NextGen Human Factors Summary Technical Review: FY 2018

To the Aviation Community

During Fiscal Year (FY) 2018, the NextGen Human Factors Division (ANG-C1) continued to deliver high value research products and engineering services that support FAA goals for safety and efficiency in aviation systems and operations. Our applied human factors research spans from remote towers to reducing training failures among developmental air traffic controllers, and from NextGen trajectory based operations to fatigue management. Underpinning our approach is the business model of ***Research to Reality*** as shorthand to explain the paths that sponsors, industry, and others use to transition our products into practical applications. The team of ANG-C1 program/project managers excels in their work in collaborating with sponsors and providing superior research products on time and within budget.

Our portfolio of FAA human factors research is comprised of four programs as shown in the following table. The core programs support the near-term research requirements of the FAA air traffic control (ATC) and regulatory missions. The NextGen programs address needs beyond the near-term focusing on inter-operability between systems for pilots and controllers.

	Near-Term	**NextGen**
Flight Deck and Flight Crew	Core Flight deck/ Maintenance/ System Integration	NextGen Air Ground Integration
Air Traffic Control	Core ATC/Technical Operations	NextGen Enterprise ATC

Among our key accomplishments in FY18 are the following:

- Completed a study evaluating the integration of flight-deck based interval management and time-based air traffic metering to provide data-driven recommendations to mitigate human factors risks and operational integration challenges in Trajectory Based Operations (TBO).
- Developed a human-system resilience assessment checklist for the ATO's Independent Operational Assessments team to use in evaluating the potential implications of system design characteristics on the resilience of the system to failure, degraded performance, and human error.
- Developed a new employee stress management guide and training class for new hire air traffic controllers. This was adapted from material used in the NASA astronaut orientation training program.
- Completed a technical evaluation on the effectiveness of Enhanced Flight Vision Systems (EFVS) for effective landing and taxiing in low visibility environments with minimal or no airport infrastructure to support the use of EFVS for operational credit at airports where aircraft would not be able to land otherwise due to low visibility conditions.

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AVIATION: A HUMAN-CENTERED ACTIVITY

Human factors is widely recognized as critical to aviation safety and effectiveness. Since aviation is a human-centered activity, human factors work that helps ensure safety and efficiency in civil aviation is a priority for the FAA. Consider these facts about U.S. aviation:

- At any given moment there are more than 5,000 aircraft traversing the U.S. skies, flown by highly qualified, trained and proficient pilots, many of whom are using the latest flight deck technologies and advanced NextGen procedures.
- The FAA is a year-round 24/7 operation, responsible for 5.3 million square miles of U.S. domestic airspace and 24 million square miles of U.S. airspace over the oceans.
- There are 43,290 average daily flights in and out of the U.S.
- More than 14,000 air traffic controllers manage traffic from many of the FAA's 700 facilities.
- Fifty-five hundred airway transportation system specialists maintain more than 70,000 pieces of equipment.
- Aviation contributes $1.6 trillion annually to the U.S. economy and constitutes 5.1 percent of the gross domestic product.
- Aviation generates 10 million jobs in the U.S. annually.

As the office responsible for FAA human factors R&D program management, the NextGen Human Factors Division has a linchpin role in supporting the integration of pilots, aircraft mechanics, controllers, and technical systems specialists with systems, equipment, and procedures. Research is conducted to address the formal requirements from sponsors and stakeholders concerning safety and efficiency considerations of new and modified aviation technologies and automation. By supporting initiatives to improve both safety and innovation, human factors research answers questions about how these technologies will impact pilots, air traffic controllers, aircraft maintenance personnel, and air traffic technical operations personnel. In 2010, the Government Accountability Office (GAO) recommended that "FAA improve collaboration of human factors efforts within FAA departments," and "establish strong human factors leadership." We have stepped up to that challenge, by integrating its efforts and collaborating with other human factors research organizations in a systematic approach to human factors (within the FAA, the Department of Transportation, NASA, MITRE, and the U.S. Air Force).

