



## 15<sup>th</sup> Annual Verification and Validation Summit – 2020 Virtual Event

### *“Resiliency in Action”*

#### Event Record

The 15<sup>th</sup> Annual Verification & Validation (V&V) Summit was held virtually on September 23-24, 2020, with 338 in attendance. Presentations and discussions addressed this year’s theme, “Resiliency in Action”, and focused on building on the theme from last year’s V&V Summit (“Resilience 360”) by delving into the many aspects of implementing resiliency. The goal was to foster resilient services, systems, personnel, organizations, leaders, and practices. There were 12 speakers from:

- FAA
- Serco, Inc.
- Ohio State University
- Applied Research Assoc., Inc.
- University of Jonkoping (Sweden)
- United States Air Force (USAF) Pentagon
- Carnegie Mellon University
- Evans Consulting

Topics addressed V&V and implementing resilience across many domains and from varying operating perspectives. The presentations and discussions addressed critical topics that included:

- *Resilient organizations and culture*
- *Innovation and emerging technologies*
- *Future of the National Airspace System (NAS)*
- *Personal resiliency and resiliency tools*
- *Adaptive capacity*
- *Machine learning and artificial intelligence*
- *Resilient engineering*
- *Systemic potentials*
- *Black swan and resilient test culture*
- *Configuration management*
- *Change and risk management*
- *Building workforce resiliency*
- *Sustainment of the NAS*

To provide additional insight and understanding of resilience, the following videos were presented: *Learning to Lead Without Giving up Control (James Whitehurst)*, *How Duct Tape Saved the Lives of the Apollo 11 Crew (Smithsonian Channel)*, and *Leaders Should Have Empathy and Perspective (Simon Sinek)*. Further, Angela Moore moderated virtual interactive surveys to engage the attendees on resiliency concepts throughout the Summit.

The V&V Summit was planned, conducted, and facilitated by the FAA V&V Strategies and Practices Branch (ANG-E5A) under the direction of the Branch Manager, John Frederick. The V&V Summit coordinator was Wanda Lopez-LaBarbera. The 12 distinguished speakers at the summit addressed the following topics:

- John Frederick – FAA, Manager, V&V Strategies and Practices Branch, welcomed the audience to the 15<sup>th</sup> Annual V&V Summit and provided an overview of V&V. He reviewed elements of last year’s theme within the context of the current COVID-19 resilient environment. He established the basis for why we need resilience in a Volatile, Uncertain, Complex, Ambiguous (VUCA) world. Resilience is adapting to change, keeping an open mind, learning, applying learning, and making connections. Resilience is accepting changes and responding effectively in

a nonlinear paradigm (e.g., a spider web). Resilience management is a balancing act of the tensions between being flexible versus consistent and defensive versus progressive. COVID-19 has presented unexpected disturbances that challenges us to be interconnected and look for opportunities to innovate and thrive.

- Jaime Figueroa, FAA, Deputy Director, William J. Hughes Technical Center, greeted the attendees and congratulated Mr. Frederick and the team for their efforts in hosting this event. He shared his thoughts on resilience – it’s bouncing back! Sudden and unforeseen challenges forced changes. Renewed focus on mission objectives, adapting, recovering and moving forward to accomplish that mission but also enduring beyond the immediate challenge. What we learn in responding to this unprecedented situation can become part of our toolkit to use in future efforts. An example of this is the application of the remote “Guacamole Software” built by Leidos Flight Systems and used by the Terminal Flight Data Manager (TFDM) test team. Mr. Figueroa encouraged all to press on as we have done so in the past to share knowledge, experience, and improve our application of V&V best practices to sustain the mission. Remembering 9/11 – no script or contingency plan existed, yet our air traffic control system landed over 4,000 planes safely.
- Keynote Speaker: Mark DeNicolò, FAA, Deputy Vice President, Program Management Organization, presented *Embracing Resilience and Innovation to Power the Future*. Mr. DeNicolò started with acknowledging resilience in action: being able to hold [the Summit] in spite of the current pandemic – but missing its in-person aspects. He reviewed the NextGen journey embarked on years ago and the V&V and Test and Evaluation (T&E) community’s significant role in achieving NextGen objectives. However, there is still plenty of work to be done to bring Next Generation (NextGen) on board such as FAA Enterprise Networks System (FENS), the next acquisition of the FAA telecommunications infrastructure; Automatic Dependent Surveillance-Broadcast (ADS-B); Commercial Space; and Unmanned Aircraft Systems (UAS) to name a few. Many programs are on the cusp of implementation. Regular Commercial Space operations in the NAS, UAS package delivery, and air taxis may be only a few years away. He also addressed the impact of COVID-19 on all aspects of Air Traffic operations and used Midway as an example to illustrate the severity of the Operational Contingency Level (OCL) event for that facility. Mr. DeNicolò cited Data Communications (DataComm) as another example of the impact experienced in the wake of COVID-19. Hiring of Air Traffic Controller staff has begun to increase after some initial retirements, although new staff are not yet certified.

