# **REDAC / Human Factors**



Name of Program: NextGen Air Ground Integration Human Factors BLI Number: 111110 Presenter Name: Dr. Victor Quach

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# Review of FY 2021 - 2024 Proposed Portfolio

# **NextGen Air/Ground Integration Human Factors Overview**

# **Program Scope**

• This program addresses research, engineering, and development requirements defined by technical sponsors in the Aviation Safety Organization (AVS). Requirements are driven by the intersection points between FAA policy documents, NextGen changes, and enabling flight deck technologies and procedures

# **FAA Benefits**

- Program outputs are transferred to AVS technical sponsors to develop and maintain, as appropriate, human factors-related rules, guidance, procedures, Orders, standards, job aids, and other materials
- Work products benefit Aircraft Certification and Flight Standards personnel who evaluate and approve emerging aircraft systems (e.g., displays, devices, controls), procedures, and operations which may not be covered by existing human factors documentation

#### **Measures of Success**

- 1. Sponsor Satisfaction did the research meet AVS's needs?
- 2. Access to Research is there sufficient awareness/access to results?
- 3. Application of Results did the research support or inform a data-driven decision?
- 4. NextGen Benefits how did the research contribute to safety, capacity, and/or efficiency?

# NextGen Air/Ground Integration Human Factors Program Managers and Researchers

#### **Program Managers**

- Tara Holmes, Division Manager (Tara.Holmes@faa.gov)
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- Dr. Bill Kaliardos (Bill.Kaliardos@faa.gov)
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## **Researchers and Laboratories**

- FAA Civil Aerospace Medical Institute
- FAA William J. Hughes Technical Center
- NASA Ames Research Center, NASA Langley Research Center
- Volpe National Transportation Systems Center, DOT
- MITRE Corporation
- Honeywell
- University of Central Florida
- University of Michigan

# NextGen Air/Ground Integration Human Factors Accomplishments in FY21

Project	Description/Product		
NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots			
HF Recommendations to Address Flightpath Management System Dependencies (training)	Developed a technical report which includes results from domestic/international airline interviews about policies/procedures operators have implemented to address manual flight operations (MFO), Flight Operations Quality Assurance (FOQA) data measuring MFO occurring in line operations, and a breakdown of manual flight maneuvers into tasks and their associated knowledge and skills.	MITRE	
Human Factors for Aircraft Systems, Displays, and Controls			
Human Factors Evaluation of Low Energy Alerting and Awareness Technologies (display and controls)	Final report describing preliminary results of HITL simulation which examined the contribution of prototype displays to pilot awareness and response to low energy events, high energy events, and loss of control scenarios (i.e., predictive information, alerts, recovery guidance, etc.). Research could help address requirements introduced by CAST SE-207 (Safety Enhancement – 207 Attitude and Energy Awareness Technologies), and to develop initial human factors evaluation criteria for future flight deck technologies.	NASA Langley	
Human Factors Considerations for Electronic Data-Driven Charts (Flight deck systems)	Final report with human factors considerations applicable to the design of electronic aeronautical charts, including whether a minimum set of information elements could be defined for these customizable electronic charts.	CAMI	
Human Factors for Advanced Airspace Procedure Design and Use			
Human Factors Recommendations to Address the Flight Deck Impact(s) of Procedure-Based Concepts	Developed a human factors research plan to examine the human factors aspects of flight operations that occur between the termination point of an arrival and an instrument flight procedure (vectors, direct-to, etc.), including challenges related to mixed navigation source transitions (conventional, PBN)	Volpe	

# NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots Research Requirement Overview

#### Objective

- Provide research data to support the NextGen human factors needs of FAA personnel who evaluate, approve, and oversee new NextGen air carrier pilot training and qualification programs, operations, and procedures.
- Identify air carrier pilot task, skill, and proficiency needs for the operational use of next generation aircraft systems, avionics equipment, and procedures.

#### How Results are Used

- Inform FAA personnel who develop evaluation criteria for pilot tasks and skills, and incorporate this information into human factors – related regulations, guidance material, procedures, standards, job aids, and other documentation to support the safety and efficiency of current & future flight operations
- In the field, criteria are used by Flight Standards (AFS) personnel to evaluate air carrier training and qualification programs for pilots using new NextGen equipment, operations, and procedures.