Mission and Goals of the Human Factors Division

Working with research sponsors and stakeholders in Aviation Safety (AVS) and Air Traffic Organization (ATO) lines of business and the NextGen Portfolio Management Office, the NextGen Human Factors Division is responsible for identifying aviation-related issues in research on human factors and for allocating and coordinating FAA's resources for internal and external research on human factors. The NextGen Human Factors Division manages the human factors research portfolio comprised of programs that provide scientific and technical information to support the regulatory, operational oversight, and system acquisition efforts of these sponsors and stakeholders. We also provide human factors engineering guidance and oversight to acquisition programs for air traffic control systems. The overall objective of human factors in the FAA is to support the attainment of high levels of human/system integration across all aviation domains within the National Airspace System (NAS). Key goals to achieve our mission include:

(1) Maintain, and when possible improve, aviation safety by reducing the impact of human error.

(2) Increase the efficiency and performance of the NAS by improving the quality of operational decisions through policy, procedures, and process.

(3) Facilitate proposed changes to the NAS to address operational needs.

(4) Increase the utilization of new capabilities.

(5) Reduce programmatic risks.

Historical Perspective

Congress enacted the Aviation Safety Research Act of 1988 (PL 100-591) calling for the FAA to augment its research effort in human factors and ensure coordination with other agencies performing such research. Also in 1988, the Office of Technology Assessment (under the auspices of the U.S. Congress) provided strong recommendations for administration of the FAA's human factors program:

- Long-term improvements in aviation safety will come primarily through systematic operational human factors solutions and such solutions will be found only with consistent, long-term support for research and development.
- Human factors responsibilities are spread piece-meal throughout the FAA and the Department of Transportation.
- FAA's functions cannot be separated into regulatory and operating (ATC) components without diminishing the effectiveness of the entire system.
- FAA needs trained staff to define and manage FAA-supported research efforts, to analyze and interpret findings, and to review and promulgate regulations.
- Staff shortages are compounded by coordination difficulties inherent in the FAA management structure.
- Congress may wish to direct FAA to allocate the resources for human factors expertise in regulatory support staffs, and **to establish an agency focal point, such as a Program Office, that could serve as a catalyst and coordinator for cooperative efforts** (emphasis added) spearheaded by NASA, and including other FAA offices, NTSB, the Department of Defense, manufacturers, airlines, and unions.

Following this guidance, the FAA adopted an early strategy document called the National Plan for Civil Aviation Human Factors. This 1995 plan identified key elements that are required for a successful human factors program at the FAA. These elements include:

- Recognition of human factors as an essential core discipline in organizational functions
- Leverage of supplemental support (contracted or borrowed) with sufficient resident human factors expertise within a well-coordinated, centrally guided program

- Use of human factors experts as the agency's "smart buyer" for human-oriented research and applications work
- Centralized control of research and application human factors resources to achieve crucial coordination and critical mass requirements.

Also, starting in 1995, the FAA's Office of Aviation Research made the Human Factors Division responsible for allocating most of the agency's Research, Engineering, and Development funds for research on human factors. So, for over a quarter century, the FAA's NextGen Human Factors Division has been working to achieve Congress' vision by planning, managing, and executing critically important human factors R&D and engineering support functions for FAA technical sponsors, stakeholders, and program offices. The Division coordinates research with other agencies performing human factors research including through representatives from NASA and the Air Force Research Laboratory serving on the FAA Research, Engineering and Development Advisory Committee (REDAC) and its Human Factors Subcommittee. The Division also coordinates with other modalities in the Department of Transportation (DOT) through the DOT Human Factors Coordinating Committee.

WHAT WE DO

The NextGen Human Factors Division enhances aviation safety and efficiency by:

a. Formulating, managing, and coordinating human factors aviation research within the FAA. Four principal budget lines are managed in the Division, including Flight Deck and Maintenance Human Factors, ATC and Technical Operations Human Factors, NextGen Air/Ground Integration Human Factors, and NextGen Enterprise ATC.

b. Providing scientific and technical leadership in managing the civil aviation human factors research program and for human factors applications in acquisition, certification, regulation, and standards.

c. Providing human factors support to research and engineering activities across the FAA.

d. Developing and implementing FAA human factors policies, programs, procedures, and process related to research and engineering activities.

e. Participating in international human engineering and human factors activities with the International Civil Aviation Organization (ICAO) and EUROCONTROL (the European intergovernmental organization with over three dozen Member States, working to build the Single European Sky that will deliver future air traffic management (ATM) capabilities).

f. Supporting the operation of the Department of Transportation Human Factors Coordinating Committee, the Research, Engineering, and Development Advisory Committee (and its Subcommittees on Human Factors, Aircraft Safety, and NAS Operations), the Department of Defense Human Factors Technical Advisory Group, and RTCA Special Committees (SC).

g. Coordinating activities for the human factors "community of practice" across the agency and with industry groups within several technical areas.

h. Maintaining an internet presence for FAA human factors research at www.hf.faa.gov.

i. Providing copies of final accepted research products to FAA and DOT libraries.

