Dynamic Tailoring System (DTS). The result is an interactive cybersecurity training activity.

ABSTRACTS

SubTAG: Human Factors Standardization

Chair: Alan Poston

Human Factors Standardization

11 May 2016 | 1330 – 1530
Room 265/266

Introduction of Attendees

Status Reports and Presentations

MIL-STD 1472H Working Group Team Meeting
Alan Poston, DoD HFE TAG Member Emeritus / Consultant
Daniel Wallace, Naval Sea Systems Command

Occupant-Centric Platform

Managing MIL-STD-1474E Software
Bruce Amrein, Army Research Laboratory: Human Research & Engineering Directorate
Paul Fedele, Army Research Laboratory: Human Research & Engineering Directorate
Charles Kennedy, Army Research Laboratory: Survivability/Lethality Analysis Directorate

NASA HIDH Update; HSI Practitioner Guide

G-45 Human Systems Integration Committee

Flight Symbology Working Group – MIL-STD-1787

Development of a Human-Systems Integration Standard

Development of a Human-Systems Integration Handbook

Human Factors Standardization Activities at the USCG

Development and application of a process standard to improve safety and efficiency of powered hand tools
Ghazi Hourani, Navy and Marine Corps Public Health Center

Recent Data Item Description Activity

Charter Changes

Election

New Business and Second Thoughts

ABSTRACTS

STANDARDIZATION SESSION I,3

Managing MIL-STD-1474E Software

Bruce Amrein, Army Research Laboratory; Paul Fedele, Human Research & Engineering Directorate; Charles Kennedy, Army Research Laboratory Human Research & Engineering Directorate, Army Research Laboratory Survivability/Lethality Analysis Directorate

Military Standard 1474E: Design Criteria Standard: Noise Limits, published by the U.S. Department of Defense in April 2015, provides 2 methods for evaluating hearing hazard from impulsive noise. The "auditory risk unit" method quantifies the mechanical damage caused by impulsive noise in the cochlea of the human ear and requires use of a computer-based electro-acoustic model of the human ear-- the Auditory Hazard Assessment Algorithm for Humans (AHAAH). AHAAH is a mathematical model of the human auditory system structured to match the physiology of the ear, element for element. It predicts the hazard from any free-field pressure and provides a visual display of the damage process as it is occurring. This code is available from the U.S. Army Research Laboratory's AHAAH website. Like any software package, AHAAH requires periodic review, maintenance, and revision. This presentation describes the formal process developed to provide oversight authority for changes to AHAAH. The AHAAH Configuration Management Plan (CMP) has been developed to control and manage AHAAH's critical configuration items. These items include software maintenance, defect reporting, and requests for features and enhancements. The oversight authority for changes to AHAAH is the AHAAH Configuration Control Board (CCB). Representation on the CCB is comprised of the principle stakeholders in AHAAH. The CCB manages all aspects of configuration control, maintenance, and development of the AHAAH code.

STANDARDIZATION SESSION I,10

Development and application of a process standard to improve safety and efficiency of powered hand tools

Mark Geiger, Naval Safety Center Liaison Office

A joint US Department of Defense (DOD), General Services Administration (GSA) and National Institute for Occupational Safety and Health (NIOSH) project addressing procurement criteria for powered hand tools was initially stimulated by cases of hand-arm vibration in a Naval shipyard. Barriers to evaluation and improvement of power tools used within DOD and related process improvements included (1) limitations of safety and health personnel in familiarity with the Defense logistics system (2) lack of regulatory drivers within the US to address hand-arm vibration and ergonomics (3) a common lack of familiarity of hand arm vibration disease and probable under-reporting and (4) administrative separation of safety/health, medical/industrial hygiene review, production and logistics with related barriers to information exchange and process improvement. A working group using an integrated and multi-disciplinary process team approach was formed to help address the above issues. Human systems integration principles were applied including human factors engineering to identify optimal product design criteria; safety and health evaluation; educational outreach and cross training of personnel.

