



Federal Aviation
Administration

REDAC / Human Factors

Review of FY 2019 Accomplishments and Future Planned Portfolio

Air Traffic Control / Technical Operations Human Factors

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Air Traffic Control / Technical Operations

Human Factors

A11.h

What are the benefits to the FAA

- Improving the safety and efficiency of complex ATC systems by application of R&D to address factors affecting human performance in air traffic control operations and ATC system maintenance.
- Recommending and testing improvements to design, procedures, training, selection and placement; and mitigations to address human performance shortfalls.
- Address operational safety and efficiency challenges identified in ATO's Flight Program

What determines program success

- R&D Sponsors and Stakeholders in the ATO are able to make important workforce policy, acquisition, and operational management decisions based on the results of thorough, timely, and focused R&D efforts.
- When programs embrace human factors processes and requirements during system acquisition, they reduce human factors risks.
- Reducing human factors risks increases the likelihood for successful system implementation and operation, while reducing the likelihood for system design and engineering rework.

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Overview Capabilities

People:

- Program Manager – Dan Herschler, ANG-C1
- Subject Matter Expert – Bill Kaliardos, ANG-C1

Laboratories:

- ANG-E25 Human Factors Branch, Aviation Research Division
Research and Development Human Factors Laboratory
- AAM-520 NAS Human Factors Safety Research Laboratory

University Partners (planned):

- University of Chicago
- Purdue University (PEGASAS COE consortium)

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Designer's Handbook for Integration of Decision Support Tools and Procedures into Air Traffic Systems**
- **Color Standard Implementation Demonstrations**
- **ATC Capability Utilization**
- **Improved Visual Scanning Techniques for Tower Controllers**
- **Controller Training and Selection Research Findings**
- **Physical Ability Requirements for the Airways Transportation Systems Specialist (ATSS) Occupation**
- **Optimization of Information Display for the Controller (Phase 2)**

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Designer's Handbook for Integration of Decision Support Tools and Procedures into Air Traffic Systems**
 - Completed a human factors handbook that guides development and training of air traffic system design related to decision support tools (DSTs).
 - Will be used primarily by human factors practitioners and systems engineers in FAA acquisition, including requirements developers, training developers, and others developing and testing air traffic control (ATC) systems.
 - Also beneficial to those individuals and agencies who look to FAA standards for human factors guidance for DST usage, operator training, and DST integration into existing systems.

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Color Standard Implementation Demonstrations**
 - Joint effort with the Tech Center Human Factors Branch and CAMI human factors experts applying the FAA ATC display color standard (FAA HF-STD-010) to demonstrate the new color palette that is designed to accommodate controllers who have color vision deficiencies.
 - The static and dynamic demonstrations on actual ATC displays provide users with opportunities to view and interact with the proposed color palette to gain controller acceptance for en route and terminal controller workstations.
 - The static and dynamic mockups include realistic traffic scenarios and supporting flight and other operational data on the display. Controllers were invited to view and interact with the mockups and to provide feedback on the suitability of the new colors.

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **ATC Capability Utilization**

- Human Factors Branch researchers continued to develop metrics and tools to support analysis of how controllers are using ERAM operationally.
- Airspace geometry:
“How far from the sector boundary did the controller initiate the handoff?”
- Controllers’ use of ERAM functions:
“How frequently did controllers manipulate their data blocks and which interaction methods did they choose (e.g., keyboard entry versus on-screen menu)?”
- Analyses use large datasets from multiple sectors and facilities over selected time periods.
- Tools leverage big data analytics and Tech Center’s data warehousing capabilities.

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Improved Visual Scanning Techniques for Tower Controllers**
 - CAMI continued field research on effective visual scanning techniques in the tower environment.
 - Intent is to develop guidance that may aid ATCSs to guard against vulnerabilities in their visual scanning.
 - Guidance could inform development of recurrent controller training in optimal visual scanning patterns.
 - FAA Academy could use the results to support development of training for new controllers to learn robust techniques for the development and maintenance of the critical visual scanning skill

Air Traffic Control / Technical Operations

Human Factors – FY2019 Accomplishments

- **Controller Training and Selection Research Findings**

- CAMI completed a summative evaluation of the air traffic collegiate training initiative (AT-CTI) for AJI-2 (Office of Technical Training).
- Completed a retrospective review to determine whether controllers who completed CTI training before they were hired were more likely to reach journeyman (Certified Professional Controller or CPC) level and if so, whether they were faster in doing so than their peers who were hired without having had CTI training.
- Results showed that CTI training does not predict successful achievement of CPC, although the time required for reaching CPC is a few weeks less with CTI training since AT Basics (taught at the Academy) can be skipped by CTI-trained new hires.
- Factors that did predict success were age at entry into the ATC occupation (younger people do better) and score on the aptitude test battery.