FLIGHT DECK HUMAN FACTORS R&D FY 2018 ACCOMPLISHMENTS

Technical Sponsors and Stakeholders

- Flight Standards Service, Office of Safety Standards
- Flight Standards Service, Air Carrier Operations Branch
- Flight Standards Service, Flight Technologies and Procedures Division, Flight Operations Branch
- Flight Standards Service, Air Carrier Training Systems and Voluntary Safety Programs Branch
- Flight Standards Service, Aircraft Maintenance Division
- Aircraft Certification Service, Policy and Innovation Division
- NextGen Portfolio: RE&D System Development – NextGen Air/Ground Integration

Focus Areas for Our Research Requirements

- Advanced Controls
- Flight Crew Interfaces
- Flight Crew Training
- Fatigue Mitigation in Flight Operations
- Human Factors Research for Improved Rotorcraft Operational Safety
- Human Factors in Aviation Maintenance
- Avionics and New Technologies
- Advanced Vision Systems

Projects

DESCRIPTION	RESULT	APPLICATION	STATUS
Training			
Identifying Crew Resource Management (CRM) training techniques used by air carriers to identify gaps that result from a lack of standardization in CRM training administration and assessment methods.	Final report	AVS will use recommendations for updates to the guidance material for both the FAA inspectors and the operators.	Complete
Report recommending pilot training and checking requirements, annotated with the	Final report	Guidance for 14 CFR Part 121,	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
results of training simulations and small group tryout activities.		Subparts N, O & Y, Air Carrier Certification, and AC 120-54, Advanced Qualification Program.	
Development of a cognitive skill degradation mitigation literature review, focus group studies, and a research roadmap.	Final report	The results of this research will contribute to the development of human factors criteria for Flight Standards inspectors when evaluating air carrier training programs to ensure conformance with FAA regulatory and guidance material.	Complete
Advanced Instrument Procedures			
Human-in-the-Loop simulation report for Interval Management with Time Sequencing and Spacing (IM/TSAS).	Final report	Provide input to RTCA SC-186, who is developing the minimum operational performance standards for Automated Dependent Surveillance-Broadcast (ADS-B).	Complete
Report evaluating the Integration of terminal time based metering concepts with interval management concepts.	Final report	Data-driven recommendations to mitigate en route human factors trajectory	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
		based operations (TBO) risks and operational integration issues; Recommendations regarding future time-based air traffic management (ATM) and TBO research needs.	
Final report on pilot pre-flight briefing strips for required navigation/required navigation performance (RNAV/RNP) arrivals and departures to update AFS charting standards.	Final report	Support AC 90-110A, Instrument Flight Procedure Service Provider Authorization Guidance for Required Navigation Performance Authorization Required Procedures.	Complete
Flight Crew Interfaces			
Report identifying features that contribute to display compellingness and potential mitigations.	Final report	Guidance for AC 120-76D, Guidelines for the Certification, Airworthiness, and Operational Use of Electronic Flight Bags, and Order 8900.1, Flight Standards Information Systems (FSIMS).	Complete
Report on HF Considerations for Electronic Data-Driven Charts.	Final report	Support update of regulatory and guidance material on the presentation of	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
		electronic charting information.	
Final Report on Electronic Flight Bag (EFB) Task Management Research.	Final report	Identify training recommendations supporting the Flight Standards Information Systems (FSIMS) or EFB Advisory Circular (AC).	Complete
Advanced Controls			
Report on human factors considerations for advanced flight deck controls involving touch technology.	Final report	Guidance supporting AC 20-175, Controls for Flight Deck Systems.	Complete
Report providing recommendations on the approach to updating CFR Part 25.777 (anthropometric rule) on flight control forces, human strength and size.	Final report	Guidance supporting 14 CFR 25.777, Cockpit Controls.	Complete
Advanced Vision			
Technical report documenting effectiveness of Enhanced Flight Visual System (EFVS) for effective landing and taxiing (LVO/SMGCS) in low visibility environments with minimal or no airport infrastructure.	Final report	Guidance supporting 14 CFR 91.176 (a) – EFVS Operations and supporting the use of EFVS for operational credit at airports where aircraft would not be able to land otherwise due to low visibility conditions.	Complete
Report on research using EFVS during LVO/SMGCS Taxi (narrow body aircraft) at airports with little or no infrastructure to determine if LVO can be extended to more airports.	Final report	Guidance supporting 14 CFR 91.176 (a) – EFVS Operations and supporting the use of EFVS	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
		for operational credit at airports where aircraft would not be able to land otherwise due to low visibility conditions.	