Resiliency encompasses many levels, such as personal, environment, situation, etc. He showed excerpts from the movie *Hidden Figures* and lauded its protagonists as examples of the situational challenges those women of color overcame. For instance, orbital trajectories for our initial space flights were calculated and verified by Katherine Johnson, the first black female engineer at National Aeronautics and Space Administration (NASA). Dorothy Vaughn trained her fellow female peers on the new IBM system installed at NASA. “Necessity is the mother of invention” as we deal with COVID-19. Embrace the changes we are presented. Lab testing continues with 90% being done remotely. How far can we take our new-found remote testing capabilities? DeNicolò challenged attendees to stop leaning on the excuse of “we have always done things this way.” Think about the why...why are we doing this? Be resilient and be innovative.

- Angela Moore, LSSMBB, Engineering Information Technology (EIT), Inc. Ms. Moore conducted four rounds of the interactive surveys (two each day) on resiliency concepts using the Polleverywhere application. Results were shown instantaneously on screen to all attendees.
- Suzanne S. Styc, PMP, FAA, Director, Management Services Office, NextGen (Acting), presented *Team Resiliency – How You Build It and Sustain It*. Ms. Styc welcomed the opportunity to speak on the consistent need for resiliency in these times. A resilient organization responds and handles situations not envisioned by the designer. Resilience provides required capability in the midst of adversity. Being able to bounce back is not as easy for a person versus a willow tree. Our choice is to either stay down or grow through it. Resilient people do not repeat mistakes. A clear perspective helps us to adapt and respond to adversity. Managing through adversity is the key to achieving our objectives.

Ms. Styc also discussed the capacity of a team to withstand and overcome stressors such as time pressures, insufficient resources, or other challenging conditions. Domains of team resilience: Vision – enables teams to be decisive, collaboration toward a shared purpose; Reasoning – taking proactive action; Composure – the team regulates its emotion; Health – collective support for the entire team. Address problems quickly and effectively, create a positive team spirit, recover and bounce back. She then gave an example about our immediate need to go to full time telework status six months ago. Trust along with open and honest communication are necessities in this environment. Technology has enabled us to continue our work in spite of the circumstances. Conduct dialog with the team on resilience and overcoming challenges. Develop a resilient team culture and sustain it. Resiliency only becomes visible when challenges arise. Minimize impacts, manage, and mend. The key takeaway was to build and nurture team resilience. Develop a growth mindset versus a fixed mindset.

- *Resilience Engineering from Inception to Action* panel consisted of George Emilio (Moderator), Director, Aviation Research, Serco North America; David Woods, Professor, Integrated Systems, Engineering Ohio State University; Christopher Nemeth, Ph.D., Principal Scientist, Cognitive Solutions Group, Applied Research Associates, Inc.; Erik Höllnagel, Senior Professor of Patient Safety, University of Jonkoping, Sweden. Mr. Emilio introduced the esteemed panel of subject-matter experts.
  1. David Woods – discussed *How Adaptive Capacity Is Built, Sustained, Degraded, and Lost in Complex Systems*. He illustrated how NASA’s failure history captures creeping complexity. He presented Resilience Engineering (RE) and adapting to cope with complexity. Systems can be both reliable and brittle, i.e., not robust or resilient. Adaptive capacity is a system’s readiness to change how it currently works to continue to fit changing situations, anomalies, and surprises. Adaptive systems feature graceful extensibility (SNAFU Catching) and sustained adaptability. Professor Woods discussed pragmatics that are the pathways to outmaneuver complexity and the four senses of resilience: rebound, robustness, graceful extensibility, and sustained adaptability. RE provides empirical patterns on adapting to cope with complexity and provides fundamental laws on layered networks and integrated systems engineering capabilities to outmaneuver complexity penalties.
  2. Christopher Nemeth, Ph.D. – discussed *Applying RE to Practice*. Dr. Nemeth focused on three main points: 1) Sociotechnical systems must reflect intense attention to behavior to be effective. 2) RE creates systems that can anticipate and self sustain when confronted by

