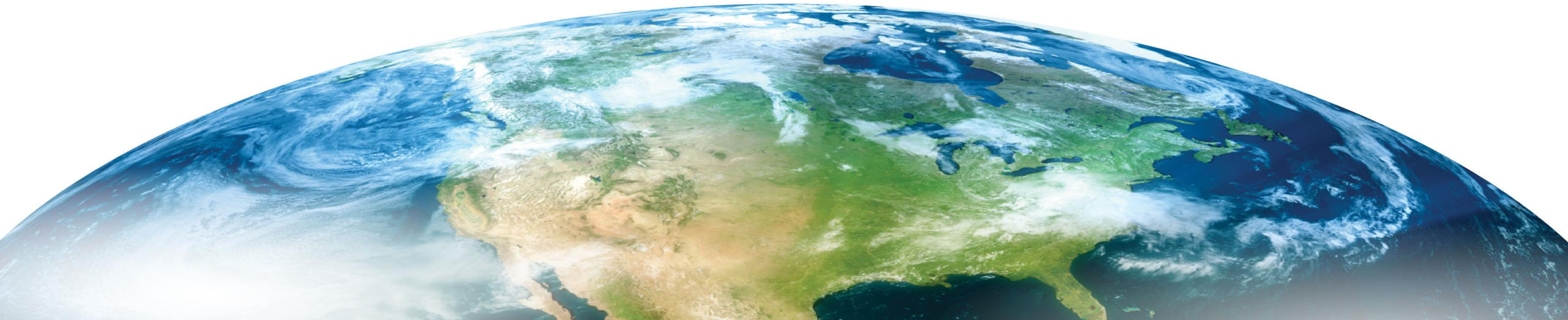# REDAC / NAS Operations

Name of Program: NextGen Air Ground Integration Human Factors

BLI Number: 111110

Presenter Name: Dr. Victor Quach

Date: September 1, 2021

Review of FY 2021 - 2024 Proposed Portfolio

Nextgen Air/Ground Integration Human Factors Overview

What is the 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

What are the benefits to the FAA

- 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

What determines program 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 Contributors

Managers and Research Managers:

- Tara Gibson, Division Manager (Tara.M.Gibson@faa.gov)
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Researchers and Laboratories:

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

Research Requirements

- *NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots* - Identify pilot tasks, skills, and proficiency needs for the operational use of aircraft systems, avionics equipment, and procedures. Examine the operational effectiveness of training and related technology

- *NextGen Human Factors for Aircraft Systems, Displays, and Controls* - Understand potential installation and integration issues that could arise when introducing or combining next generation aircraft changes with current systems, displays, controls, and their respective modes of operation.

- *NextGen Instrument Procedures* - Understand the human factors impact of advanced procedure flyability/acceptability, charting, use of automated systems, and pilot competencies

- *NextGen Human Error and Complex Systems* - Understand how aircraft systems, operations, and procedures will impact the role of pilots and the expectations placed on them

- *Advanced Vision Systems* - Understand the contribution of advanced vision system technologies to pilot performance during new low visibility concepts of operation

FY21 Accomplishments

Project	Description/Product
NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots	
Cognitive Skill Degradation – Verification and Validation	**Completed data collection (cognitive walkthroughs).** Identified cognitive skills and knowledge required for Flight Path Management (FPM) tasks in transport category aircraft during 14 CFR Part 121 flight operations. Identified the strategic impact of enabling technologies/procedures to baseline cognitive skills and knowledge.
NextGen Human Factors for Aircraft Systems, Displays, and Controls	
Validation of CDTI Display Features in a Metered and Non-Metered Environment – Dependent Staggered Approaches (DSA)	**Developed draft research report.** Draft research data on the operational acceptability of multiple Cockpit Display of Traffic Information (CDTI) display requirement implementations defined in avionics standards (RTCA), and draft research data on sequential IM clearances using multiple modes of communication.
NextGen Human Error and Complex Systems	
Human-System Safety / Human Factors Risk Analysis Method Alternatives	**Developed draft research report.** Draft research data on the applicability and use of alternative methods to factor human behavior in system-safety / risk assessments during an initial set of certification-based scenarios .
Pilot Response to Unexpected Events	**Complete data collection (agenda-based discussions).** Obtained data from 50 pilot participants (Part 121, 135, 91K) on startle and surprise events to support future development of a research plan for an empirical study.
NextGen Advanced Vision Systems	
EFVS Visual Advantage Operational Data Collection	**Developed draft interim research report.** Reports of actual enhanced flight vision system (EFVS) performance during low visibility approach, landing, and rollout operations. Created an interactive dashboard to visualize and filter results.