Report on airport infrastructure database to support the use of EFVS for operational credit.	Final report	Guidance supporting 14 CFR 91.176 (a) – EFVS Operations and supporting the use of EFVS for operational credit at airports where aircraft would not be able to land otherwise due to low visibility conditions.	Complete
Report comparing synthetic vision in HMD with HUD for 100 ft. and 150 ft. DH to evaluate minimum for both general aviation, Part 121, and Part 135.	Final report	Support development of operational standards and approval criteria for specific SVGS operations (e.g., SVGS at 150-ft DH / 1200 RVR and 1400 RVR). Results will also inform as to minimum training, recent flight experience, and proficiency requirements for SVS on SA CAT I approaches.	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
Literature review and survey of advanced vision market technologies.	Final report	The executive reports will help provide operational criteria and guidelines for evaluating head up, head down, and head mounted displays for use in Part 121 operations.	Complete
Human Error			
Literature review and research report on decision making for unexpected events.	Final report	Support 14 CFR Part 119, Certification: Air Carriers and Commercial Operators, 14 CFR Part 121, Advanced Qualification Program, and 14 CFR Part 135, Air Carrier and Operator Certification.	Complete
System State			
Final report on displays and alerting for airplane systems state awareness.	Final report	Support the development of specific criteria for evaluating such systems for intended function under 25.1301 and 25.1302 and for failure modes under 25.1309.	Complete
Developed the human factors methodology and test plan to assess and select aircraft	Final report	Support the development of display and	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
energy state awareness and alerting prototypes for further FAA evaluation.		alerting criteria for the evaluation of energy state awareness technologies for intended function under 25.1301, 25.1302, 25.1322, and for failure modes under 25.1309. These criteria would address novel aspects of emerging technologies that current FAA guidance does not cover.	
Aircraft Maintenance			
Maintenance field study of the relative utility of alternative fatigue countermeasures in reducing risk, safety, and cost with guidance for FAA inspectors and cargo operations.	Final report	Provide industry with empirically tested approaches and tools to proactively manage maintenance safety risks. It will consist of fatigue risk management approaches modified for maintenance operations. The research will also provide the FAA with a scientific basis for guidance and future requirements pertinent to effective risk	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
		management strategies in maintenance operations.	
Fatigue			
Reviewed the scientific integrity of fatigue risk management system proposals during the processes outlined in AC 120-103A as required for certificate holders in their demonstration of an alternative means of compliance with the new regulations. Assisted in the preparation, documentation, review, and release of other fatigue-related materials associated with 14 CFR Part 117 flight crew member duty & rest requirements.	Final report	Research will be used to develop and update policy for 14 CFR Part 117, Flight and Duty Limitations and Rest Requirements: Flightcrew Members.	Complete
Unmanned Aerial Systems (UAS)			
Completed a human-in-the-loop simulation assessing detect and avoid (DAA) system displays with flight path information that are necessary to allow a UAS pilot to remain well-clear of other aircraft.	Final report	Proposed recommendations and requirements for UAS displays in support of self-separation systems, including RTCA Detect and Avoid System Minimal Operational Performance Standards (MOPS).	Complete
Interviewed UAS operators and ATC regarding en route contingency operations leading to a research plan for a human-in-the-loop simulation assessing mitigation of workload and safety impacts.	Final report	Results from this research will inform standards development for UAS operations in contingency situations, including minimum service	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
		standards for ATC.	
Rotorcraft			
Completed a literature review for scenario based training and identified human factors affecting pilot workload in rotorcraft operations. Provided recommendations for operating limitations and other mitigations such as RNAV/RNP for helicopters.	Final report	Supports design of helicopter training devices scenario based training for parts 61, 91, 141, and 135 operations, and helicopter crew resource management (CRM) for Part 91 and 135 operators including helicopter air ambulance operators.	Complete

Transitions

- The primary purpose of AVS-sponsored research is to support the development of policies, regulations, standards, and guidance materials needed to meet the FAA safety goals and objectives.
- AVS will use the material in the assessment of the applicant's compliance with applicable regulations and guidance and the safety implications as part of the process for granting certification approval.
- Industry will also use research results and guidance material including in their development of systems, equipment, and training to reduce the risk in operational approval.

