National Aeronautics and Space Administration

AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

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Patent Office Issues DWR Patent

POC: DAVE MCNALLY

On October 27, the United States Patent Office issued Patent 9,171,473, titled "Method and System for Dynamic Automated Corrections to Weather Avoidance Routes for Aircraft in En Route Airspace." The patent application was initially filed in December 2012. NASA has developed the Dynamic Weather Routes (DWR) ground-based automation system that continuously and automatically analyzes in-flight aircraft in en route airspace to identify potential time and fuel-saving corrections to weather avoidance routes. DWR is estimated to have saved more than 1,200 minutes in flying time for 260 American Airlines revenue flights in Fort Worth Center during testing conducted from July 31, 2012 to November 5, 2013.

FAA Flow Evaluation Team Visits NTX

POC: PAUL BORCHERS

Industry and government members of the Federal Aviation Administration's (FAA) Flow Evaluation Team visited NASA's North Texas Research Station (NTX) on November 4. The team observed video demonstrations of the human-in-the-loop evaluation of the integrated demand management concept that was conducted in the Airspace Operations Laboratory at NASA Ames Research Center in August 2015. NTX personnel provided an overview of their facility, and provided additional demonstrations of the Precision Departure Release Capability and Dynamic Weather Routes tools.

DWR user display at American Airlines Integrated Operations Control Center, Fort Worth, Texas.

NASA Attends Boeing Technical Interchange Meeting

POC: SHERI BROWN

Boeing Flight Services (BFS) hosted NASA researchers at the BFS Miami Training Campus on November 8-10 to observe numerous line-oriented flight training sessions, and to evaluate experimental scenarios and a NASA-designed training protocol. The protocol was specifically designed for upcoming research in a full-motion, high-fidelity commercial aircraft simulator at NASA Langley Research Center.

NASA is leading research chartered by the government-industry group known as the Commercial Aviation Safety Team in order to develop and assess commercial flight training methods and flight deck technologies focused on enhancement of energy and attitude state awareness; mitigation of the effects of attention-related human performance limiting states; and prevention of unusual attitudes and control upsets during commercial flight operations.

The Technologies for Airplane State Awareness (TASA) Sub-Project of the Airspace Technology Demonstration Project sponsored the travel to enable the NASA researchers to brief and receive feedback on proposed scenarios designed to induce channelized attention and startle/

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surprise. The scenarios will be used to test innovative crew state monitoring and detection technologies, synthetic vision systems (SVS), and other flight-deck-display avionic concepts. Researchers will also evaluate the efficacy of training and AHPLS detection measures, and investigate whether the established attitude and energy awareness benefits afforded by SVS and other flight-deck displays could be extended to prevent unusual attitudes for commercial aircraft operations.

TASAR Pilot User Interface Display

Loss of control in flight represents the single largest category of aircraft accidents and incidents, and the present work is expected to deliver solutions complementary to other NASA efforts ongoing in TASA and other research projects, both within and outside NASA.

TASAR Meetings with Boeing Working Group and the FAA

Research engineer David Wing of NASA Langley Research Center gave an invited briefing to the Boeing Company's Airline Data Communications Working Group (DCWG) on NASA's concept and technology for Traffic Aware Strategic Aircrew Requests (TASAR) on November 10. The Working Group was started four years ago by Boeing, and is widely attended by airlines and vendors from around the world to track the latest international happenings in air/ground data communications and related technologies. The DCWG promotes a common understanding of current events and trends and how they will affect aircraft equipage.

NASA's TASAR concept offers onboard automation to advise pilots of traffic-compatible trajectory changes that would benefit their flights. Whereas TASAR supports today's voice communications environment to enable immediate operational use, integration of TASAR with data communications could benefit users and air traffic controllers by enabling more complex requests, reducing workload and frequency congestion, and reducing communications errors.

The Federal Aviation Administration's (FAA) data communications program is one of several Next Generation Air Transportation System (NextGen) technologies being considered by NASA's Third Airspace Technology Demonstration (ATD-3) sub-project for air/ground TASAR integration. Other NextGen technologies being considered include System Wide Information Management (SWIM) and Time-Based Flow Management (TBFM). Outreach activities have confirmed a significant and growing interest within the operational community of linking TASAR's airborne route optimization capabilities with SWIM and TBFM.