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Physical Ability Requirements for the Airways Transportation Systems Specialist (ATSS) Occupation**
 - CAMI completed a review of the five specialties within the ATSS occupation to:
 - describe and compare the frequency of physically-oriented work activities performed in the course their job tasks and
 - identify and compare the profile of sensory, physical, and psychomotor abilities required in each specialty.
 - Environmental specialty (HVAC systems) required physically-oriented activities more often than other specialties and the Automation (software) specialty was the least physically demanding specialty.
 - None of the specialties experienced more than moderate physical demands, nor were different in the sensory, physical, or psychomotor abilities needed to perform the job.
 - AJG, AJW, and AHR will use the results for defining job requirements in each specialty area and that will be included in vacancy announcements

Air Traffic Control / Technical Operations Human Factors – FY2019 Accomplishments

- **Optimization of Information Display for the Controller (Phase 2)**
 - Completed preparations for a HITL simulation examining the integration of multiple near-term enhancements onto the ERAM controller workstation.
 - Allows researchers to identify human factors issues in complex interactions among multiple systems, functions, and user interface elements
 - Many programs' enhancements are brought together onto a single controller workstation for the first time (see next slide for details).
 - Data collection is delayed until FY2020 due to participant scheduling challenges (consequence of 2019 shutdown)

Specific En Route HITL Capabilities

- 43-inch UHD displays for the Radar Position, 24-inch displays for the Radar Associate position
- Conflict Probe - integration on the R position (in addition to the RA Position)
- Trial Planning
 - Integration on the on the R position (in addition to the RA Position), Probed menus, Altitudes, Routes; Probed trajectories
- Electronic Coordination
 - Sector directed coordination: altitudes, heading, direct to fix, speed, reference aircraft
- Electronic horse collars to replace the paper version
 - Including names of sectors, frequencies, etc.
- Probe View
- Route Display on R Position
- Movable menus
- **DataComm Full Services**
 - Clearances
 - Altitude, Speed, Direct-To-Fix, Altimeter, Transfer of Communications, Full Route, Resume Normal Speed
 - Crossing Restrictions (cross fix at altitude and/or fix/speed)
 - Reports: Confirm Assigned Altitude, Confirm Assigned Route, Confirm Speed
 - Advisory messages
 - Pilot Initiated Downlinks: Altitude, Direct to Fix, Reroute, Deviation
- **Time Based Flow Management**
 - Delay Countdown Time, GIM-S Speed Advisory
- **Traffic Flow Management System**
 - AirBorne ReRoute
- **Cross Program Capabilities:**
 - ERAM Enhancements X DataComm
 - Probed Controller to Controller Coordination menus with ability to uplink approved APREQs
 - ERAM Enhancements X DataComm X TFMS:
 - Probed TFM Reroute (ABRR) menus with Trial Planning Capabilities
 - Probed ABRR route display from R-position indicator
 - ERAM Enhancements X DataComm X TBFM
 - GIM-S speed advisory uplinks
 - GIM-S NO ADVISORY initiated Path Stretch Solutions voiced or uplinked

Anticipated Research in FY2020

Planned Research Activities (not yet approved)

- Continue work for FAA's Program Management Organization (AJM):
 - Facilitate transition of new ATC display color standard requirements (developed through research) into fielded systems
 - Conduct research to develop design handbook guidance and user training for effective implementation of signaling systems (alarms and alerts) in ATC systems
 - Implement design handbook guidance to evaluate existing decision support tools (DSTs) in air traffic operations
 - Collect controller performance data in human-in-the-loop (HITL) simulations of integrated, advanced ATC capabilities in the en route (ERAM) domain
 - Initiate new work for AJM sponsor:
 - Analyze human factors aspects of advanced ATC capabilities in the terminal (STARS) domain; plan HITL to collect controller performance data
 - Conduct initial research to evaluate touch-based user interface technologies and identify human factors considerations affecting air traffic controller performance
 - Update the Human Factors Job Aid (guide for acquisition programs' human factors leads)
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- Continue work for ATO's Management Services (AJG):
 - Evaluate the ATCS selection process to identify better predictors of successful completion of training
 - Initiate new work for AJG sponsor:
 - Support requirements development for an AHR contract effort to update the Air Traffic Selection Aptitude test battery
 - Conduct an analysis to align ATSS competencies using 2015 job task analysis data
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- Continue work for ATO's Office of Safety and Technical Training (AJI):
 - Human factors issues for integrating remote towers into NAS operations (RTS)
 - Evaluate the effectiveness of ATO's controller fatigue mitigation strategies
 - Develop best practices, guidance, and recommended training for improved visual scanning for tower controllers
 - Initiate new work for AJI sponsor:
 - Conduct a workload study to determine on-position fatigue effects and recommend mitigations
 - Develop additional "common competencies" Academy training for ATC new hires that will better prepare them to succeed in field training

Anticipated Research in FY2020

Planned Research Activities (not yet approved)

