

NASA Advanced Air Mobility Vehicle Research

Noah H. Schiller
Project Manager, Revolutionary Vertical Lift Technology
The Vertical Flight Society's 81th Annual Forum & Technology Display
May 20, 2025

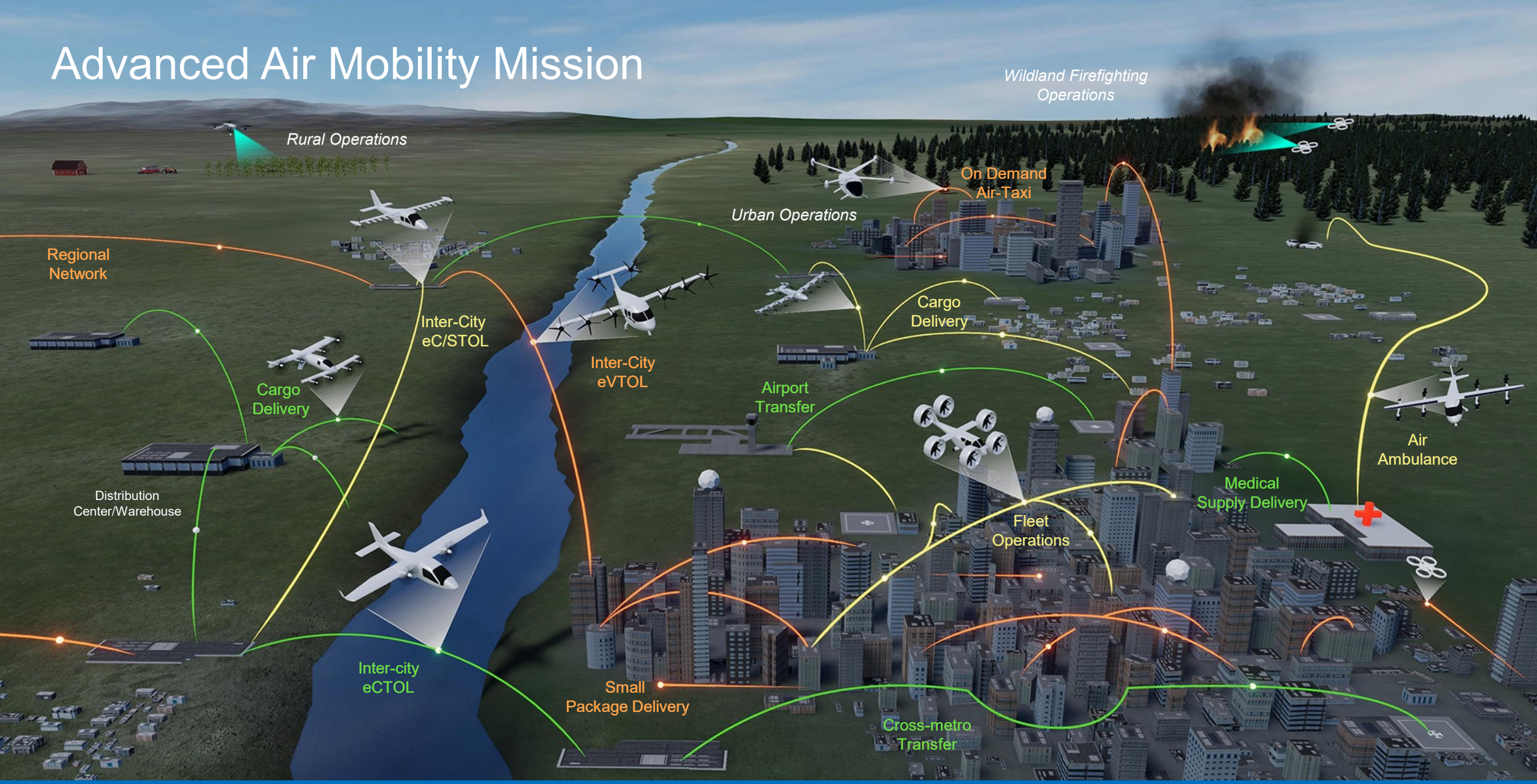

ULTRA-EFFICIENT AIRLINERS


FUTURE AIRSPACE AND SAFETY


HIGH-SPEED COMMERCIAL FLIGHT


ADVANCED AIR MOBILITY

Advanced Air Mobility Mission



Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

www.nasa.gov/aam







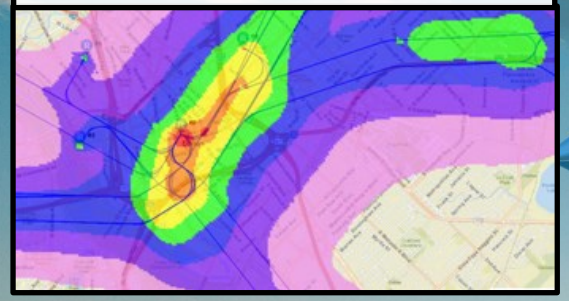


NASA Projects Supporting AAM

- Air Mobility Pathfinders (AMP)
- Airspace Traffic Management Exploration (ATM-X)
- System-Wide Safety (SWS)
- Advanced Capabilities Emergency Response Operations (ACERO)
- Revolutionary Vertical Lift Technology (RVLT)
- Flight Demonstrations & Capabilities (FDC)
- Transformational Tools & Technologies (T^3)
- Convergent Aeronautics Solutions (CAS)