At another meeting on November 20, David Wing and NASA Langley research engineer Mike Guminsky met with Jon Standley, portfolio manager for the FAA's SWIM effort. Because SWIM offers a common real-time source for such operational data such as aviation weather, traffic data, airspace status, and flow management constraints, Mr. Standley feels TASAR provides complemen-

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Human Systems Integration Laboratory.

tary capability to the FAA's SWIM aircraft access initiative.

NASA has been investigating SWIM as a one-stop data source, and discussions continue regarding a possible integrated air/ground demonstration of connectivity between NASA's Traffic Aware Planner software and SWIM, via the third Airspace Technology Demonstration (ATD-3) Subproject of AOSP's ATD Project. As lead for the Shadow Mode Assessment Using Realistic Technologies for the National Airspace System Project (SMART-NAS), Mr. Guminsky is working to establish a SWIM access point at NASA Langley to support widespread research and development activities. Partnerships with Alaska Airlines and Virgin America may be a viable early test case for the SMART-NAS connection to SWIM through TASAR.

Final UAS Traffic Management TCL One Test Completed

POC: MARCUS JOHNSON

On November 18, the Unmanned Aerial Systems (UAS) Traffic Management (UTM) team conducted a final demonstration at Moffett Airfield in Sunnyvale, Calif. The UTM team successfully tested the connection of a UAS ground control station to the UTM system over a cellular network, as well as the UTM system that alerts UAS operators of non-conformance with an operational plan (i.e. flying outside the designated flight area), and messaging between the UTM manager and the UAS operator.

In order to accomplish these objectives, an Iris+ UAS was flown on the airfield and a simulated vehicle was flown virtually from the

UTM field testing.

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Multi-Aircraft Control System. Both live and virtual aircraft were shown on a UTM manager display in the Human Systems Integration Laboratory, in the field via an iOS app, and in NASA Ames Research Center's SMART-NAS (Shadow Mode Assessment Using Realistic Technologies for the National Airspace System) Testbed. This live-virtual-constructive environment allowed for the UTM system to interact via alerts and messages with both the UAS airfield operator and an operator in the lab.

NLR Visit to NASA Langley's CSAOB

POC: NEIL O'CONNOR

On November 19, 2015, NASA Langley Research Center engineers from Langley's Crew Systems and Aviation Operations Branch hosted the Division Manager for Aerospace Operations Marja Eijkman and Head of Air Traffic Management and Airports Rolandus W. Vercammen, both from the Netherlands Aerospace Centre (NLR).

NLR is one of the Netherland's major technological institutes, and performs a large part of the applied research within the country. Its activities are market-oriented, independent, with a socially relevant emphasis. NLR works under research contracts, amounting to 75% of its activities, with the remaining 25% funded by the Dutch government for basic demand-oriented research programs and development of research equipment. NLR has a staff of about 650 people, and maintains operations in Amsterdam and Marknesse.

Ms. Eijkman and Mr. Vercammen were provided an overview of the Air Traffic Operations Laboratory, and a demonstration of the SMART-NAS (Shadow Mode Assessment Using Realistic Technologies for the National Airspace System) Testbed capabilities. Other discussion topics included trajectory based operations, and the Traffic Aware Strategic Aircrew Requests and Pairwise Trajectory Management tools.

NASA Langley and NLR currently have an active agreement in flight deck interval management, and have a long history of collaboration focused on air traffic management research. They continue to collaborate on Traffic Manager, a multiple aircraft desktop simulation program created by NLR and further developed jointly with NASA. Opportunities for continuing collaborations were also explored, including a demonstration of some of Langley's acoustics simulation capabilities.

TASAR Technology Evaluation Licenses Issued

POC: DAVID WING

Evaluation licenses for NASA's Traffic Aware Strategic Aircrew Requests (TASAR) technology have been issued to two prominent commercial aviation system providers: the Information Management Systems (IMS) Division of Rockwell Collins International and Gogo LLC. A third company, United Technologies Corporation Aeronautical Systems (UTAS), has also applied for a TASAR evaluation license.