AIR TRAFFIC AND TECHNICAL OPERATIONS HUMAN FACTORS R&D FY 2018 ACCOMPLISHMENTS

Technical Sponsors and Stakeholders

- Air Traffic Organization, Safety and Technical Training
- Air Traffic Organization, Management Services
- Air Traffic Organization, Program Management Organization
- Air Traffic Organization, Air Traffic Services
- Air Traffic Organization, Flight Program Operations
- Air Traffic Organization, Technical Operations Services

Focus Areas for Our Research Requirements

- Human Factors Standards
- Workforce Optimization
- Improved Safety
- NAS Technology Integration
- Human Performance Enhancement

Projects

DESCRIPTION	RESULT	APPLICATION	STATUS
Conduct a training effectiveness assessment of the field qualification training process to better understand why some developmentals fail to succeed.	Final report	ATO's Safety and Technical Training will determine if interventions or policy changes to improve facility success rates are needed.	Complete
Develop an ATC stress management training manual and training materials for newly hired air traffic controllers	Training manual Training materials	ATO's Management Services will provide the manual and training to new hires at the FAA Academy.	Complete

DESCRIPTION	RESULT	APPLICATION	STATUS
Assess the costs and benefits associated with hiring graduates from post-secondary educational institutions participating in the Air Traffic Collegiate Training Initiative (AT-CTI) program with a summative evaluation for the period 2006 – 2013.	Final report	ATO's Management Services and FAA Human Resources offices will evaluate the utility of the CTI program after 25 years of operation.	Complete
Conduct HF research on tower controller visual scanning practices that will result in guidance for tower controllers on scanning.	Final report	ATO Safety and Technical Training will work with the FAA Academy to develop controller training in scanning best practices.	Complete
Complete an update of existing human factors guidance on displays and printers in HF-STD-001B (Human Factors Design Standard).	Final report	ATO's Program Management Organization will levy these updated requirements on new acquisition programs.	Ongoing
Complete the second section of Technical Operations Graphical User Interface (GUI) Style Guide, addressing the systems in large TRACONs.	Final report	ATO's Program Management Organization and Technical Operations Services will provide this guidance to system developers.	Ongoing
Produce a handbook to guide the design of decision support tools (DSTs) to address human factors requirements and to recommend standards for controller training in the use of DSTs.	Final handbook	ATO's Program Management Organization and Safety and Technical Training will use these products to facilitate	Ongoing

DESCRIPTION	RESULT	APPLICATION	STATUS
		integration of decision support tools in the NAS.	
Develop methods for mining operational data to identify human factors and system usability challenges that affect the use (actual employment) of new capabilities.	Final report	ATO's Program Management Organization will use the results to identify future software upgrades to improve the usability of new capabilities.	Ongoing
Analyze and conduct simulation experiments to assess the integrated work environment for controllers to identify system functionality and user interface aspects that may impede controller performance.	Analysis report Final report	ATO's Program Management Organization, Air Traffic Services, and the Safety and Technical Training service units will apply the initial risk assessment and recommended risk mitigations in design of updates to ATC systems and procedures.	Ongoing
Conduct an assessment of Established-on-RNP (Required Navigation Performance) Human Factors to identify best practices.	Final report	ATO's Program Management Organization, Air Traffic Services, and System Operations will apply the recommended Established-on-RNP human factors guidance for future implementations.	Complete

Transitions

- The focus areas of current human factors efforts for ATO sponsors are training, selection, performance enhancement, safety, system design, and developing standards.
- Human factors efforts also focus on human performance risks, training implications, and maintenance issues, including issues resulting from NextGen technology enhancements and ensuring human factors is incorporated into system development activities as a matter of process.
- Human factors research efforts support ATO with the necessary scientific information to support the full range of policies and system design activities that enable the air traffic control system to perform efficiently and safely.
    - ATO is responsible for the entire ATC operation, including:
        - Staffing,
        - Personnel recruitment (in collaboration with AHR),
        - Selection,
        - Placement,
        - Training,
        - System development and implementation, and
        - Operational service delivery.