Revolutionary Vertical Lift Technology Research

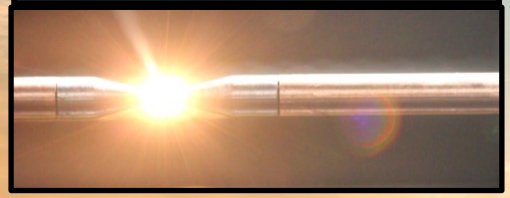
Acoustics - Community Response



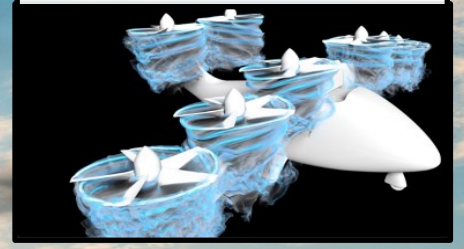
Conceptual Design



Electric Propulsion



High-Fidelity Simulations



Crash Safety



Passenger Ride Quality



Piloted Handling Qualities



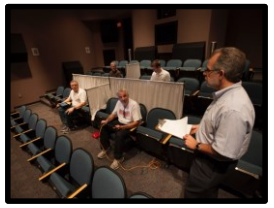
Validation Tests



Investing in the future of advanced vertical flight

Focus Area: Acoustics – Community Response Survey Preparation

