Clean-Fuel e-VTOL Air Mobility Vehicles for Unmanned and Manned Operations

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The Future of Air Mobility Vehicles and Services and The Implications for Training Systems

Dr. Bruce J. Holmes, Larry D. McCarroll, Henry Vu, Bruno T. Villela, and Brian D. Morrison
How Will We Train?

Then: We could not go far enough – Now: We can.
Strategic Context for Aeronautics Innovation

Public Value Proposition (The Outcome)

Demand for Solutions (The Pull)

Converging Technologies (The Push)
On-Demand Mobility (ODM) Vision
Urban and Thin-Haul Regional Distribution of People and Goods
http://www.nianet.org/ODM/roadmap.htm

Vision for On-Demand Mobility:

“... air transportation for anyone, from here to there, anytime, anywhere ...”

• An Hypothesis: Widespread public use of ODM supports transformative increases in U.S. productivity.

Enabled by:
• Electric Propulsion
• Connectivity
• Automation and Autonomy

“The convergence of technologies, and new business models enabled by the digital revolution, is making it possible to explore this new way for people and cargo to move within our cities.”

... Jaiwon Shin, NASA’s Associate Administrator for Aeronautics Research.
Unprecedented Innovation Landscape

- Globally, more than 40 aircraft development projects underway.
- Urban Air Mobility (e.g., Uber Elevate) - UAM
- Regional (Thin Haul) On-Demand Mobility
- Regulatory transformation underway
- Public value proposition includes vastly increased connectivity among virtually all markets.
- Investments in $Billions

Norway aims for all short-haul flights to be 100% electric by 2040. The Guardian.

August 13, 2018
Connectivity for Aviation Innovation

*and implications for crew training*

**V2V**
Vehicle-to-Vehicle for Sense and Avoid, Trajectory Separation, “WAZE” for Pilots

**V2ANSP-FOC**
Vehicle to Air Navigation Service Provider (ATC) and Flight Operation Center (Dispatch), Machine-to-Machine

**C2**
Command and Control to enable Beyond Visual Line of Sight (BVLOS) for UAS, Remote Pilot Operations

**V2Cloud Services**
Streaming Data on Return Link for Total Aircraft System Prognostics and MRO Optimization

These connectivity solutions create a new capabilities and new challenges for operations, crew training, and proficiency maintenance.
Connected Aviation – Feature Innovation Landscape

- Digital Twin
- Supersonic Trajectory Management
- Wake Hazard Avoidance
- Cost Index without an FMS
- Software and operating system updates
- Smart Airports
- Runway Incursion Mitigation
- Graphical METARs, TAFs, IFR Clearances and Releases
- “Waze” for Pilots

These candidate innovations demand training strategies.
What pilot functions might be more reliably performed through autonomy or through off-board applications (remote or optionally piloted)?
Simplified Vehicle Operations Roadmap & Candidate Outcomes

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- **Reliability**
- **Safety**
- **Cost**

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Summary Remarks

• How Will We Train?
• How Will ‘How We Train’ Drive Innovation in Aircraft, Airports, Airspace Systems?