13th Annual Verification and Validation Summit - 2018

"Systems Thinking – Thinking"

Event Record

The 13th Annual Verification & Validation (V&V) Summit was held at the Resorts Hotel in Atlantic City, NJ, September 19-20, 2018, with 212 in attendance. There were 17 speakers from FAA, the United States Air Force, NASA, the Carnegie Mellon University Software Engineering Institute (SEI), US DOT Volpe Center, Stevens Institute of Technology, National Aviation Traffic Services (NATS) UK, Boeing, and private industry who addressed this year's theme: "*Systems Thinking – Thinking*". To provide additional perspectives on how to implement Systems Thinking, the following videos were presented: *"The Value of Systems Thinking", Systems Thinking – Rethink Everything", "Systems Thinking" and "A Systems Story"*. During check-in and breaks at the summit, attendees were able to learn and interact at the FAA NAS Animated Storyboard and FAA Runway Safety display booths.

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 17 distinguished speakers at the summit addressed the following topics:

- John Frederick - FAA, Manager, V&V Strategies and Practices Branch: welcomed the audience to the 13th Annual V&V Summit and provided an overview of V&V. He then provided definitions for Systems Thinking. Systems Thinking is a way of thinking that recognizes the world is a set of highly interconnected technical and social entities which are hierarchically organized producing emergent behavior. Systems Thinking is a framework for seeing interrelationships and patterns with a set of principles spanning fields as diverse as physical and social sciences, engineering and management. Mr. Frederick highlighted the benefits and stoic virtues of systems thinking that focus on being mindful of the diverse principles in daily life, turning obstacles into opportunities, maintaining a holistic perspective, and mutual interdependence.

- Shelley Yak - FAA, Director, William J. Hughes Technical Center: highlighted the WJHTC 60 years in aviation. Ms. Yak encouraged all to adopt systems thinking through our collaborations and relationships to gain a deeper understanding of each other's perspective. When we "can't see the forest for the trees", most likely we are focusing on one aspect of the problem and we have lost the holistic view. She encouraged us to embrace problems as opportunities for innovation, look for connections and trends, and focus on a common mission for the greater good.

- Paul D. Nielsen, Ph.D. - Carnegie Mellon University, Software Engineering Institute, Director and Chief Executive Officer: emphasized that everything we do in life is part of a larger system that continuously changes and gains more complexity – we have to adapt. He discussed a world of autonomy "in motion" and "at rest", the challenges in designing autonomous systems, and

trust issues between human and systems. He compared the challenges of implementing autonomous systems to raising children. Trust and autonomy increases in tandem over time.

- Joseph Rios, Ph.D. - NASA, Chief Engineer, UAS Traffic Management: discussed Unmanned Aircraft Systems (UAS) Traffic Management (UTM) implementation. Dr. Rios described UTM as the industry's ability to supply services under FAA regulatory authority where these services do not exist. He provided an overview of the UTM architecture, core operating principles, and the six technical capability levels (TCL) where TCL 1, 2, and 3 demonstrations have been completed with the test organizations, industry and academia involved. Dr. Rios described the UTM requirements development process and emphasized that operational testing in all six TCLs will be conducted to assist in requirements development. He mentioned that the FAA and NASA are closely collaborating to ensure appropriate regulatory and operational requirements are included.

- Pamela Whitley - FAA, Acting Assistant Administrator for NextGen: Ms. Whitley provided her thoughts on the theme when considering the "what, why, when and how" to understand how the system works. She discussed the next major step is understanding the desired results. She provided status on the following programs: Automatic Dependent Surveillance Broadcast (ADS-B), Standard Terminal Automation Replacement (STARS), En Route Automation Modernization (ERAM), Data Communications (DataComm), and Performance Based Navigation (PBN). Ms. Whitley provided an overview on the Northeast Corridor (NEC) that is designed to address key issues that negatively impact NEC operational performance, especially deconflicting arrivals into the New York area. She emphasized the importance of focusing on the outcome, not just the inputs and outputs. She closed with discussing the evolution of the NAS drastically changing the role of the human and requiring us to move beyond understanding individual systems.