Project	Description/Product	Timeline		
NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots		**FY22**	**FY23**	**FY24**
Manual Flight Operations	• **Technical Report** on the current state of low altitude manual flight operations (MFO) in the NAS, industry line/training policies and procedures for MFO, and the potential impact of enabling technologies to MFO practice opportunities in future NextGen line operations.	FY22 Q2		
	• **Human Factors Verification and Validation Plan** for a Minimum Set of Manual Flight Operation Maneuvers with Maximum Task, Knowledge, Skill Coverage • **Final Technical Report** on Criteria to Evaluate Manual Flight Operation Tasks, Knowledge, Skills and New NextGen Training and Qualification Needs	x	x	FY24 Q1
Cognitive Skill Degradation	• **Technical Report** on baseline cognitive skills and knowledge required to complete flightpath management (FPM) tasks in current Part 121 operations, including the use of automated systems and potential risks related to development/retention of skills.	FY22 Q2		
	• **Human Factors Research Plan** for NextGen Cognitive Skill Degradation Mitigations • **Final Technical Report** on Criteria to Evaluate Cognitive Skills for NextGen Flightpath Management Tasks and the Operational Effectiveness of Mitigations	x	x	FY24 Q1
Techniques to Evaluate Monitoring Training and Monitoring Performance	• **Technical Report** on a range of viable methods/techniques which could be used to evaluate monitoring tasks, training, and performance during line operations, including a recommended subset for future verification and validation.	FY22 Q4		
	• **Human Factors Verification and Validation Plan** for Alternative Methods to Evaluate Monitoring Training and Operational Effectiveness • **Final Technical Report** on Criteria to Evaluate Innovative Training Methods for New NextGen Monitoring Tasks and the Operational Effectiveness of Training	x	FY23 Q4	

Project	Description/Product	Timeline		
		FY22	**FY23**	**FY24**
NextGen Human Factors for Aircraft Systems, Displays, and Controls				
Human Factors Considerations for Multi-Modal Controls (Speech Controls) – Rotorcraft *(Pending)*	**Research Plan** to examine 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.	x		
	Technical Report with research data characterizing single/dual pilot performance and human factors considerations when using multifunction controls with new methods of operation in rotorcraft – specifically various combinations of voice/speech controls		x	FY24 Q2
Customizable Devices for Connected Information Automation Systems *(Pending)*	**Technical Report** on anticipated human – machine interface and interaction issues with connected flight deck technologies that combine and present information wholly or partially derived from uncertified data.	x	x	FY24 Q2

Project	Description/Product	Timeline		
		FY22	**FY23**	**FY24**
NextGen Instrument Procedures				
Flight Deck Impacts of Procedure-Based Concepts, including Established on Required Navigation Performance (RNP) and Multiple Airport Route Separation (MARS)	**Technical Report** on the effect of operational complexity to pilot performance and flight deck procedures during arrival to approach operations and how these impacts might change if concepts such as Multiple Airport Route Separate (MARS) or others are implemented in high density airspace, such as the northeast corridor.	FY22 Q2		
	Research Plan to identify and evaluate potential flyability/human factors considerations for new PBN arrival and departure procedures with reduced areas of separation (e.g., segment of 2 authorized procedures less than 3NM apart and ATC uses monitored procedural separation)	x	FY23 Q2	

Project	Description/Product	Timeline		
		FY22	**FY23**	**FY24**
NextGen Human Error and Complex Systems				
Pilot Response to Unexpected Events	**Final Technical Report** with research data on potential training interventions which could support resilient crew behavior(s) during unexpected events.	FY22 Q1		
Human-System Safety / Human Factors Risk Analysis Method Alternatives	**Final Technical Report** on the verification and validation of methods to factor human behavior in system-safety / risk assessments, the benefits and limitations of each method evaluated, and evidence-based recommendations to support the applied integration of 14 CFR 25.1302 and 25.1309.	FY22 Q4		
Impact of Clearance Complexity and Flight Deck Procedures to Pilot Error in North Atlantic Flight Operations	**Final Technical Report** with research data on causes of gross navigational errors and large height deviations attributed to an air/ground misunderstanding during clearance negotiation, methods used by pilots to avoid errors when responding to lateral flightpath changes issued by ATC on/off oceanic track route assignments, and recommendations to perform clearance negotiation using Controller Pilot Data Link Communications (CPDLC).	FY22 Q4		
Flight Deck Information Management – Phase 1 Baseline Assessment *(Pending)*	**Research Plan** documenting an approach to analyze 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	x		
	Technical Report on the quantity and type of information available to air carrier pilots (visual, aural, tactile) in modern aircraft, how air carrier pilot tasks have changed to manage this information, and mitigations successfully and/or unsuccessfully applied to address current-day information management vulnerabilities.		x	FY24 Q2
Flightcrew Task Management During NextGen Flight Operations *(Pending)*	**Research Plan** documenting an analysis available data on flightcrew task management and the casual and contributing factors to task management deficiencies in monitoring, safety critical system malfunctions, and ATC interventions which effect flight path management.	x-	x	FY24 Q2

Project	Description/Product	Timeline		
NextGen Human Error and Complex Systems		**FY22**	**FY23**	**FY24**
Flightcrew Task Management During NextGen Flight Operations *(Pending)*	**Research Plan** documenting an analysis available data on flightcrew task management and the casual and contributing factors to task management deficiencies in monitoring, safety critical system malfunctions, and ATC interventions which effect flight path management.	x		
	Technical Report documenting vulnerabilities and evaluations of the acceptability if mitigations and operational effectiveness..		x	FY24 Q2