unforeseen threats in high stakes sectors. 3) Air Traffic Control (ATC) and NAS design, technology procurement, operation, and maintenance roles are well suited to benefit from RE. He used the Burn Intensive Care Unit (BICU) at the Department of Defense (DOD) to describe the model for the BICU cognitive work, barriers faced, essential aspects of BICU work, and solutions to barriers. He then discussed the implications for FAA V&V as it pertains to RE. The operational domain requires one to obtain a valid grasp of how operators create resilient performance, develop understanding of what goes well in ATC and NAS, and how to capitalize on that as an asset for accurate translation into research and solutions.

3. Erik Höllnagel – discussed *How to Measure and Manage Systemic Potentials*. Professor Höllnagel discussed what management is, how to change an organization, and the types of information and measurements of managing. He provided insight on systemic potentials to respond to, learn from, anticipate, and monitor behavior. Systemic potentials can be used to show the current position of an organization and can also represent the goal or target. This measurement tool can generate a visual as-is versus to-be state.
- Pamela D. Whitley, FAA, Assistant Administrator for NextGen (Acting), discussed *Organizational Resilience in the FAA*. Ms. Whitley started by stating that we are all still connected via technology in spite of the 2020 pandemic. Community engagement is necessary to achieve acquisitions in the pipeline. Principles of V&V are being applied in new ways. Leadership crisis is one outcome of the pandemic, which forced many into this “crisis leadership” scenario. Limitations affected our everyday routine necessitating changes to the tools we use and how we engage with our teams. Leaders facilitate success of their organizations. Managers needed to shift approach to keep programs moving and ensure all personnel were doing well in the new paradigm. We had to readjust priorities to meet the challenges of the mission. Resilience is innate, but reinforced by training. Ms. Whitley expressed pride with how ANG has met the challenge of these times. Focus on people first. Meet their needs to carry on important work. New infrastructure continues to be deployed in support of NextGen objectives. This shift in personal and professional life presents us opportunities to grow.
  - Colonel Steven W. Speares, Chief, Air Force Test and Evaluation Policy, Programs, and Resources Division, United States Air Force Headquarters at Pentagon, presented *Diversity of Thought: How Black Swans Help Build a Resilient Test Culture*. Col. Speares examined the resilient practices applied and what was learned in last year’s summit, stating we have become more resilient in the Test Community as a result. The black swan event (like the pandemic) is a rare, unexpected event that drives large impacts. Black Swans illustrate how we handle unexpected events. It is the ability to get back up after being knocked down. Testing is not an “anchor” practice but a “stepping stone” practice. Cutting-edge technology is built from understanding complex systems. Ariane 5 launch failure led to a \$500M loss due to untested software and fault testing omitted due to its similarity with Ariane 4 platform. Mars Polar Landing mishap is another example in which underfunding led to design decisions that were not robust, and flight software was not subjected to fault testing. The unit crash landed when engines cutoff early in descent regime. Highly complex systems of today require a more robust test engine. Col. Speares used the standard “V” diagram to illustrate these points. There is no way to test everything. Hard things are hard to do. He discussed last year’s takeaways from the V&V Summit. What produces resilience like connections? The pandemic made new connections and methods necessary. We have moved away from a 50-year focus on platforms to platform-agnostic capabilities, emergent capabilities,

machine learning, and nondeterministic systems. These outcomes position us for the next decade. Change is inherent in everything we do and pushes us outside of our comfort zone. Finding the personnel with the skills to handle this paradigm is daunting. The COVID-19 black swan hit on Friday, the 13<sup>th</sup> of March 2020. Shutdowns and school closures become the new normal, including virtual school at the dining room table, shortages of necessities, and the list goes on. Air travel saw huge drops in enplanements. Understanding your Organizational Sphere of Influence became a must. Hindsight dictates that it should have been expected. The data were there but unaccounted for. Teleworking became the accepted way to do work safely, maintaining connections and adjusted our behaviors to meet our objectives. Cultural Resilience is humanity's capability to break down barriers and expand our knowledge. Culture Resilience = Competence + Confidence. Why were connections the key to resilience? Pasteur said, "Chance favors the prepared mind." An Apollo 12 system engineer made the call that saved the mission after the rocket was struck by lightning. General Brown, "Accelerate change or lose." Prepare for the next black swan; it can't be predicted.