- Major General (Ret) Matthew Molloy - United States Air Force Retired: emphasized three pillars of complex systems thinking: 1) modeling and simulation (M&S) developmental work, 2) big data analytics, and 3) prototyping. Mr. Molloy discussed the challenges and opportunities associated with advanced weapon systems operational test and evaluation (OT&E) as it relates to the three pillars. He discussed culture of "Failing Forward", testing at the "speed of need" and the importance of finding and learning from mistakes. His take-aways included: integrated testing is needed, M&S will play an increasing role in system analysis; big data will continue to get bigger. Mr. Molloy stated that a big data strategy is needed and prototyping/experimentation are useful acquisition tools.

- Mark Flanigan - National Air Traffic Services (NATS), Chief Innovation Officer: provided an overview of physical and digital 4th industrial environments. The physical environments: 1) SMART airport and cities: smart, connected transport for a seamless travel experience, 2) AIREON satellite surveillance: global, real-time surveillance, and 3) Urban Traffic: new airspace users; dealing with drones and future, on-demand mobility. The digital environments: 1) Tower digital transformation: initially using computer vision to augment digital towers and evolving augmentation to automate, 2) Augmented Intelligence (AI): moving the machine towards executive control and designing agents, and 3) Mixed Reality: building value creation platforms for future collaboration and control. Mr. Flanigan also discussed biometrics: human

performance data. He stressed the importance to employ human-centered design with systems thinking to encode technologies with societal values and design systems to give people more choice, opportunity, freedom, and control.

- Gregory S. Woo, Ph.D., PMP - U.S. DOT Volpe Center, Chief of Aviation Systems Engineering: focused on system-oriented requirements development and provided helpful techniques: 1) assume change will occur – use thought based experimentation to test flexibility and adaptability of requirements, 2) assess the entire system and enterprise when assessing flexibility and adaptability, 3) embrace uncertainty using models, and 4) review and reassess the requirements and the system regularly and across the program lifecycle. Dr. Woo stressed being mindful of the interconnectivity systems as a critical systems thinking habit.

- Daniel J. Fogarty - Boeing, Technical Fellow and Development Assurance Focal: discussed the "5A" safety framework: airplane, airspace, airline, air traffic control and airport. Mr. Fogarty emphasized the need for a 5A framework to evaluate system of systems safety impact, to derive and levy failure probability, availability, integrity requirements. This will help to ensure that there are no discrepancies between safety requirements. He discussed Boeing's Model Based Systems Engineering (MBSE) and Model Based Safety Analysis (MBSA) processes and tools that are used to address integration challenges with the 5A air traffic management environment.

- Daniel P. Murray - FAA, Manager, Space Transportation Development Division: Mr. Murray described the three R's for commercial launch and reentry operations: reduce - apply flexible planning tools and advanced analysis techniques to safely **reduce** the amount of airspace that must be closed to other users in advance of a launch or reentry operation; respond - automate safety calculations and data transfer to allow ATC to effectively **respond** to contingencies and maintain safety during operations; and release - automate data ingest and transfer to allow ATC to quickly **release** airspace to normal operations once it is no longer affected. He discussed the Space Data Integrator (SDI) that provides a capability to automate the current manual process for accommodating commercial space launch and reentry operations in the NAS. SDI will leverage currently planned enhancements to reduce commercial space operations threshold times from minutes to seconds.

- William D. Miller – Innovative Decisions, Inc., Executive Principal Analyst; Stevens Institute of Technology, School of Systems & Enterprises, Adjunct Professor: discussed challenges of cyber-physical systems, systems thinking theory, and grounding V&V in the systems sciences. Mr. Miller described "a system of thinking about systems" and provided an overview of a systems world perspective that encompasses environments, domains, technological advances, and systems sciences. His discussion focused on the challenges of artificial intelligence and autonomous systems. Mr. Miller highlighted potential system impacts of driverless cars. He also went on to discuss theoretical foundations of systems engineering and the roadmap for future research.