A precursor to a full commercial license, an evaluation license is a key step in NASA's technology transfer process. The core of TASAR technology is the Traffic Aware Planner (TAP), a software application developed by Engility Corporation for NASA that is hosted on an electronic flight bag (EFB) in the cockpit. TAP reads aircraft and traffic data directly from onboard avionics and, through internet connectivity, leverages an array of external data sources relevant to flight optimization, such as wind predictions, convective weather, and restricted airspace status. Processing all this information, TAP computes flight optimizing trajectory changes in real time and provides these advisories to the aircrew.

Rockwell Collins IMS is already in discussions with a major U.S. air carrier about their involvement as a potential launch customer for TASAR commercialization. Gogo is an inflight communications service provider, partnering with 11 major commercial airlines, including Alaska Airlines and Virgin America, NASA's two TASAR airline partners.

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Gogo is supporting upcoming Alaska Airlines operational trials by hosting TAP software on their onboard server and by providing internet connectivity to the application.

UTAS is similarly involved in the Alaska Airlines TASAR trials, providing avionics connectivity to Alaska's iPad EFBs in the cockpit and also hosting TAP on their hardware. NASA is working directly with UTAS and Gogo to have the TAP application tested and ready for operational trials by Alaska Airlines in spring 2016.

NASA Commences ATD-1 Avionics Phase 2

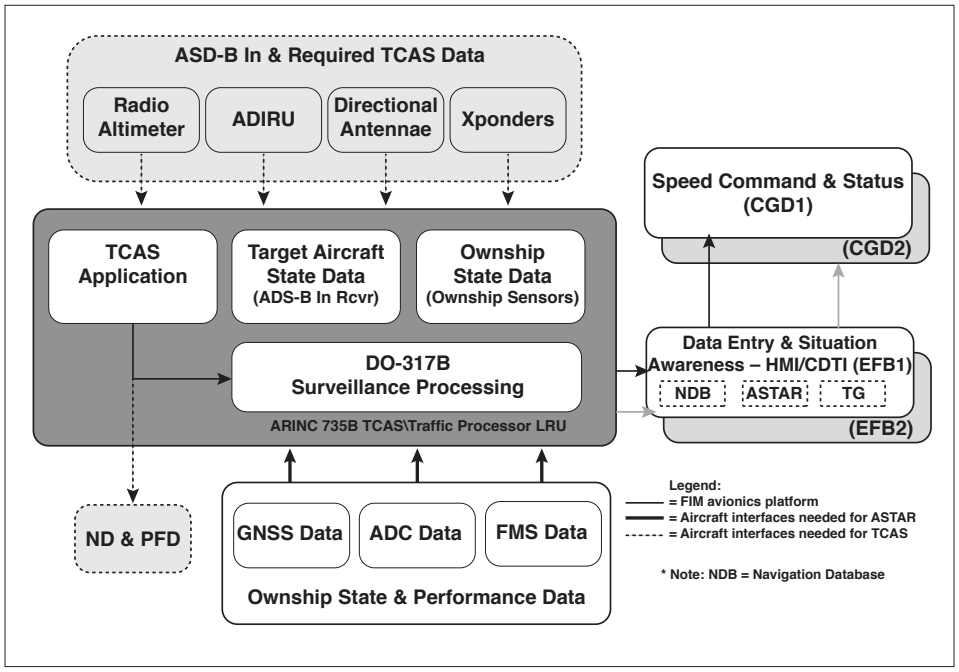
POC: SHERI BROWN

Early this past quarter, NASA Langley Research Center received official commitment for aircraft in support of a Boeing Company-managed flight test demonstration under the terms of a $10.9 million, two-year flight-critical systems research contract task entitled "Air Traffic Management Technology Demonstration 1 (ATD-1) Avionics Phase 2." ATD-1 is a major applied research and development activity of the Airspace Operations and Safety Program (AOSP), and the first of a series of AOSP sub-projects advancing the technology readiness level of innovative NASA technologies through system-level demonstrations in relevant environments.

A primary goal of ATD-1 is to operationally demonstrate an integrated set of NASA arrival management technologies for planning and executing efficient arrival operations in the terminal environment of a high-density airport. These technologies are intended to assist flight crews, controllers, and air traffic managers with meeting the Next Generation Air Transportation System (NextGen) objective of increased fuel efficiency during periods of high runway throughput.