Human Factors Engineering for Acquisition Programs

The NextGen Human Factors Division provides a specialty engineering service that supports integration of human factors design standards, methods, and data within FAA acquisition and safety programs. The Division has delegated responsibility from the Secretariat for the Joint Resource Council for formal approval of human factors items contained in the In-Service Review (ISR) Checklist, as well as updates of Acquisition Management System (AMS) Policy. We are members of the FAA Safety Collaboration Team (SCT) that provides cross-organization safety risk assessments for planned changes to the National Airspace System (NAS) and other FAA safety issues.

Partnerships

FAA Scientists and Research Labs at CAMI and Technical Center

Each year the human factors research programs coordinate ATC and flight deck projects with CAMI and the William J. Hughes Technical Center (WJHTC). The programs fund the salaries of FAA scientists who also execute work of varying scale for other FAA offices.

NASA

The NextGen Human Factors Division has Interagency Agreements with NASA Ames and Langley Research Centers. In FY18, we funded NASA to conduct NextGen flight deck research spanning aircraft system state and pilot problem solving and decision-making. These agreements enable leveraging NASA's best scientists and excellent flight deck simulation systems to address important research challenges.

Air Force Research Laboratory

Collaboration with the Air Force Research Laboratory and MIT Lincoln Laboratory on resiliency research.

MITRE Center for Advanced Aviation System Development (CAASD)

We collaborate with MITRE CAASD on several fronts including NextGen Air-Ground Integration research involving time-based separation as well as controller training front-end analysis and design activities for initial Trajectory Based Operations (iTBO).

Volpe Center

They have a number of NextGen flight deck tasks with technical leadership from their senior human factors scientist.

Honeywell Aerospace

Our agreement produces valuable information on advanced flight deck controls, and the cost-share ensures that the industry partnership pays efficiency dividends.

EUROCONTROL

In FY18, we started Coordination Plan 1.7 to align human factors between NextGen and the Single European Sky ATM Research (SESAR) program in order to harmonize best practices.

ICAO

Participation on the Human Performance Task Force including development of guidance for integrating human factors in the Aviation System Block Upgrade (ASBU) program.

Universities

Research grants established with the University of Central Florida, University of Michigan, and through the NEXTOR program with The Ohio State University.

WHAT'S NEXT - OUTLOOK FOR FY19 AND BEYOND

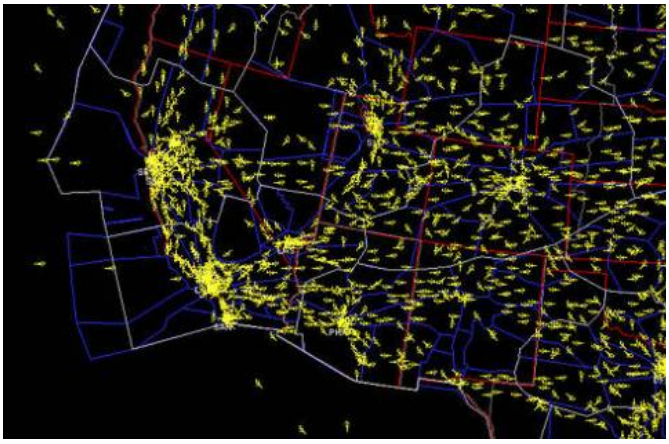
Flight Deck Research

In FY 2019 and beyond, the flight deck human factors R&D program will continue to provide scientific and technical information to assist AVS technical sponsors in several important areas:

- Assessment of strategic flight crew information integration in a time-based control environment for en route and terminal.
- Support for training of the next generation of Air Carrier Pilots such as training the new millennial work force including recommendations on operational effectiveness of contemporary training methods and devices as well as emerging technologies (e.g., virtual reality and mobile devices).
- Research findings supporting flight crew interfaces with recommendations for advanced display technologies including 3D, stereoscopic, holographic, and head-worn glasses and displays.
- Data communications research assessing operational limitations for displaying D-Taxi clearances and displays and procedures required for dynamic 4-D trajectory management.
- Development of feasible alternative human error assessment methods aimed at clarifying and evaluating applicant compliance with 25.1302.
- Research on advanced vision systems including completion of human-in-the-loop simulations to evaluate human factors and crew coordination aspects of dual pilot head-up display (HUD) Category (CAT) III operations compared to single HUD CAT III operations.