- Ann M. McDonald - U.S. DOT Volpe Center and Jennafer Miller, PMP - Evans Incorporated: provided an overview of the Program Management Organization (PMO) Requirements Management (RqM) process. Ms. McDonald and Ms. Miller engaged the audience by conducting a group exercise to connect systems thinking with RqM. The audience engaged in

discussion and collaborated to piece together 4 common elements of Systems Thinking and Requirements Management:

1. Adoption of Process
    a. Buy-In
    b. Training
    c. Discipline
    d. Roles and Responsibilities
2. Clarity
    a. Definition of Scope
    b. Success Measures
    c. Metrics Usage
    d. Bi-Directional Traceability
3. Feedback Loop
    a. Definition of Scope
    b. Success Measures
    c. Metrics Usage
    d. Bi-Directional Traceability
4. Tools
    a. Definition of Scope
    b. Success Measures
    c. Metrics Usage
    d. Bi-Directional Traceability

- Maureen Keegan - FAA, Manager, Technical Analysis and Operational Requirements Group: provided an overview of the Concepts, Validation, and Requirements (CVR) operating modeling process. The CVR operating model is a 12 step process for defining and validating operational needs within the NAS. It consists of three main components: 1) Responsible, Accountable, Support, Consult and Inform (RASCI), which identifies the organizational roles for ATO Operational Concepts, Validation and Requirements work for ANG and non-ANG driven operational needs, 2) standard intake process for sourcing and identifying operational needs in the NAS, and 3) alignment of the work to be prioritized and assigned through portfolio management. It also consists of four summary phases that overlay the FAA Acquisition Management System (AMS) which Ms. Keegan described in detail: needs – operational needs assessment, concepts – concept of operations development, requirements – requirements development, and test – refine, test and confirm requirements.

- Maureen Molz - FAA, Manager, Research and Development Management Division: described the FAA Research and Development (R&D) organization including R&D areas, governance and external advisory system, planning and reporting cycle, and planning frameworks: Annual Modal Research Plan (AMRP) and National Aviation Research Plan (NARP). Ms. Molz provided her own personal experiences in the quest to understand how the NAS worked and the challenges in introducing a new concept for NAS integration and testing. She wanted the BIG picture, the "zoom out" to see the higher level of NAS Operations. In her quest, she developed a conceptual view of the current NAS and a "Net-Centric NAS" with focus on a system of systems (SOS) assessment platform. Ms. Molz noted, be careful of your experiences that may create a biased influence on your systems thinking perspective. It could hinder or affect your perspective on how you think about the system. To solve tough problems you need to be able to create a mental model to ensure understanding. She stressed - we need to plan a vision then adjust the vision depending on the constraints of the program execution.

- Donald Taylor - FAA, Manager, Surveillance/Weather Systems In-Service Management: provided an overview of the FAA's Technical Operations (TechOps) organization which operates and maintains both legacy NAS systems and NextGen systems. Mr. Taylor described the importance of TechOps in the FAA lifecycle management, specifically the investment analysis phase where it is the most cost effective opportunity to setup a program's Integrated Logistics Support (ILS). He emphasized the major challenges in the balance of the workforce's skillsets between legacy NAS and NextGen systems (evolutionary or revolutionary). He stressed

the importance of culture and success depends on the respect, diversity, collaboration, and commitment of the workforce. He also stressed the need to cultivate a "deep bench of talent" in the workforce and then transfer that knowledge across disciplines.

- Gina Oliver - FAA, Front Line Manager, SLE Program Management: provided an overview of the Second Level Engineering (SLE) process. Ms. Oliver highlighted the past, present, and future roles of SLE testing. She provided examples of current SLE enterprise tests. Ms. Oliver identified the ways in which the SLE test team has adopted a systems thinking mindset: structured testing paradigm to focus on the interactions among the many NAS elements (systems, capabilities, interfaces, users) and established a functional organization to foster stronger communication paths among all affected entities.

The speakers at this year's Summit addressed "Systems Thinking – Thinking" by defining systems thinking concepts, exploring past, present and future elements of systems thinking, and discussing how systems thinking should be applied to aspects of our work environment. This V&V Summit reinforced and promoted a collective mindset on Systems Thinking that included the following takeaways:

1. The discipline of Systems Thinking requires us to be mindful (not always in our nature)
2. Embrace problems, recognize opportunities to innovate, and learn from failure
3. Seek Interconnectivity (just because it's not readily found, doesn't mean it's not there)
4. Systems Thinking is not just technical - It spans many fields
5. Change your perspective to understand, gain a holistic view, and take on new roles

All FAA participants (who attended both days) 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 13th 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.