12th Annual Verification and Validation Summit - 2017

"Achieving Complexity Consciousness"

Event Record

The 12th Annual Verification & Validation (V&V) Summit was held at the Resorts Hotel in Atlantic City NJ on September 13-14, 2017. Over 218 participants attended the annual summit. There were 16 speakers from the FAA, the United States Air Force, NASA, the Carnegie Mellon University Software Engineering Institute (SEI), Stevens Institute of Technology and private industry, who addressed this year's theme: "*Achieving Complexity Consciousness*".

To provide additional perspectives on how to address Enterprise Capability V&V challenges, the following three videos were presented: *Systems Thinking: A Little Film About a Big Idea"; "Digital Twins: Data Modeling Eliminating Unplanned Downtime" and "Minds + Machines: Meet a Digital Twin"; and "The Astounding Athletic Power of Quadcopters"*.

The V&V Summit was planned, conducted and facilitated by the FAA V&V Strategies and Practices Branch, under the direction of the Branch Manager, John Frederick. The V&V Summit coordinator was Wanda Lopez-LaBarbera. The 16 distinguished speakers at the summit addressed the following topics:

- **John Frederick** – FAA, Manager, V&V Strategies & Practices Branch: welcomed the audience to the 12th Annual V&V Summit and showed a video that celebrated and highlighted the evolution of the past 2 years of V&V Summit. Mr. Frederick also discussed lifecycle V&V concepts from research to service operations. He stressed the value of continual improvement in V&V related methods, tools, and practices, quoting Peter Drucker: "Knowledge has to be improved, challenged, and increased constantly, or it vanishes".

- **Jaime Figueroa –** Deputy Director, Federal Aviation Administration William J. Hughes Technical Center: stood in for **Shelley Yak** – Director, Federal Aviation Administration William J. Hughes Technical Center: Mr. Figueroa summarized key points from Ms. Yak's recent ITEA journal article on Complexity Consciousness. He defines as complexity consciousness the purposeful awareness of the intricacies of interrelated capabilities and systems. A culture of complexity consciousness has the full understanding of the role, needs, and contributions of all stakeholders. Achieving consciousness of complexity also requires an acute awareness of the operator, system, and service role – past, present, and future.

- **William C. Redmond** – United States Air Force, Executive Director, Air Force Operational Test and Evaluation Center (AFOTEC): Highlighted the efforts of three DoD services in testing the F-35 fighter jet. Mr. Redmond addressed the Pace of Need (Speed = Life). Mr. Redmond discussed five key "Points of Leverage" 1) T&E Early 2) 5th generation Design of Experiments, 3) Modeling and Simulation, 4) T&E Connective Tissue, and 5) T&E Automation. He emphasized the importance of providing Operational Truth to members of the armed forces.

- **Wilson N. Felder, Ph.D. –** Stevens Institute of Technology, Industry Professor and Director, Systems Engineering Research Center's Doctoral Fellows Program: Discussed "Addressing the Complexity Challenge with Adaptive Verification and Validation." Dr. Felder identified

"adaptive V&V Tools" applied at appropriate points across the AMS lifecycle: 1) Life Cycle Governance, 2) Model-Based Engineering, 3) Agile Development, and 4) Formal Methods and Recurrent Surveillance. He emphasized the importance of early and often collaboration and closed with a recommended action plan.

- **Sarah Sheard, Ph.D. –** Carnegie Mellon University Software Engineering Institute, Senior Engineer: Dr. Sheard discussed how to assess and manage complexity. She spoke of the difficulty of accountability for safety in complex distributed systems, and the level of effort to perform safety case assessment. Dr. Sheard provided recommendations to address V&V across complex systems: 1) Assess complexity of components, 2) Assess complexity of system of systems interfaces, 3) Understand the risks, 4) make parts as reliable as possible, and 5) insist on static analysis of design documentation, algorithms, and code.

- **Timothy K. Brady** – NASA Engineering and Safety Center, NASA Johnson Space Center: Mr. Brady described system level V&V challenges and provided a simplified view of the model based system engineering (MBSE) methodology. He also discussed the visualization tools that integrate with Systems Modeling Language (SysML) to help find issues when integrating multiple levels of testing and multiple test facilities. Mr. Brady emphasized that MBSE methodology provides an opportunity to automatically, consistently, and methodically analyze the system model.

- **Ryan C. Chartrand** – NASA Langley Research Center, Research Directorate, Crew Systems and Aviation Operations Branch: Mr. Chartrand described the simulation for time, speed, and spacing methods for flow management. He described the simulation environment, experiment design, independent and dependent variables, and design of scenarios used and provided the preliminary results.