Researchers at NASA Langley have developed the Airborne Spacing for Terminal Arrival Routes algorithm for trajectory-based control law for time-based spacing of Flight Deck Interval Management System (FIM) operations. The Avionics Phase 2 task leverages Phase 1-identified solutions for equipping existing in-service aircraft with FIM airborne spacing tool technology under development at NASA for flight test demonstrations slated for January through March 2017.

The Avionics Phase 2 team is comprised of recognized leaders in the community. The Boeing Company, in partnership with Honeywell and United Airlines, will build, test and fly the ATD-1 avionics prototype FIM system, which NASA plans to eventually transfer to the Federal Aviation Administration. Both Honeywell and United provided official letters of commitment confirming the availability of flight test assets. Honeywell is providing two



System Architecture for ATD-1 Avionics Phase II and Flight Test

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test aircraft at no cost: a 757 flying test bed and a Falcon 900/Sabreliner 65 as a lead aircraft. United is providing a commercial service B737-700/800/900 aircraft at just $8,000 per flight hour, and is not charging for any lost revenue while the plane is participating in these flight test demonstration trials. Boeing's partnership with Honeywell and United will provide a very large cost savings to the government, leveraging the expertise of highly experienced contractors to conduct a flight test demonstration using commercial aircraft, underscoring industry's commitment to ensure flight-test success and the advancement of the FIM prototype.

NASA Langley engineers attended an initial flight demonstration air traffic control coordination meeting hosted at Seattle Air Route Traffic Control Center (ARTCC). The Phase 2 flight test demonstration follows the Phase 1 787 ecoDemonstrator and T-38 concept demonstration held in December 2014, but with wider and more complex testing of FIM operations. This latest effort will utilize the three aircraft mentioned above, conducting four different flight deck spacing procedures with custom arrivals and published approaches into Moses Lake, Washington in non-revenue flight operations. Variability will include different arrival procedures and en route transitions, diverse starting altitudes and descent speed profiles of the lead aircraft, and variation of the amount of delay the spacing algorithm must resolve.

The objective of the coordination meeting was to familiarize the Seattle ARTCC staff with the flight test demonstration plans and needs, to understand their airspace procedures and constraints, solicit feedback about the proposed flight test routes, discuss methods to minimize the need for controller intervention during each test procedure, and to plan follow-on coordination meetings. The next meeting is planned in late January 2016 and will also include staff from the Moses Lake Terminal Radar Approach Control Facility.

Denise Scearce will be the ATD-1 avionics lead and technical point of contact for the Phase 2 task. Brian Baxley is the ATD-1 flight test lead, and Will Johnson is the ATD-1 subproject manager and chief engineer.

SMART-NAS Testbed Demonstration

POC: JOHN ROBINSON, KEE PALOPO

On December 2, the Shadow Mode Assessment Using Realistic Technologies for the National Airspace System (SMART-NAS) Testbed team demonstrated initial data integration and visualization capabilities. The Testbed is intended to accelerate transformation of the NAS by enabling high-fidelity human-in-the-loop and automation-in-the-loop simulations and tests that are either impractical or not achievable today. The Testbed will also harmonize test and evaluation activities of the entire product development lifecycle, from NASA research to routine use. It will use operational systems and high-fidelity models to evaluate realistic current and future traffic scenarios for all phases of air traffic operations, leveraging cloud-based services to provide cost-effective scalability for large, multi-facility, multi-organization simulations.

In the past year, the SMART-NAS Testbed team focused on developing a proof-of-concept implementation of a distributed simulation environment used to perform technology evaluation of potential middleware and client software solutions. The high-throughput, publish-and-subscribe messaging system called Apache-Kafka (used by Twitter, Netflix, and LinkedIn) and the cluster-computing engine for big-data processing called Apache-Spark were evaluated. The WebGL-based Cesium framework and NASA's Java-based WorldWind geospatial visualization capabilities were used to create both a Testbed mobile and desktop application.