- Flightpath Management Systems Dependencies (manual flight operations) Research
- Air Carrier Pilot Cognitive Skills Research
- Training and Evaluation Techniques for Flightcrew Monitoring Tasks

## NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots On-going research in FY22+

Project	Description/Product	Vendor	Est. Completion
Manual Flight Ops – Low Altitude Terminal Operations	Evaluate the current state of low-altitude manual flight operations (MFO) in the NAS, and how industry maintains/evaluates MFO skill proficiency. Examine the potential impact of flight guidance system and flight control system dependencies to baseline MFO tasks, and the potential impact of NextGen changes to MFO practice opportunities in future line operations.	MITRE	FY22 Q2
Cognitive Skill Degradation – Verification and Validation	Baseline the cognitive skills and knowledge required to complete flightpath management (FPM) tasks in current Part 121 operations, including the use of automated systems to complete FPM-related tasks.	Honeywell	FY22 Q2
Techniques to Evaluate Monitoring Training and Monitoring Performance <i>(Planned)</i>	Identify a range of viable methods/techniques which could be used to evaluate flight deck monitoring training and to evaluate monitoring performance during flight operations, including a subset of methods potential methods for verification and validation.	NASA AMES	FY22 Q4

## NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots Potential Program Plans (FY21 – FY23+)

\* Indicates research builds upon on a project within the current portfolio

- Flightpath Management Systems Dependencies (manual flight operations) Research\*
- Air Carrier Pilot Cognitive Skills Research \*
- Training and Evaluation Techniques for Flightcrew Monitoring Tasks\*
- Pilot Training and Evaluation Needs for Diverse Flight Operations / Extensible Air Traffic Management Services
- Identification of Pilot Knowledge, Skills, and Abilities Impacted by Advanced Technologies and Procedures, including Trajectory Based Operations (TBO)



# NextGen Human Factors for Aircraft Systems, Displays, and Controls Research Requirement Overview

#### Objective

• Provide research data to support the NextGen human factors needs of FAA personnel who evaluate and approve emerging aircraft systems, displays, and controls, including their intended function and operation.

#### How Results are Used

- Inform FAA personnel who develop and maintain human factors related regulations, guidance material, procedures, standards, job aids, and other documentation to support the safety and efficiency of current & future flight operations
- In the field, criteria are used by Aircraft Certification (AIR) personnel to evaluate and check for human factors
  installation and operational integration issues that could arise when introducing or combining next generation aircraft
  changes with current systems, displays, controls, and their respective mode(s) of operation.

- Aircraft Display Features and Functions for Integrated NextGen Flight Operations
- Multifunction Aircraft Controls with New Methods of Operation



# NextGen Human Factors for Aircraft Systems, Displays, and Controls

### **Ongoing Research and Anticipated in FY21+**

Project	Description/Product	Vendor	Est. Completion
Validation of CDTI Display Features in a Metered and Non-Metered Environment – Dependent Staggered Approaches (DSA)	Final report describing results of a HITL simulation to evaluate various implementations of the minimum CDTI display requirements, defined by RTCA SC-186 WG4, for IM DSA flight operations in a metered and non-metered Terminal environment.	MITRE	FY21 Q4
Human Factors Considerations for Multi- Modal Controls (Combined Controls) – Fixed Wing	Final report describing the results of a HITL simulation which examined the human factors aspects of multi-function aircraft controls; specifically multi-touch touchscreen controls and voice activated/recognition controls.	Honeywell	FY21 Q4
Human Factors Considerations for Multi- Modal Controls (Speech Controls) – Rotorcraft <i>(Planned)</i>	Examine the human factors aspects of multi-function aircraft controls; specifically speech recognition controls and speech activated controls during single and dual pilot flight operations in a rotorcraft.	Industry	FY22 Q4

## NextGen Human Factors for Aircraft Systems, Displays, and Controls Potential Program Plans (FY21 – FY23+)

\* Indicates research builds upon on a project within the current portfolio

- Aircraft Display Features and Functions for Integrated NextGen Flight Operations\*
- Multifunction Aircraft Controls with New Methods of Operation\*
- Novel Control Inceptor Design and User Interactions
- Configurable Devices for Information Automation Systems
- Prototype Airplane State Awareness Technologies



#### NextGen Human Factors for Advanced Airspace Procedure Design and Use Research Requirement Overview

#### Objective

• Provide research data to support the NextGen human factors needs of FAA personnel who evaluate, approve, and oversee pilot procedures and flight deck operations for performance – based navigation (PBN) procedures.