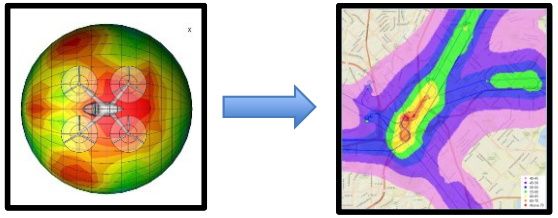
Psychoacoustic Testing

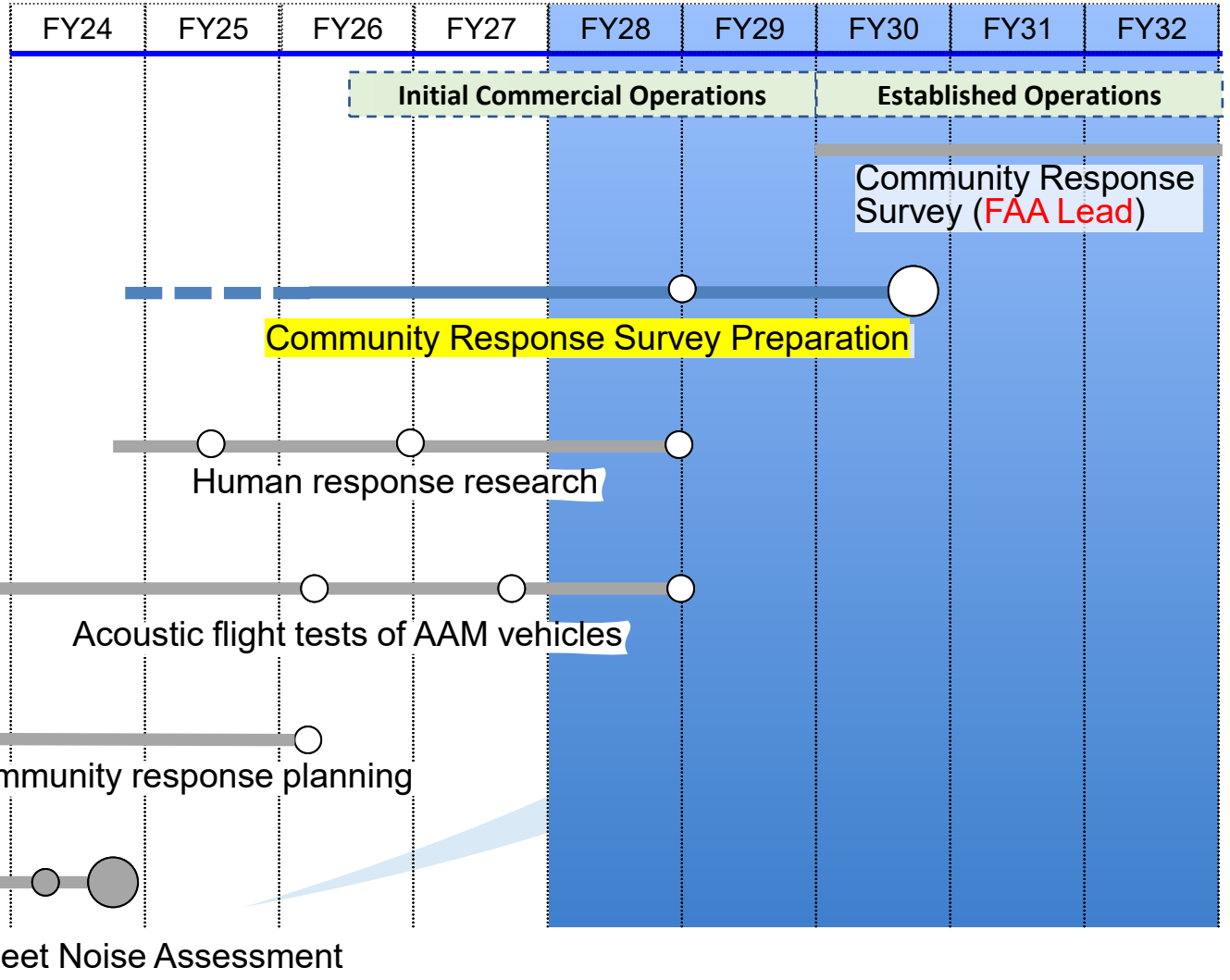


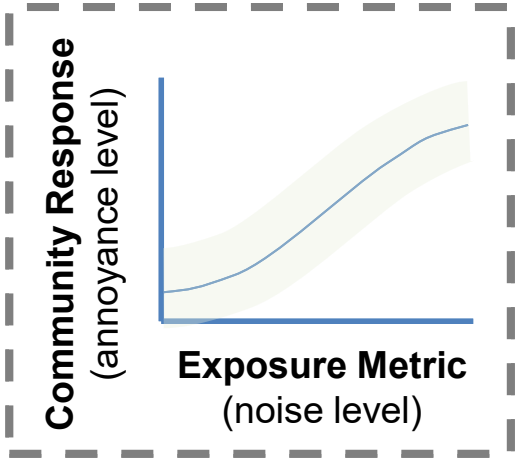
Acoustic Flight Tests



Noise Prediction







Notional AAM Exposure-Response Curve

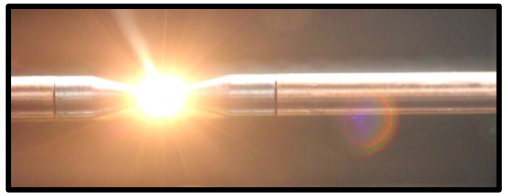
Laying the groundwork for future AAM community response surveys by developing tools, methods, and metrics to quantify the exposure-response relationship for AAM vehicles