- Dionisio de Niz, Ph.D., Principal Researcher and Technical Director, Assuring Cyber-Physical Systems, Software Engineering Institute, Carnegie Mellon University, presented *V&V for Autonomous and ML Enabled Systems*. Dr. de Niz discussed two perspectives: How Artificial Intelligence (AI) helps us to do software engineering and how we do software engineering. Challenges exist in both areas. Use AI to improve software development. Starting with AI for software engineering, first use AI techniques to construct the code, prevent errors and discover vulnerabilities. Can we detect the patterns in the model? Second, use AI for V&V of software engineering projects. Speculative techniques are in use in this domain. Actual experiments allow us to use Machine Learning (ML) techniques to test algorithms. What aspects of ML are a problem? Apply use of neural networks to train the system and the weights of the neurons to improve the result. Try to discover the processing engine attributes to train the ML, then move to an evolving ML maturity. Dr. de Niz presented two approaches to study V&V for trained ML as examples: Reluplex and Verisig. He described how each approach works, used a common drone problem as an example, showed how analysis was conducted, and plotted the results to demonstrate understanding of the problem.
- George Emilio, Director Aviation Research, Serco, Inc., presented *The Limitations of Risk Management (RM)*. Mr. Emilio spoke on the focus on Safety Risk Management and the context of resilience. He cited the 2008 financial downturn as an example of risk management and how it can go wrong (it worked great right up the point where it failed). In that financial crisis, the financial institutions seemed to only include themselves within their risk scope, excluding risks to their clients and partners. The financial sector had plenty of RM in place, but no Resilience Management. He highlighted three areas to address with RM: dubious math application to RM, language of probability, and cognitive biases. RM is not safety. Mr. Emilio used Monte Carlo simulations to illustrate the first point. He talked about the FAA's Flight Risk Assessment Tool, identified issues with how to score on an ordinal scale, and examined accident statistics to illustrate probable risk scenarios. He used a medical test to illustrate RM, it is instructive to understand Hazard Identification (most are false alarms). He also introduced Prospect Theory, risk tolerance is nonlinear and is cognitively biased. It is subjective and that is how the cognitive bias enters the equation.

- Jennafer Miller, PMP, Principal for Community Engagement, Evans Consulting, presented *Building Organizational Toolkits for Resiliency in Action*. Ms. Miller introduced the Mentimeter polling tool used during her presentation, illustrated its use, and demonstrated how a manager might use it to gain insight into the people of an organization and its performance, especially during change. Ms. Miller noted that developing resilience is a process. What are the elements of organizational resilience? Overcoming obstacles are a key to resilience. Obstacles are inevitable. Resilience and engagement is another element. Transition out of the risk environment and learn what the next step of engagement is. Teamwork is essential to success, having shared values, and being innovative and resilient. Building your Resilience Toolkit means knowing “when to hold ‘em and when to fold ‘em” associated with the idea of nonreactivity (keeping a poker face). Connection is made through engagement with your team. Some people report having Zoom (meeting) fatigue. Reframe a negative, turn it positive, and don’t forget to breathe.

Finally, Ms. Miller explained that a **Resilience Forum** has been established and is accessible from the V&V Summit website. There you can share what you do to keep your team resilient in the coming year. Results will be shown at the next Summit.

The speakers at this year’s Summit addressed the Resiliency theme by stressing adaptability, connectedness, communication, mitigation of risk, and innovation. Main takeaways are as follows:

1. Resilience is critical in a VUCA world: Volatile, Uncertain, Complex, Ambiguous.
2. Resiliency is the ability to bounce back and recover from a global pandemic, cope with setbacks, keep going in the face of adversity, adapt to change, thrive and not just survive, innovate from adversity, and bounce forward.
3. To increase resilience we must learn from the past, optimize connections, anticipate change, take risks, use risk-based thinking, and establish rules (checks and balances). Nothing produces resilience like connections.
4. Organizational Resilience is a balancing between behaviors that are defensive (stopping bad things happen) and those that are progressive (making good things happen), as well as between behaviors that are consistent and those that are flexible.

All FAA participants who attended both days at this year’s V&V Summit received FAA eLearning Management System (eLMS) credits. V&V Summit feedback forms will be assessed to improve future summits. The 15<sup>th</sup> Annual V&V Summit presentations, final agenda, video links, survey results, and pictures are located at:

[http://www.faa.gov/about/office\\_org/headquarters\\_offices/ang/offices/tc/library/v&vsummit/v&vsummits.html](http://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/library/v&vsummit/v&vsummits.html)