Initial SMART-NAS Testbed capabilities that were demonstrated included:

- Automation of simulation design and execution using a graphical, drag-and-drop editor of simulation components;

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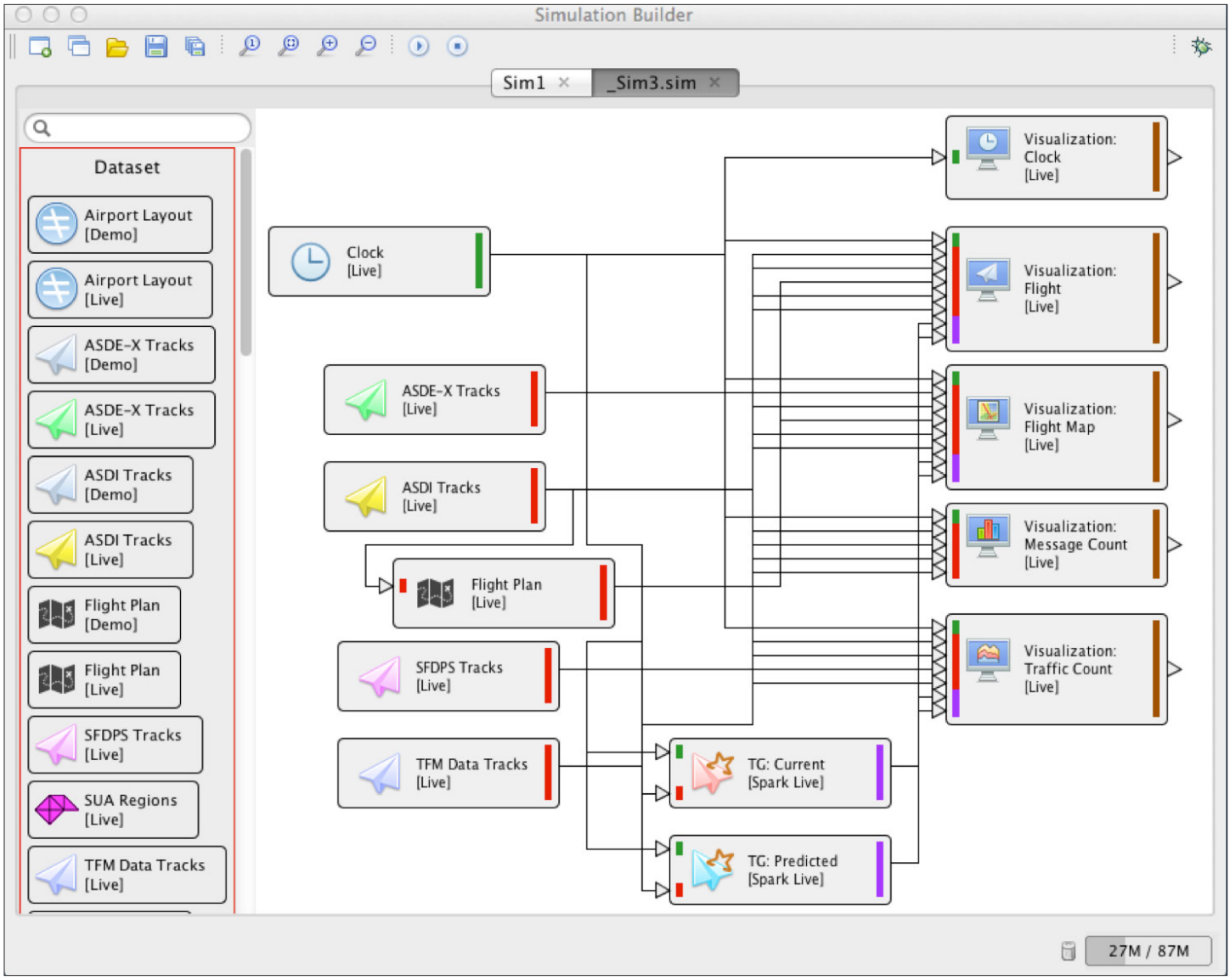

SMART-NAS Testbed Distributed Collaboration Tool for Plugging-in Modules, Configuring and Running Simulations.

- Communication between distributed simulation components at NASA Ames and NASA Langley Research Centers using NASA's GovCloud infrastructure;
- Integration of live, recorded, and simulated air traffic and airport vehicle position Information from the Federal Aviation Administration, NASA's Ames, Glenn and Langley Research Centers, and the University of California at Santa Cruz;
- Prediction of aircraft trajectories using each aircraft's flight plan and surveillance information;
- Visualization of air traffic tracks and flight plans, weather information, and airspace boundaries on a high-resolution, three-dimensional geo-spatial viewer; and

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- Execution of real-time analytics to evaluate operational metrics like delay and sector transit time, as well as health metrics like message rates and latencies.