Focus Area: Electric Propulsion

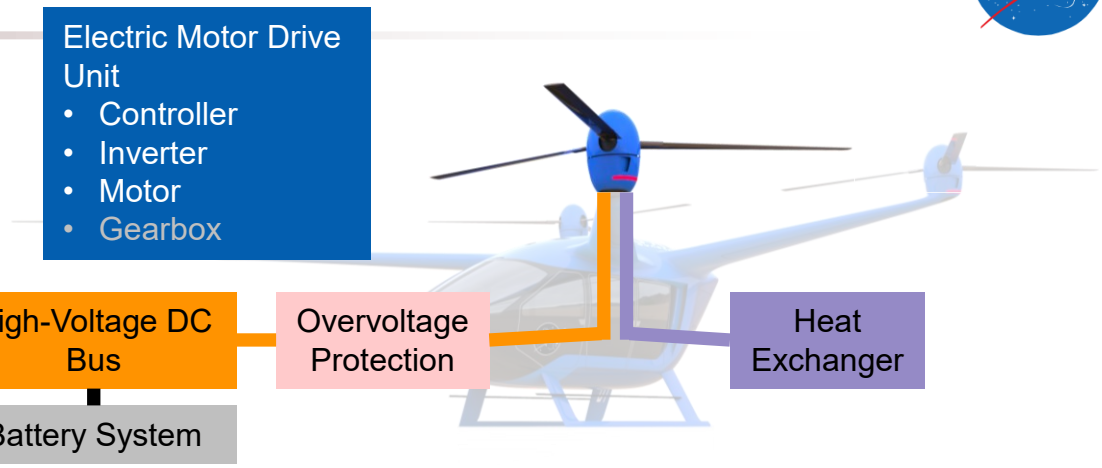
Objective: Deliver design-and-test guidelines, data, and technologies to improve electric propulsion system safety and reliability

Status:

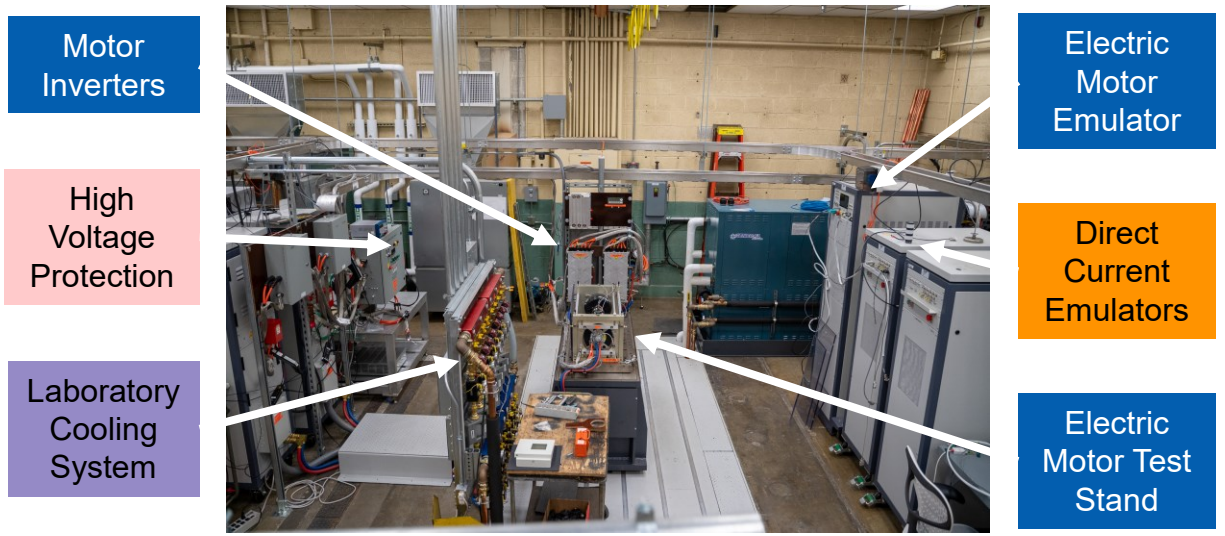
- Developed powertrain **reliability models** and design guidelines for reliable electric machines
- Built and evaluated advanced **fault tolerant modular electric motor demonstrator** with the University of Wisconsin
- Delivered high power data to validate models and inform standards using the Advanced Reconfigurable Electrified Aircraft Lab (200 kW, 800 VDC bus)
- Released modeling toolsets for electric propulsion
- Leading **consensus standards development** of High Voltage Power Quality SAE AS-7499 and Permanent Magnet Motor Performance SAE AS-8441 standards
- Conducting **common mode failure investigation** with industry partners
- Developing **arc fault detection** algorithms