Project	Description/Product	Timeline		
		FY22	FY23	FY24
Advanced Vision Systems				
EFVS Visual Advantage Operational Data Collection	**Final Technical Report.** Research data characterizing actual/reported enhanced flight vision system (EFVS) performance during low visibility approach, landing, and rollout operations. Data will support validation of visual advantage values established for existing EFVS models (Infrared-based sensors) and support on-going implementation of the new EFVS rule which broadly accommodates existing and future EFVS systems/sensors not yet evaluated.	FY22 Q2		
Human Factors Aspects of Emerging Head-Mounted Display (HMD) Applications – Small Aircraft	**Final Technical Report.** Data on pilot performance and human factors considerations associated with the use of an HMD during approach and landing operations. The report will also include data that indicates whether an operationally significant difference exists between monocular and binocular HMDs, and the potential impact of eye dominance.	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	**Technical Report.** Results from the evaluation of a monocular Heavy Weight Deflectometer (HWD) with flight information only vs. a monocular HWD with EFVS during approach, landing, and rollout operations in low visibility conditions (SA CAT I).	FY22 Q3		
Low Visibility Operations Using Synthetic Vision Guidance System (SVGS) Information on HMDs	**Final Technical Report.** Results from the evaluation of SVGS on a head-down display during low visibility flight operations (SA CAT I, SA CAT II, CAT II minima) to airports/runways with reduced infrastructure.	FY22 Q4		

Anticipated Research FY22-FY24 (7 of 7)

Project	Description/Product	Timeline		
Advanced Vision Systems		**FY22**	**FY23**	**FY24**
Enhanced Helicopter Vision System (EHVS) Technologies	**Technical Report.** Contribution of emerging EHVS technologies to pilot performance, including use as a potential safety enhancement and to potentially conduct low visibility approach and landing operations.	x	FY23 Q1	
Combined Vision Systems (CVS)	**Final Technical Report**. Results from the evaluation of a Combined Vision Systems (CVS) on a head-up display (HUD) and a CVS on a head-down display (HDD) during low visibility flight operations (takeoff, approach, landing, touchdown/rollout) to airports/runways with reduced infrastructure.	x	FY23 Q1	

Emerging FY24 Focal Areas (1 of 2)

NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots
- NextGen Changes from Full/Dynamic TBO to Tasks, Knowledge, Skills, and Abilities (KSA)
- Extensible Traffic Management (xTM) Impacts to Pilot Training and Qualification

NextGen Human Factors for Aircraft Systems, Displays, and Controls
- Rotorcraft Multifunction Controls with New Methods of Operation (e.g. Speech/Voice, Touch, Gaze)
- Simplified Controls in Highly Automated Aircraft
- Aircraft Display Features and Functions for Integrated NextGen Flight Ops (e.g. combined uses of Interval Metering, Required Time of Arrival)
- Connected Aircraft Automation Systems (e.g. Information Source Differentiation Criteria)

NextGen Human Error and Complex Systems
- Task Management During NextGen Flight Operations
- Flight Deck Information Management Vulnerabilities
- Human Factors of Automated Systems
- Resiliency in Human – System Performance
- Integration Communication, Navigation, Surveillance (CNS) Capabilites
- Advanced Pilot – Air Traffic Interactions
    - Clearance Complexity
    - Communication Technology Design & Use

Emerging FY24 Focal Areas (2 of 2)

Advanced Vision Systems

- Enhanced Flight Vision System (EFVS) Operations Below 1,000 Runway Visual Range (RVR)
- Aircraft Evaluation Group (AEG) Pilot Evaluation Aids for New Technology
- Novel Display Technologies, Implementations, and Concepts of Use
  - Head-Worn Displays – use of EFVS on a monocular HWD
  - EFVS on a HWD for Lower than Standard Takeoff
  - Hybrid HWD/Heads-up-Display (HUD) and Dual HWD Installation & Use

Nextgen Air/Ground Integration Human Factors

Research Requirements

- NextGen Procedures, Tasks, Skills and Training for Air Carrier Pilots
- NextGen Human Factors for Aircraft Systems, Displays, and Controls
- NextGen Instrument Procedures
- NextGen Human Error and Complex Systems
- Advanced Vision Systems

Outputs/Outcomes

- Data to understand how next generation aircraft systems, operations, and procedures will impact air carrier pilots and the expectations placed on them
- Data to take steps to mitigate automation dependency risks that could be intensified by NextGen changes with precise navigation requirements, and to identify the skills needed for next generation aircraft systems, operations, & procedures.
- Data is used to develop and maintain, as appropriate, human factors-related rules, guidance, procedures, Orders, standards, job aids, and other materials

FY 2024 Planned Research

- If prioritized for funding:
  - Examine the complexity impacts of TBO to management of tasks and use of systems.
  - Examine the impacts of interdependent systems on pilot performance

Out Year Funding Requirements

RE&D	FY21	FY22	FY23
	$ 5M	$ 3M	$ TBD

F&E	FY21	FY22	FY23
	$ 0	$ 0	$ 0

Note: RE&D FY23 is notional.
This program does not receive F&E funding