


# UAS Automation & Intelligent Systems

*A11L.UAS.61*

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# Categorizing UAS Integration Research: Research Informs Operational Capabilities

**UAS Operations Today**

- *Part 107*
- *UAS Waivers to Part 107:*
  - *Night Operations*
  - *Operations Over People*
  - *BVLOS Operations*
  - *Operations above 400'*
  - *Operations from a Moving Vehicle*
- *Part 135 Operations*
- *UTM Pilot Program (UPP)*
- *Integration Pilot Program (IPP)*
- *Partnership for Safety Program (PSP)*
- *UAS Low Altitude Authorization & Notification Capability (LAANC)*
- *Exemptions*
- *UAS COAs*
- *Experimental Certificates*

**Research + Operations = Rules**


***Detect and Avoid***

***UAS Traffic Management (UTM)***

- ***UAS Remote Identification***
- ***UAS Low Altitude Authorization & Notification Capability (LAANC)***
- ***Dynamic Airspace Management***

***Standards***

***Policy***

***Rules***

***Enablers***

- *Supports **UAM/AAM** vehicle design and flight characteristic development for <u>several</u> operational capabilities*
- *Defines necessary flight handling design considerations and flight test strategies for policy development of UAM/AAM vehicles.*

# Research Purpose

- First step in to **develop a long-term automation strategy** to work towards approval of UAS intelligent systems.
- The intent is to **identify considerations for certification**, including general human factors, flight test strategies, and flight envelope design for UAS/eVTOL vehicles.
  - The *design features and architectures* identified will provide input to the traditional certification processes for automatic flight path control and flight critical systems.

# Background

- This R&D will look at the state-of-the-art of automation and intelligent systems to move towards identifying mitigations, both in terms of software standards and human factors considerations for UAS.

| Statistics of Automation Failures and Considerations for Premise of Research: | | | |
|---|---|---|---|
| 44% of accidents and 44% of major incidents was attributed to automation behavior that was unexpected and unexplained | Approximately 33% of accidents and 22% of major incidents was because the pilots' understanding of automation was inadequate | Approximately 15% of accidents and 20% of major incidents was the result of automation that was too complex | 25% of accidents and 23% of major incidents were attributed to automation that lacked reasonable functionality |

# Legislative Direction

- Research supports:
  - Findings in the *Final Report of the Performance-based operations Aviation Rulemaking Committee/Commercial Aviation Safety Team Flight Deck Automation Working Group (2013)* stated that automated systems may need additional standardization and policy guidance.
  - Supports the development of regulations, system safety policy, and certifications processes for approving automation systems in UAM/AAM/UAS aircraft.
  - Helps in closing the gap in affordable technology and encourages flight control guidance that is currently not covered by 14 CFR 2X.1329 and 2X.1309.

# Projected Benefit of Research

## Policy

- Regulatory Process and Guidance for Aircraft Certification and Operational Approvals: Improve the regulatory processes and guidance for aircraft certification and operational approvals, especially for new technologies and operations, to improve consideration of human performance and operational consequences in the following areas:
  - Changes to existing flight deck design through Supplemental Type Certificates (STCs), Technical Standard Orders (TSOs), or field approvals, and
  - Introduction of new operations or changes to operations, to include implications for training, flightcrew procedures, and operational risk management.

## Concept Development

- Flight Deck Design Process and Resources: Ensure that appropriate human factors expertise is integrated into the flight deck design process in partnership with other disciplines with the goal of contributing to a human-centered design.

# Research Approach

- **Research was originally split into three tasks, but the project was re-scoped in FY19 to include only one task.**
- **Task 1:** Investigate human factors issues and automated system certification challenges on Vertical Take-off and Landing (VTOL) aircraft. Specifically, investigate pilot vehicle and control station interface while performing a confined area vertical take-off and landing from both prepared and unprepared surfaces. This includes the development and execution of one or more related experiments.