Electrical Arc



Advanced Reconfigurable Electrified Aircraft Lab (AREAL)



Delivering data to improve electric propulsion system safety and reliability

Focus Area: Crash Safety

Objective: Deliver data to inform eVTOL standards development, along with test guidelines, modeling best practices, and vehicle technologies for crash mitigation

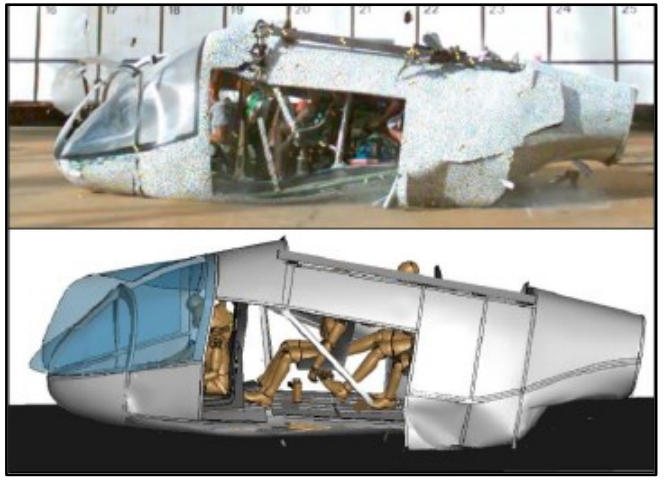
Approach

- Conduct full-scale and component level tests
- Develop test guidelines, modeling best practices, and vehicle technologies for crash mitigation
- Deliver crash and impact data to consensus standards organizations

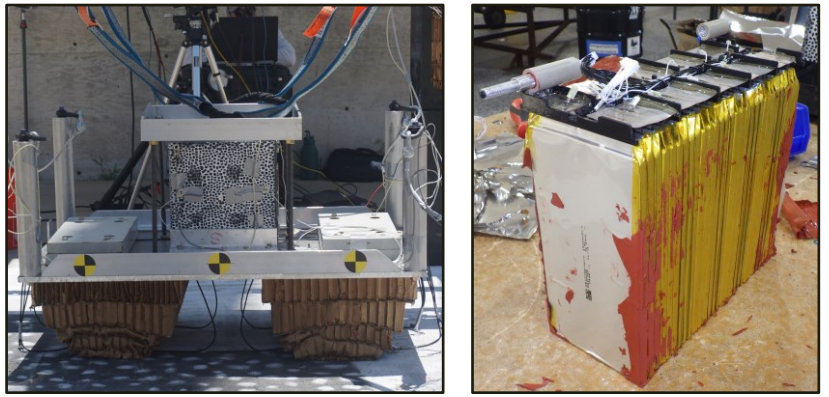
Status

- Updated cabin impact simulations in preparation for a **second full-scale drop test this summer**
- Continued developing and testing energy absorbing structures to reduce occupant injury risk
- Developed a **bird strike impact test method**, SAE AS-7254, recently approved and submitted for publication
- Conducted 50-ft **drop tests of deenergized battery modules** and post-test forensic inspections to assess likelihood of thermal runaway

Delivering data and technologies to improve occupant safety



Cabin Impact Test and Model Correlation



Battery Module Drop Test

Focus Area: Handling and Ride Qualities

Objective: Deliver handling and ride qualities (HQ and RQ) guidelines and flight dynamics and control modeling tools for UAM vehicle design