Extensive outreach and education accompanied this project to help address the above barriers. However, it became apparent that the potential for creation of occupational disease needed to be linked to productivity and life-cycle cost to develop the most effective case for product and process improvements. GSA stimulated the involvement of the SAE EG1-B Hand Tools committee and affiliated industry participants, primarily producers of powered hand tools. Committee efforts focused upon development of a Society for Automotive Engineering Standard that considers productivity, hand-arm vibration, other safety and health factors and life-cycle costs in procurement criteria for powered hand tools. Aerospace Standard, AS 6228 Safety Requirements for Procurement, Maintenance and Use of Hand-held Powered Tools, was published in September 2014, after several years of development. Concurrently, a new committee, EG1-B1, Powered hand tools, Productivity, Ergonomics and Safety, evolved from the EG1-B subcommittee initially formed to address this topic. The standard provides a process for semi-quantitative assessment and comparative weighting of factors including life-cycle cost, vibration, ergonomics and noise into the evaluation and procurement decision. GSA has adapted the standard in evaluation of powered hand tools and is currently making approximately 140 lower vibration/ergonomic tools available to Federal users. Current efforts are focused on outreach to industry and DOD; development of a technical report describing application of the AS 6228 standard and extending the processes described here to other commodities and industrial processes.

ABSTRACTS

SubTAG: Extreme Environments

Chair: Rachael Lund & John Plaga

Extreme Environments

13 May 2016 | 0830 – 1030
Room: 265/266

Increasing Crew Autonomy for Future Human Spaceflight Missions
Kerry McGuire, NASA

Measuring Stress from Behavioral, Biological, and Psychological Perspectives during Simulated Mars Missions in Hawaii
Jocelyn Dunn, Purdue University

Investigating Hypoxia: Challenges and Lessons Learned
Brenda Crook, 711 Human Performance Wing/HPIF

Coast Guard Arctic Operations
Christian Kijora, U.S. Coast Guard

EXTREME ENVIRONMENTS SESSION I, 1

Increasing Crew Autonomy for Future Human Spaceflight Missions

Kerry McGuire, NASA

In the past, NASA's crewed missions have been confined to the Earth-Moon system. In this system speed-of-light communication delays between crew and ground are practically nonexistent. The close proximity of the crew to the Earth has enabled NASA to operate human space missions primarily from the Mission Control Center (MCC). Currently, NASA is investigating future human spaceflight missions that include Martian destinations and Near Earth Asteroid (NEO) targets.

Missions beyond the Moon will be of much longer duration and further away from the Earth. NASA is funding a number of projects to develop and test operations concepts for these future missions. Some of these projects are looking into the balance between crew autonomy and vehicle automation. Future crews will need to make decisions without real-time communication with the MCC. Future crews cannot take on all functions performed by ground today, and so vehicles must be more automated in order to reduce the number of tasks that crews are responsible for performing. The Autonomous

Mission and Operations (AMO) project and the exploration medical systems project are two examples of how NASA is addressing the increase in crew autonomy needed for future crewed spaceflight missions.

The NASA Advanced Exploration Systems AMO project conducted an experiment to turn over operation and management of selected ISS systems to the on-board crew. The systems selected spans two types of ISS hardware: the Total Organic Carbon Analyzer (TOCA), a water quality analyzer, and Station Support Computer (SSC) systems, non-critical crew computer systems. The crew autonomously operated these systems, taking on mission operations functions traditionally performed by ground. They did so with the aid of new software tools that provide decision support algorithms for planning, monitoring and fault management, hardware schematics, as well as system briefs, and data displays that are normally unavailable to the crew. The resulting experiment lasted seven months, during which ISS crews managed TOCA and SSCs on 22 occasions. The combined performance of the software and crew achieved an 88% success rate on managing TOCA activity. AMO was the first experiment conducted in which spacecraft crew autonomously managed a complex system with no assistance from the ground.