# Research Team & Level of Effort

- Sponsor
  - Sabrina Saunders-Hodge, AUS-300
- FAA Co-Sponsor:
  - AIR-301 (POC: David Sizoo)
- Research Partners:
  - ANG-E271 (POC: Robert McGuire)
  - NASA (POC: Michael Feary)
- Primary Technical Monitor
  - Evelina Bern, AUS-310
- Secondary Technical Monitor
  - Katie Constant-Coup, AUS-310
- ANG-C2 PM
  - Philip Maloney, ANG-C35

# Status

- Phase I of Research is complete:
  - Develop prototype novel V/STOL aircraft pilot interface integrated into a Flight Deck Z part task simulator software (10/25/2019)
  - Develop initial Matrix of Test Maneuvers for interface concepts for initial pilot testing. (12/20/2019)
  - Refine the V/STOL aircraft pilot interface test matrix for pilot usability testing in the Vertical Motion Simulator (03/25/2020).
  - Evaluate the integrated concept and provide feedback after successful integration of V/STOL simulation with representative display, control and interceptor concepts (05/25/2020)
  - Conduct Study 1 and report on collection & analysis of data (Study completed on 06/24/2021)
- Phase II of research started is underway; Phase II Includes:
  - Develop novel V/STOL aircraft pilot interface in medium fidelity simulator for industry representative eVTOL aircraft.
  - Conduct Study 2 and report on collection & analysis of data

# Key Accomplishments to Date

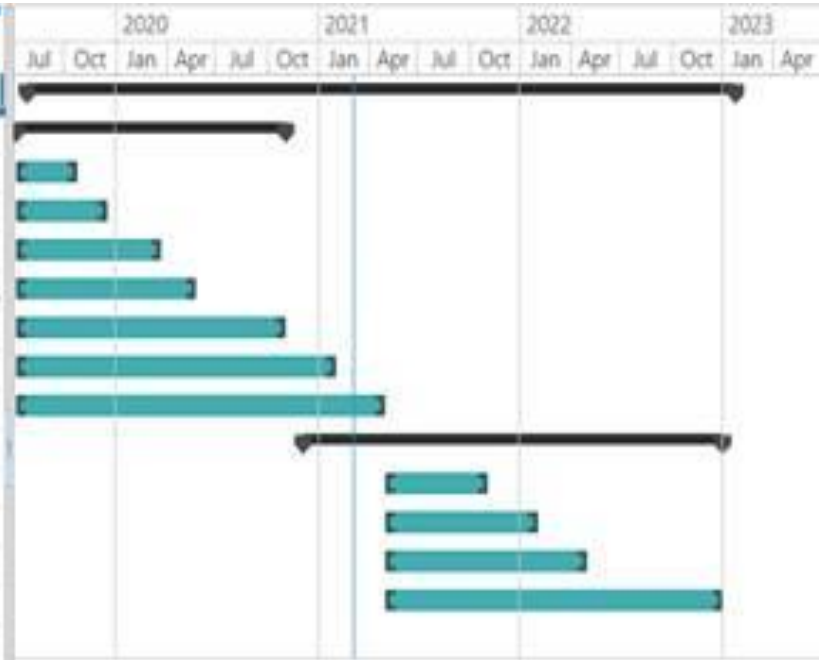
- Prototype novel V/STOL aircraft pilot interface integrated into a Flight Deck Z part task simulator (10/25/2019)
- Initial Matrix of Test maneuvers for interface concepts for initial pilot testing (12/20/2019)
- Refined V/STOL aircraft pilot interface test matrix for pilot usability testing in the Vertical Motion Simulator (03/25/2020)
- Completion of Study 1 (06/24/2021)

# Future Plans

- Prepare for Study 2 using VMS capability and Refined Test Matrices:
  - NASA is presently planning the scheduling/availability of NASA laboratories to conduct HITL studies using the developed Vertical Motion Simulator (VMS) capability

# Master Schedule

| Name |
| --- |
| Automation and Autonomy |
| Project Phase 1 |
| Prototype novel V/STOL aircraft pilot interface integrated into a Flight Deck Z part task simulator software |
| Initial Matrix of Test maneuvers for interface concepts for initial pilot testing. |
| Refine the V/STOL aircraft pilot interface test matrix for pilot usability testing in the Vertical Motion Simulator (VMS). |
| Evaluate the integrated concept and provide feedback after successful integration of V/STOL simulation with representative display, control and interceptor concepts. |
| Report on collection and analysis of data from the VMS Pilot Usability study. |
| Draft technical report at the completion of Phase 1 |
| Deliver final technical report after comment and review. |
| Project Phase 2 |
| Novel V/STOL aircraft pilot interface in medium fidelity simulator for industry representative eVTOL aircraft. |
| Study 2 maneuver, vehicle and interface concept test matrix |
| Implementation of novel V/STOL aircraft pilot interface concept(s) in Vertical Motion Simulator (VMS) |
| Draft Technical Report and a Final Technical Report including summary of Study 2 data collection and analysis |



# Challenges and Risks

- Laboratory Availability
  - NASA laboratories have limited access during the COVID-19 pandemic and scheduling time for a study has been challenging.

- Long Period of Performance

# Questions?