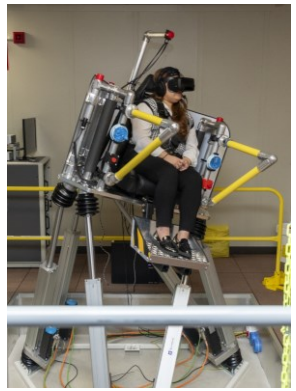
Approach

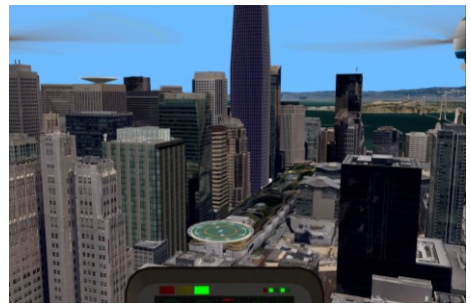
- Conduct human subject testing to assess handling and ride qualities
- Establish handling and ride qualities guidelines for UAM vehicles
- Develop flight dynamics and control modeling tools for conceptual design

Status

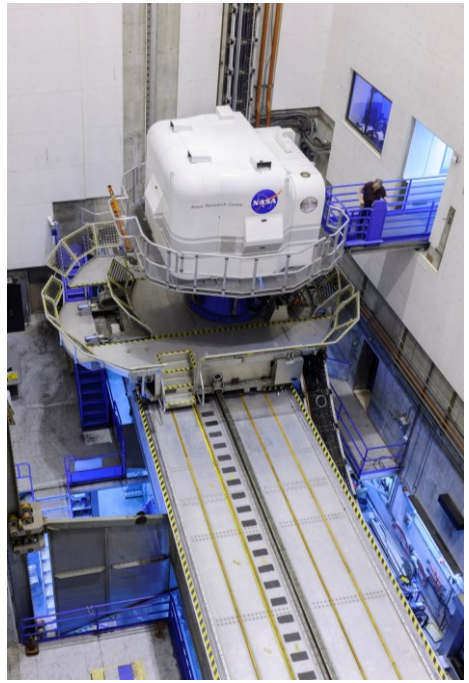
- Analyzed results of a **handling qualities test in the Vertical Motion Simulator** of an eVTOL with a degraded powertrain
- **Developed real-time powertrain models** for handling qualities tests
- Preparing for second Vertical Motion Simulator test in March of 2026
- Completed first **UAM passenger study in the Ride Quality Laboratory** combining virtual reality and 6DOF motion base
- Collected cabin noise and vibration stimuli from a pre-production eVTOL prototype – subsequent ride quality study is being planned
- Evaluating and preparing Flight Dynamics and Control Modeling Tool for Conceptual Design (FlightCODE) for public release

Developing validated handling and ride quality recommendations





Ride Quality Laboratory



VMS cab exterior



VMS S-cab interior



Quadrotor after departing vertiport

Focus Area: Validated Design and Analysis Tools

Objective: Deliver a validated and documented set of tools for assessing tradeoffs between the noise and performance for UAM aircraft

Approach

- Plan and conduct a series of benchmark tests
- Share data for tool validation
- Improve the efficiency and accuracy of conceptual design and analysis tools

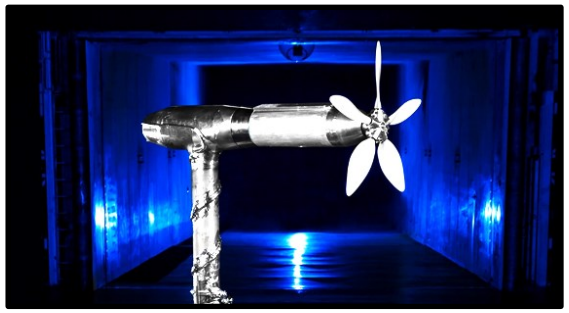
Status

- **Hover validation test** data released including thermography, particle image velocimetry, blade pressure, and updated airloads https://rotorcraft.arc.nasa.gov/HVAB/
- **Multirotor Test Bed #2 Test** data processed and released; preparing for acoustic testing
- **Tiltwing Test Rig** performance testing began in the 14- by 22-ft tunnel this month, acoustic testing planned for next year
- **Outwash Test Rig** checkout testing completed, preparing for outdoor testing later this month, dual rotor testing this summer
- **Propeller Noise Test** will begin this summer