#### How Results are Used

- Research data will inform FAA personnel who develop and maintain the human factors portions of PBN-related regulations, guidance material, procedures, standards, job aids, operational evaluation criteria and other documentation to support the safety and efficiency of current & future flight operations
- In the field, human factors criteria and evaluation methods support Flight Standards (AFS) personnel who evaluate the:
  - Design of PBN procedures to ensure they can be flown safely (e.g., flyability bank angle, airspeed, climb/descent gradients, workload issues, procedure complexity, runway alignment, etc.)
  - Documentation of PBN procedures (charting)
  - Complete other activities that support instrument flight procedure validation.

#### **Current Research Portfolio Topics**

 Flight Deck Human Factors Impacts of Procedure – Based Concepts, including Established on Required Navigation Performance (EoR) and Multiple Airport Route Separation (MARS)

#### NextGen Human Factors for Advanced Airspace Procedure Design and Use Ongoing Research through FY21+

Project	Description/Product	Vendor	Est. Completion
Flight Deck Impacts of Procedure- Based Concepts, including Established on Required Navigation Performance (RNP) and Multiple Airport Route Separation (MARS)	Conduct an analysis to understand current-day flight deck human-system integration issues related to PBN, and opportunities to prevent these issues from resurfacing in future procedure-based concepts with a PBN dependency.	Volpe	FY22 Q2

# NextGen Human Factors for Advanced Airspace Procedure Design and Use Potential Program Plans (FY21 – FY23+)

\* Indicates research builds upon on a project within the current portfolio

#### **Planned Research Portfolio Topics**

 Flight Deck Human Factors Impacts of Procedure – Based Concepts, including Established on Required Navigation Performance (EoR) and Multiple Airport Route Separation (MARS)\* - expansion to additional sites / flight operations



# NextGen Human Factors for Error and Complex Systems Research Requirement Overview

#### Objective

- Provide research data to support the NextGen human factors needs of FAA personnel who evaluate, approve, and
  oversee new NextGen technologies and equipment, pilot training and qualifications programs, flight deck operations,
  and pilot procedures.
- Understand how next generation aircraft systems, operations, and procedures will impact the role of air carrier pilots and the expectations placed on them.

#### How Results are Used

 Inform FAA personnel who develop and maintain human factors – related regulations, guidance material, procedures, standards, job aids, and other documentation (evaluation criteria) to support the safety and efficiency of current & future flight operations

- Resilience
- Human-System Safety / Human Factors Risk Assessment Methods
- Advanced Pilot Air Traffic Interactions
- Mitigations to Address Flight Deck Information Management Vulnerabilities (relates to past REDAC recommendation)

# **NextGen Human Factors for Error and Complex Systems**

### **Ongoing Research and Anticipated in FY22+**

Project	Description/Product	Vendor	Est. Completion
Pilot Response to Unexpected Events	Conduct an analysis to provide efficacy data on potential training interventions which could promote resilient behavior during unexpected events.	University of Central Florida	FY22 Q1
Human-System Safety / Human Factors Risk Analysis Method Alternatives	Evaluate and document current-day methods used by the FAA and other high-risk industries to factor and include human performance in safety assessments and human factors risk assessment.	NASA Ames	FY22 Q4
Impact of Clearance Complexity and Flight Deck Procedures to Pilot Error in North Atlantic Flight Operations	Analyze subjective and objective data related to Gross Navigational Errors (GNEs) attributed to complex clearances and clearance negotiation during NAT flight operations, including voice communications, Data Communications, and 3 <sup>rd</sup> party voice communications	Volpe	FY22 Q4
Flight Deck Information Management – Phase 1 Baseline Assessment <b>(Planned)</b>	Analyze the available data, displays/interfaces, display configurations, accessibility of information, and the resulting demands and challenges introduced by modern transport category across phases of flight to pilots. Examine current-day information management vulnerabilities and the mitigations successfully and/or unsuccessfully applied to address them	University of Michigan	FY22 Q4