NASA's Human Research Program Exploration Medical Capability element is starting to develop an exploration medical system. Exploration class missions will present significant new challenges to crew health. Crew will sometimes need to address these challenges without the assistance of an MCC flight surgeon. This future medical system is being designed to augment the crews medical capabilities, reduce the likelihood of medical errors and harm and integrate seamlessly with the vehicle and non-medical systems.

EXTREME ENVIRONMENTS SESSION I, 2
ORAL PRESENTATION/REVIEW 1:ORAL PRESENTATION

Measuring Stress from Behavioral, Biological, and Psychological Perspectives during Simulated Mars Missions in Hawaii

Jocelyn Dunn, Purdue University

For Hawaii Space Exploration Analog and Simulation (HI-SEAS) research, crews of six "astronaut-like" individuals are immersed in simulated Mars missions on Mauna Loa volcano in Hawaii. After serving as Chief Scientist on the 8-month mission in 2014-2015, Dunn has continued her research of health and stress monitoring methods in the on-going 12-month HI-SEAS mission. Three primary sources of data are supporting this research: 1) wearable device data from wrisnds measuring sleep and activity patterns, 2) biological samples for quantifying hormones and metabolites, and 3) questionnaires inquiring about perceived stress levels. This research is developing and comparing methods for health and stress monitoring to address NASA behavioral health and performance gaps in the risk area of adverse behavioral conditions. Data collection in the isolated, confined, extreme environment at HI-SEAS is improving knowledge of how adverse behavioral conditions develop in small teams during long-duration missions and how to promote adaptive and resilient responses.

EXTREME ENVIRONMENTS SESSION I, 3

Investigating Hypoxia: Challenges and Lessons Learned

Brenda Crook, 711 Human Performance Wing/HPIF

Hypoxia is defined as a lack of oxygen to the cells and tissues sufficient enough to cause impairment of function. In aviation, this is often the result of failures in cabin pressure and/or oxygen systems. In the former case, the pilot and aircrew may or may not have aircraft cabin pressure warnings to rely on. In the later, there may be oxygen system failures or inadequacies that can lead to hypoxia despite a speedy application and/or disciplined use of the oxygen mask. In the best cases, the mishap investigator can rely on the recovered pilot's reports of hypoxia symptoms in flight and relevant other aircraft state data for root cause analysis. In fatal mishaps, the investigator is left piecing together what little data may remain. This presentation will review the causes and effects of hypoxia in aviation operations, difficulties associated with investigating mishaps where hypoxia is indicated or may be suspected, and lessons learned from investigations where human and aircraft system state data may be incomplete or unknown. Recommendations for hypoxia prevention and toolkits for hypoxia mishap investigation will be discussed as well as technology solutions to minimize the role of the pilot and crew as point-of-failure sensors for pressurization and oxygen systems.

EXTREME ENVIRONMENTS SESSION I, 4

Coast Guard Arctic Operations

Christian Kijora, U.S. Coast Guard

The Coast Guard is the only US agency that is building and operating icebreakers to support national interests in the Arctic region. The USCG Arctic Implementation Strategy provides details on how the Coast Guard plans to execute and meet the objectives contained in the National Arctic Strategy. The current state of the icebreaker fleet will be discussed; upgrades being made to existing ships as well as requirements development for new medium and heavy ice breakers. Operations in the Arctic region certainly brings challenges, not only for maneuverability of the icebreakers, but also for the humans operating these ships. Human Systems Integration (HSI) Engineer, Chris Kijora, will provide an overview of the US Arctic Strategy, the USCG Arctic Implementation Strategy, and an update on the Coast Guard's Polar Icebreaker Program (PIB).