Acquiring and sharing validation data relevant to new eVTOL configurations



Tiltwing Test Rig before testing in the 14- by 22-ft Subsonic Tunnel



Propeller in the 14- by 22-ft Subsonic Tunnel



Multirotor Test Bed in the U.S. Army 7- by 10-ft Wind Tunnel



Outwash Test Rig before testing at the Outdoor Aerodynamics Research Facility

Focus Area: Validated Design and Analysis Tools

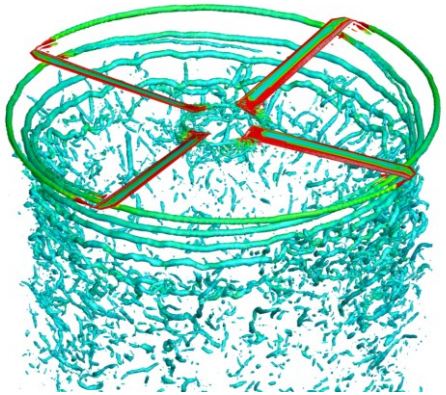
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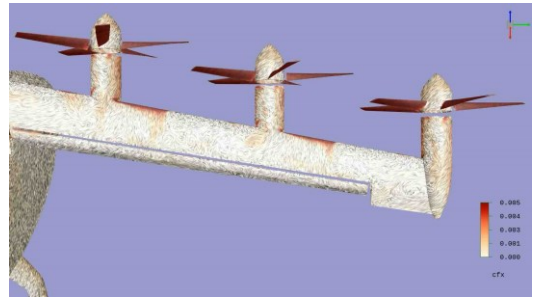
- **Improving accuracy and efficiency** of flow solvers (OVERFLOW and FUN3D)
  - Improved computational efficiency and scaling performance with a focus on emerging HPC architectures (GPU)
  - Improved coupling with other rotorcraft analysis tools including comprehensive analysis and acoustic codes
- Developing tools to **automate overset structure grid generation** to reduce the time from conceptual design to CFD simulations
- **Assessing accuracy of hover predictions** by comparing coupled CFD/CSD simulations with Hover Validation Test data
- Continuing support and development of the NASA rotorcraft design and analysis tool (NDARC), which includes example models of multiple NASA UAM concept aircraft
- Incorporating new capabilities within the NASA acoustics tool ANOPP2, including a simulation tool to simplify the calculation of noise power distance data for fleet noise assessments



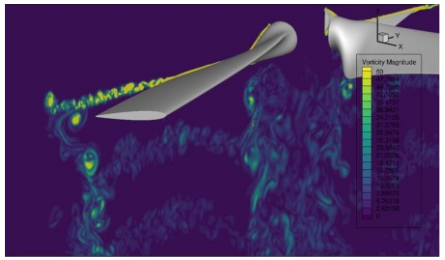
Automatically-generated overset structured meshes

Hover prediction for comparison with recent measurements

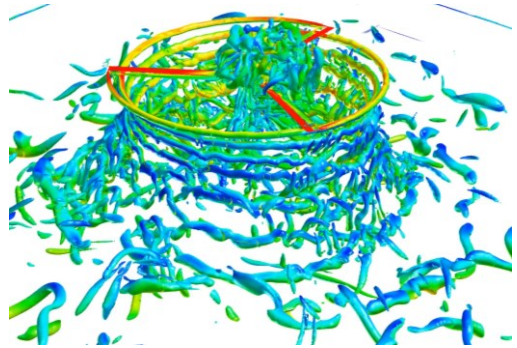




Skin friction coefficient on the tilt-wing vehicle in transition



Vorticity contours on isolated propeller



Outwash prediction for a hovering rotor in ground effect

Streamlining tools to enable faster and more accurate predictions

Summary

- NASA Aeronautics is focused on ultra-efficient airliners, future airspace, high-speed commercial flight, and Advanced Air Mobility

- RVLT is focused on providing tools and technologies to improve next-generation vertical lift vehicles to support continued growth of the Advanced Air Mobility market