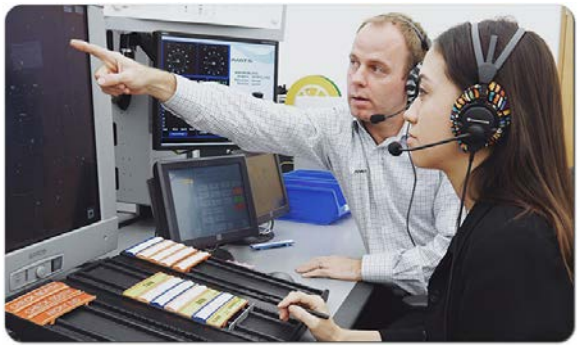
- Evaluation of flight deck system alternatives that aim to mitigate aircraft energy state awareness risks with emerging technologies.
- Research on human performance impacts of features and functions of combined vision systems.

Air Traffic Control and Technical Operations Research



Additional human factors R&D efforts are planned in FY 2019 to produce scientific information and data-based guidance that will assist the Air Traffic Organization's (ATO) technical sponsors:

- Develop handbooks for ATO's Program Management Office and system acquisition developers for alarms and alerts in air traffic systems, and integration of decision support tools in air traffic automation
- Evaluate evidence of human factors contributions to wrong-surface landings in flight operations, and recommend mitigations for the ATO's Safety and Technical Training service unit to apply in controller field training and evaluation
- Continue human factors analysis activities to aid in the integration of Remote Towers into the National Airspace System, including recommendations for guidance for their safe operation, given the capabilities and limitations of the system and the controllers who operate them
- Evaluate the suitability of existing online psychometric and perceptual speed measurement tools for assessing controller applicants' performance and aptitude on job-relevant criteria



Acronyms

3D	3 Dimension
4D	4 Dimension
AC	Advisory Circular
ADS-B	Automated Dependent Surveillance - Broadcast
AFS	FAA Flight Standards Office
AHR	FAA Human Relations Office
AJW	ATO Technical Operations Service
ASBU	Aviation System Block Upgrade
AT-CTI	Air Traffic – Collegiate Training Initiative
ATC	Air Traffic Control
ATM	Air Traffic Management
ATO	Air Traffic Organization
AVS	Office of Aviation Safety
CAMI	Civil Aerospace Medical Institute
CFR	Code of Federal Regulations
CRM	Crew Resource Management
DAA	Detect and Avoid
DH	Decision Height
DOT	Department of Transportation
DST	Decision Support Tool
D-Taxi	Departure-Taxi
EFB	Electronic Flight Bag
EFVS	Enhanced Flight Vision System
EURO-CONTROL	European Organization for the Safety of Air Navigation
EVS	Enhanced Vision System
FSIMS	Flight Standards Information Systems
FY	Fiscal Year
GAO	Government Accountability Office
GUI	Graphical User Interface
HF	Human Factors
HMD	Head Mounted Display
HUD	Head Up Display
ICAO	International Civil Aviation Organization
iTBO	initial Trajectory Based Operations

LVO/ SMGCS	Low Visibility Operations/ Surface Management Guidance and Control System
MIT	Massachusetts Institute of Technology
MITRE CAASD	Center for Advanced Aviation System Development
MOPS	Minimal Operational Performance Standards (MOPS
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NextGen	Next Generation Air Transportation System
NTSB	National Transportation Safety Board
OpSpec	Operations Specification
PBN	Performance Based Navigation
PL	Public Law
PMP	Project Management Professional
R&D	Research and Development
RE&D	Research, Engineering and Development
REDAC	Research, Engineering and Development Advisory Committee
RNAV	Area Navigation
RNP	Required Navigation Performance
RTCA SC	Radio Technical Communications of America Special Committee
RVR	Runway Visual Range
SESAR	Single European Sky
SA CAT I	Special Authorization Category I
SVGS	Synthetic Vision Guidance System
TBO	Trajectory Based Operations
TRACON	Terminal Radar Approach Control
UAS	Unmanned Aerial System
WJHTC	William J. Hughes Technical Center