# NextGen Human Factors for Error and Complex Systems Potential Program Plans (FY21 – FY23+)

\* Indicates research builds upon on a project within the current portfolio

- Resilience\*
- Advanced Pilot Air Traffic Interactions\*
- Mitigations to Address Flight Deck Information Management Vulnerabilities\*
- Flightcrew Task Management During NextGen Flight Operations
- Human Factors of Automated Aircraft Systems
- Operational Integration of NextGen Communication, Navigation, and Surveillance Capabilities



# NextGen Human Factors for Advance Vision Systems Research Research Requirement Overview

#### Objective

 Provide research data to support the NextGen human factors needs of FAA personnel who evaluate and approve advanced vision systems, sensor-based technologies, and emerging head-worn technologies for new low visibility concepts of operation.

#### How Results are Used

 Inform FAA personnel who develop and maintain regulations, guidance material, procedures, conditions, limitations, job aids, and other documentation, including authorization for operational use

- Enhanced Flight Vision System (EFVS) Visual Advantage Research
- Emerging Head-worn Display Technologies
- Combined Vision Systems (CVS)
- Helicopter Enhanced Flight Vision System (H-EFVS) Research



# NextGen Human Factors for Advance Vision Systems Research On-going research in FY22+

Project	Description/Product	Vendor	Est. Completion
EFVS Visual Advantage Operational Data Collection	Conduct a longitudinal study to validate visual advantage values established for existing EFVS models (Infrared-based sensors) – i.e. are current values adequate, too restrictive, or too lenient. Data will help implement the new EFVS rule, which broadly accommodates existing and future EFVS systems/sensors not yet evaluated.	САМІ	FY22 Q2
Human Factors Aspects of Emerging Head-Mounted Display (HMD) Applications – Small Aircraft	Final report describing results of a HITL simulation in a fixed-based simulator to evaluate the initial pilot performance implications which may be introduced by emerging HMD features (i.e. mixed reality) and functions in small aircraft. This study will also examine the initial human-system performance impacts of monocular vs. binocular displays.	САМІ	FY22 Q3
HWDs with Flight Info. Only & use of HWD with EFVS to Conduct Lower than Standard Approach and Landing Minima Flight Operations – SA CAT I	Evaluate pilot performance, human factors, and operational impacts associated with using a HWD to conduct low visibility operations that are currently approved to be conducted using a heads-up display (HUD).	CAMI	FY22 Q3
Low Visibility Operations Using Synthetic Vision Guidance System (SVGS) Information on HMDs	Evaluate the pilot performance considerations and viability of using SVGS-HMD for 150ft decision heights in 1400 runway visual range (RVR) conditions. Research builds on recent efforts that helped update AC 120-118 in July 2018 (SVGS-HDD).	САМІ	FY22 Q4
Enhanced Helicopter Vision System (EHVS) Technologies	Conduct a study to evaluate the contribution of emerging EHVS technologies to pilot performance, including their use as a potential safety enhancement, and to potentially conduct low visibility approach and landing operations in a helicopter.	WJHTC	FY23 Q1
Combined Vision Systems (CVS)	Conduct a study to examine the contribution of CVS to pilot performance. This research will evaluate the potential use of CVS as a substitute for required airport infrastructure during low visibility takeoff operations. It will also examine the preliminary contributions of CVS to pilot performance during low visibility approach, landing, and rollout operations. This study will evaluate CVS on a head-up display and CVS on a head-down display.	CAMI	FY23 Q1

## NextGen Human Factors for Advance Vision Systems Research Potential Program Plans (FY21 – FY23+)

\* Indicates research builds upon on a project within the current portfolio

- Enhanced Flight Vision System (EFVS) Operations Lower than 1,000 Runway Visual Range (RVR)
- Aircraft Evaluation Group (AEG) Pilot Evaluation Aids for New Technologies
- Emerging Head-worn Display Technologies\*



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