- **Eric Hoover** – FAA, NWP Lead Test Director, Aeronautical & Weather Services Verification Branch, ANG-E67: Mr. Hoover described the FAA's experience with using Agile methods on the NextGen Weather Processor (NWP) program and discussed related challenges for the test and evaluation. He cited the additions to the newly revised FAA T&E Handbook which summarizes and references new AMS guidance on agile acquisitions

- **Kimberly Gill** – FAA, Division Manager, NAS Enterprise Architecture & Requirements Services Division, ANG-B1: Ms. Gill stressed that traceability is essential to avoid scope creep and to remain aligned to the vision for the NAS. She described the use of the Dynamic Object-Oriented Requirements System (DOORS) being used to trace from high level NAS requirements down to Program Requirements Documents and system-level specifications. When fully implemented, traceability will allow results from V&V to be mapped to high level NAS requirements. Ms. Gill emphasized the importance of collaboration.

- **Robert X. Williams, PMP** – Veracity Engineering, Senior Program Manager, ATC Operations: Mr. Williams spoke of his experiences in multiple programs where obtaining early input from all relevant stakeholders was essential, especially for the implementation of capabilities that rely on multiple systems in a System of Systems environment. His briefing discussed the following key elements: 1) stakeholder identification, 2) analyzing stakeholders, and 3) understanding stakeholders. Mr. Williams emphasized that this early and continual involvement with stakeholders results in an expansion of better ideas for the program.

- **Pamela Whitley** – FAA, Deputy Assistant Administrator for NextGen, ANG-2: Ms. Whitley brought the Summit attendees up to date on the plans for Trajectory Based Operations (TBO). These plans include "Full TBO" improvements being implemented in the current Bravo segment of NextGen (2016 – 2020) and "Dynamic TBO to be implemented in the next segment (Charlie, 2021 – 2025). She provided a notional airspace illustrating the integration of space and time concepts of TBO. Ms. Whitley stressed the importance of evolving the human operator's skill set to operate in time-based management of air traffic flows.

- **Carla A. Hackworth, Ph.D.** – FAA, Division Manager, Aerospace Human Factors Research Division, AAM-500: Referencing Tesler's 'Law of Conservation of Complexity", Dr. Hackworth noted that designs must not hide complexity but allow operators to be aware and have appropriate levels of control. Designs must bring additional information to where it can be used with approaches such as cameras for remote activities and color-coding that is appropriate for the technology being used, the environment, and the user base. Ms. Hackworth described humans as being part of the system and human factors requiring an integrated system of systems approach. She emphasized that human factors research is an integral part of V&V and key to success of the implementation of complex systems.

- **Mark DeNicuolo** – FAA, Acting Director of Safety, AJI-1 and FAA, Director, Policy & Performance, AJI-3: Mr. DeNicuolo reviewed the variety of safety programs in ATO, highlighting that V&V has a critical role in both Safety Assurance and Safety Risk Management (including Independent Operational Assessments (IOAs)). He described how the ATO manages safety by the Collect, Find, and Fix cycle. Mr. DeNicuolo related how safety integrates with V&V throughout the lifecycle and stated that "safety is a lifecycle discipline". Safety identifies safety hazards and safety requirements to address those hazards early in the lifecycle while IOA conduct provides a readiness decision for In-Service Decision.

- **Jason Coon** – FAA, Program Manager, Technology Transfer Office, ANG-E2: stood in for Philip Bassett **–** FAA, NextGen Advanced Concept Development and Validation, ANG-C54: Mr. Coon discussed Space Vehicle Operations (SVO) as a "New Entrant" into the NAS planning, described NAS shortfalls, and reviewed the updated SVO solution concepts. The Space Data Integrator is a key component for tracking launch and return to earth events. One of the goals is to reduce the duration of airspace closures. Mr. Coon closed with discussion on current and future research.

- **Adam C. Greco** – FAA, Support Services Section, ANG-E312: Mr. Greco provided an overview of the drone package delivery paradigm including stakeholders. He reviewed a wealth of statistical data on the perception and attitudes of the public towards drone use. Attitudes are much more favorable when potential improvements in package delivery speed are being considered. Demographic factors such as age and gender are highly correlated to receptivity and acceptance of the new technology into daily life.

The speakers at this year's V&V Summit addressed "complexity consciousness" by discussing how to identify, assess, and manage complexity while integrating new enterprise capabilities. They explored human integration and utilizing tools such as modeling, simulation, visualization tools, and storyboards. Understanding complexity and how it relates to both sides of the lifecycle "Vee" model builds complexity consciousness and enables a comprehensive approach to operational integrity. This corporate awareness of complexity among all stakeholders with a common understanding on how to

manage the elements is critical to effective and efficient implementation of concepts from research to operations.

All FAA participants at this year's V&V Summit received FAA eLearning Management System (eLMS) credits (course # FAA30020006). V&V Summit feedback forms were collected at the end of each day and will be assessed to improve future summits. The 12th Annual V&V Summit presentations, final agenda, video links, and pictures can be found on the internet at:

http://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/library/v&vsummit/v&vsummits.html.