ABSTRACTS

SubTAG: Cognitive Readiness
(moved to Extreme Environments Session)

Chair: Joe Geeseman

Cognitive Readiness

COGNITIVE READINESS

EEG-based Artificial Neural Network classification of intuition and analysis cognition

Joseph Nuamah, Seeung Oh, Marcia Nealy, Younho Seong, North Carolina A&T State University

The use of autonomous systems is on an increase, and there is the need to optimize the fit between humans and these systems. Whereas human operators must be aware of the autonomous system's dynamic behaviors, the autonomous system must in turn base its operations among other things on an on-going knowledge of the human operator's cognitive state, and the context. The human operator's performance and augmentation are critical for autonomous systems to enable effective decision making. Two types of decision making processes exist; analytical and intuitive. The main difference between both is cognitive effort. Whereas the intuitive decision making is triggered effortlessly by stimuli encountered in the environment, analytic decision making is controlled. Physiological measures are one means for communicating functional state from a human to an autonomous system. In our research an Artificial Neural Network (ANN) using electroencephalographic signals (EEG) is used to determine whether a human operator is in a high (analytic) or low (intuitive) workload state to allow their working environment to be optimized.

COGNITIVE READINESS - Moved to Poster Session on Thursday

Quantifying shelter liner acoustic properties and impacts on Soldier performance

Breanne Hawes, Natick Soldier Research, Engineering, and Development Center (NSRDEC; Tad Brunye, NSRDEC; Clinton McAdams, NSRDEC

A current effort of the Army Strategic Energy Security Goal is the research and development of energy efficient technologies in Soldier operating bases. Advanced shelter liners provide energy efficiency gains of 40–50% by incorporating thin layers of insulating materials, such as 3M ThinsulateTM, to decrease heat transfer through shelter walls. While evaluating shelter liner technologies, it is important to understand the, often overlooked, effect of the technology on Soldier behavior and cognition. More specifically, the effect of the shelter liner on reflectance and absorption of sound in the shelter which, in turn, may affect Soldiers' ability to maintain, direct, and control attention. Researchers at the Natick Soldier Research Development and Engineering Center are currently evaluating the influence of several shelter liners on human performance. The current evaluation, in progress, will first conduct an in-laboratory, baseline study examining the effects of sound location, pitch and amplitude on maintaining, orienting, and controlling visual attention. Data from this evaluation will be used to populate a predictive model relating sound properties to human performance outcomes. Individual shelter liners will then be evaluated for their influence on acoustics within and through shelter walls, using the predictive model to relate these specifications to human performance outcomes. A second field evaluation will examine a subset of liners and sound sources to validate model predictions. Together, laboratory and field evaluations will provide novel insights into shelter liner acoustic properties, acoustic property influences on human performance, and aid in the down-selection of shelter liners for future operations.

ABSTRACTS

SubTAG: Personnel

Chair: Rachael Lund & John Plaga

Personnel

13 May 2016 | 0830 – 1030
Room: 201/202

8:30 – 8:40	**Administrative tasks/discussion**
0840 – 0910	**Non-Cognitive Methods to Improve Military Personnel Classification: Interest and Job Previews** James Johnson, HQ Air Force Personnel Center, Randolph AFB, TX
0910 – 1010	**The Aviation Selection Test Battery - E: Preliminary Results and Discussion** Mike Natali, USN
0940 – 1010	**UAS Pilot Person-Job Match Optimization using Aptitude and Personality** Hector Acosta, HQ Air Force Recruiting Service
1010 – 1030	**Additional remarks, review, closing**

PERSONNEL SESSION I, 1

Non-Cognitive Methods to Improve Military Personnel Classification: Interest and Job Previews

James Johnson, HQ Air Force Personnel Center, Randolph AFB, TX; Laura Barron, HQ Air Force Personnel Center, Randolph AFB, TX

The United States military is unique from other organizations as the hiring decision to enter the organization (i.e., to enlist) is made without identification of the type of career field (e.g., financial, medical, mechanical) in which the new hire will work. The standardized assessments used in the United States Air Force enlisted classification process are primarily aptitude-based, specifying minimum “cut scores” on ASVAB-based composites for Air Force careers. Vocational interest, while informally assessed via interaction with AF recruiters, is not a systematic component of the US military classification process. This presentation details USAF initiatives to expand the enlisted classification process to consider additional, non-cognitive indicators of career success including vocational interest and person-job fit as determined via realistic job previews (RJP).