In 2016, the Testbed team will extend and mature the proof-of-concept capabilities to include account/session management services, automated simulation scenario generation and validation using big-data analytics, on-demand creation of simulated aircraft from live traffic conditions, and distributed voice communications for remote simulation participants.

FAA Interest in DWR Technology

POC: DAVE MCNALLY, KAPIL SHETH

During the Federal Aviation Administration/NASA quarterly meeting held at NASA Ames Research Center on December 1-3, senior FAA managers expressed strong interest in the Dynamic Weather Routes System (DWR) technology as a candidate for inclusion in the FAA's Collaborative Air Traffic Management Technologies Work Package 5, now scheduled for a final investment decision in 2019. In preparation for meeting its milestones, the FAA indicated that the technology would be targeted for the Traffic Flow Management System, and requested that additional information, including shortfall analysis, operating concepts, functional requirements, technical papers, and prototype software be provided by the end of calendar year 2016. The FAA also expressed interest in NASA's extensions of DWR, which are proposed components of NASA's Air Traffic Management Technology Demonstration (ATD)-3 subproject, including the Multi-Flight Common Route (MFCR), which finds common air traffic controller-friendly routes for multiple flights, and Dynamic Routes for Arrivals in Weather (DRAW), which extends DWR for merging arrivals and metering during weather events. The FAA expressed strong interest in connecting the Airborne Reroute (ABRR) mechanism with NASA's MFCR technology. The FAA-developed ABRR sends reroutes from the traffic manager to the controller electronically.

SEMINARS AND PRESENTATIONS

Cognitive Engagement Presentation at Tech3Lab, HEC Montreal

POC: SHERI BROWN

Dr. Alan Pope of NASA Langley Research Center was the invited guest speaker on November 12 at HEC (École des hautes études commerciales) Montreal for World Usability Day. Dr. Pope held technical interchanges with researchers in the Tech3Lab of HEC, a research laboratory in human-computer interaction specializing in the business-user experience. The laboratory uses an array of behavioral and neurophysiological measurement instruments to observe and analyze people's interactions with technology – such as eye movements, cardiac activity and electroencephalography – to analyze interactions among organizations' technological interfaces and employees or consumers.

Dr. Pope presented research conducted by NASA Langley's crew state monitoring (CSM) team that included development of an electroencephalographic (EEG) index of cognitive engagement. The CSM team is currently conducting studies employing EEG, functional near infrared spectroscopy, and sympathetic nervous system measures to detect attentional state during motion-based flight simulation. Overall, the work aims to reduce commercial aviation accidents and incidents by mitigating the effects of attentional human performance limiting states, thus improving crew awareness.

The work is in response to the Commercial Aviation Safety Team Safety Enhancement 211 entitled "Training for Attention Management" supported by the Airspace Operations and Safety Program's Technologies for Airplane State Awareness Sub-Project.

Duke University Optical Neuroimaging Talk

POC: SHERI BROWN

On November 18, Dr. Angela Harrivel of NASA Langley Research Center was invited by Dr. Missy Cummings at Duke University to speak about her work using functional near infrared spectroscopy (fNIRS). Professor Cummings directs the Humans and Autonomy Laboratory in the Duke Institute for Brain Sciences in the Pratt School of Engineering, and is a member of the NASA Advisory Council's Aeronautics Committee. Her group is interested in detecting vigilance decrement by employing dual-channel fNIRS to measure brain activity in human subjects during long-duration driving simulations, assessing oxygenation changes in the prefrontal cortex coincident with driving-performance metrics.

Dr. Harrivel's discussion included a presentation, followed by a questions-and-answers session regarding her recent research sensing executive attention and resting-state networks in the brain with multi-channel fNIRS, and using adaptive signal filtering, behavioral responses and pattern classification to predict task engagement.

Invited Talk at the Stanford University Department of Computer Science

POC: BANAVAR SRIDHAR

Invited by Dr. David Cheriton, Professor of Computer Science at Stanford University, NASA Ames Senior Scientist for Air Transportation Dr. Banavar Sridhar on November 19 presented a freshman seminar entitled "What is Aviation Operations and How Does Computational Thinking Influence Its Design?" The talk was organized as a series of dozen questions, with a third of the time devoted to the impact of new technology on future aviation operations.

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