First, we introduce the Air Force Work Interest Navigator (AF-WIN), a web-based, job-interest matching tool that pairs USAF recruits with enlisted careers based on interest overlap with SME-derived job profiles. We describe development of the tool based on career field ratings from 2,792 SMEs. Second, we present early-stage reaction feedback and utility data from AF Basic Military Training trainees on the AF-WIN. Third, we briefly discuss the history of RJP use in the US military, and describe the USAF initiative to pilot test RJPs for select career fields (e.g., air traffic control), with the intent to reduce early career field attrition via expectation management.

Potential impact is discussed in terms of retention of valuable human capital in an increasingly competitive job market. Criteria on which to evaluate impact of vocational interest and RJP interventions are discussed including honesty and trust perceptions, training attrition, first-term re-enlistment, and overall job satisfaction and performance.

PERSONNEL SESSION I, 2

The Aviation Selection Test Battery - E: Preliminary Results and Discussion

Mike Natali, USN

The Aviation Selection Test Battery Series E (ASTB-E), released in December 2013, is the most up-to-date version of the selection test used to select naval aviation candidates for the United States Navy, Marine Corps, and Coast Guard. The new version features computer adaptive testing format (CAT) versions of cognitive abilities and job knowledge tests (previously only available in static format); a personality inventory: the Naval Aviation Trait Facet Inventory (NATFI); a psychomotor assessment battery: the Performance Based Measures Test (PBM); and a biodata measure: the Biographical Inventory Response Verification (BIRV). These new enhancements improve the test's validity and help the services find better qualified aviation candidates. With the ASTB-E now operational for over two years, initial aviation training performance data from individuals who were selected into training based on their ASTB-E scores are now available. This presentation will discuss how well the ASTB-E predicts various training performance criteria including initial ground school grades of student aviators and attrition. Additionally, the currently utilized 90-day retest interval was examined and compared to other retest lengths to determine whether a shorter minimum retest window could be used without negatively impacting test validity. Results will be discussed.

PERSONNEL SESSION I, 3

UAS Pilot Person-Job Match Optimization using Aptitude and Personality

Tomas Carretta, Air Force Research Laboratory; Mark Rose, Air Force Personnel Center; Laura Barron, Air Force Personnel Center; Hector Acosta, HQ Air Force Recruiting Service

Extensive evidence supports the utility of measures of cognitive ability, psychomotor, and aviation knowledge/experience for manned aircraft pilot training. These measures also have shown utility for unmanned aircraft systems (UAS) pilot training selection. Although several personality factors have been proposed as important for both manned and UAS pilot training, empirical studies have shown weak evidence for their predictive validity. The current study examined the predictive validity/incremental validity of personality for completion of US Air Force UAS training completion. In addition, personality profiles were examined for aircrew training applicants based on their preference for manned vs. UAS aircraft training. Study 1 results indicated measures of aptitude predicted UAS training completion at a similar level as demonstrated for manned aircraft training (r = .37 observed and .55 after correction). Measure of personality had much lower validities and lacked incremental validity over aptitude. Study 2 results indicated that interest in a UAS career was associated with lower levels of assertiveness, an individualistic attitude, and a tendency to view oneself as cultured. Although the utility of personality for aircrew training selection is marginal, it may play a greater role in assignment of aircrew applicants to manned aircraft vs. UAS careers. Also discussed are new US Air Force measures involving the assessment of task prioritization/time sharing and work interests under evaluation for UAS training suitability.

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