- Continue work for FAA's Flight Program Operations (AJF):
 - Create a method to develop normative task times and efficient aircraft inspection methods.
- Initiate new work for AJF sponsor:
 - Recommend means to improve coordination between Flight Check pilots and controllers during operations.
 - Conduct a survey study of FAA pilots to identify factors contributing to and preventing exceedance of aircraft operating limitations.
 - Coordinate with AVS to leverage prior efforts to develop ways to limit pilot workload and errors (and to mitigate pilot deviations) due to ATC issuance of "last-minute" approach clearances that require FMS reprogramming.
- Initiate new work for ATO's System Operations Services (AJR):
 - Develop means to encourage controllers to increase solicitation of pilot reports (PIREPS) in areas of rapidly-changeable weather
- Continue work for ATO's Air Traffic Services (AJT)
 - Identify extant research (in progress or completed) on the impact of TBO implementation on Air Traffic Control Specialists. Develop research plan to investigate TBO impacts.
- Initiate new work for AJT sponsor:
 - Identify changes to competencies needed for successful performance as an ATCS.
 - Assess changes to ATCS workload, e.g., increase/decrease, type of workload.
 - Evaluate reliance on automation and situation awareness in the TBO environment.

Emerging FY2021 Focal Areas

- **Develop Technical Operations Workforce Skills for Setting Maintenance Priorities**
 - Develop maintenance triage decision and task management guidance with AJW subject matter experts.
 - Validate application of maintenance guidance in AJW-specified workforce using focused workshops and follow-up surveys.
- **Update the Human Factors Design Standard**
 - Address latest research and methods for guiding implementation of air traffic controller automated tools in an update to section 5.1 Automation.

Emerging FY2021 Focal Areas (cont.)

- **Identify and Mitigate Automation Effects on Controller Performance**
 - Mine available system data and conduct site visits to determine what automation effects exist that limit controller performance
 - Conduct small scale simulation study to test mitigations (CHI changes, procedures, training methods)
- **Continue Runway Safety Research on Effective Controller Scanning**
 - Validate and recommend best-practices and evaluation techniques for visual scanning

Emerging FY2021 Focal Areas (cont.)

- **Develop Controller Selection Tools that Predict Performance at First Field Facility**
 - Evaluate commercially available cognitive, psychomotor, and relevant job sample tests for predictive utility in the air traffic control job for tower, TRACON, enroute, and traffic flow management controllers.
 - Conduct validation studies of prospective air traffic controller selection tools using Academy and field training success as effectiveness criteria

Air Traffic Control / Technical Operations

Human Factors

Research Requirement

Workforce Optimization – Provide research results to ATO sponsors and FAA Academy and AHR stakeholders on policies affecting controller and technician recruitment, selection, placement, staffing, and performance evaluation

Improved Safety – provide recommendations to improve procedures and operating practices for ATC and Technical Operations personnel

Human Factors in NAS Technology Integration – Develop human factors standards and recommend methods and tools to support air traffic control system acquisition programs as they address human factors during concept development, including prototyping and scenario evaluations

Human Performance Enhancement - Identify job tasks and minimum qualification standards of performance for ATC and Technical Operations personnel (e.g., initial training)

ATO Flight Program Human Factors - develop human factors and safety recommendations supporting ATO aircraft maintenance and missions

Outputs/Outcomes

1. Recommended practices for facility managers to help trainees succeed in field training
2. Improved ATC coordination during flight check operations
3. Recommended approach and methods for obtaining data on controllers' use of new equipment and system functions to identify potential challenges in use of fielded systems
4. Recommendations for redesign of controller CHI to achieve user-system performance objectives.

FY 2020 Planned Research

- Conduct analyses and develop recommended practices for facility managers to increase the likelihood that controller trainees will succeed in field training, such that trainees are not lost due to factors other than their ability to control air traffic.
- Develop data mining methods to obtain and evaluate controllers' use of new equipment and system functions that provide additional air traffic control capabilities, and develop an approach for analyzing the data that will provide insights to acquisition programs and operational evaluation teams about which capabilities have been under-used as well as some of the operational human factors aspects that may limit their use.
- Identify and analyze elements of air traffic control system user interfaces that may introduce human error potential in ATC operations, and recommend candidate elements for additional evaluations through high fidelity human-in-the-loop simulations that include multiple new systems and functions.
- Conduct research for FAA's Flight Program Operations to recommend ways to improve ATC coordination with flight check pilots

Out Year Funding Requirements

FY19	FY20	FY21	FY22	FY23
\$0.389 M	TBD	TBD	TBD	TBD

Statutory Basis for Human Factors Research

49 US Code Section	Title
*44505(b)	Research on Human Factors and Simulation Models
*44505(c)	Research on Developing and Maintaining a Safe and Efficient System
44506(a)	Research on Effect of Automation on Performance
44506(b)	Research on Human Factor Aspects of Automation
*44513(b) (1)(A)(iii)	Regional Centers of Air Transportation Excellence, Responsibilities. --
44516(a)	Air Traffic Controllers

* In-scope for REDAC per 49 USC Section 44508, Research Advisory Committee

Statutory Basis for Human Factors Research (cont.)

49 US Code Section	Title
*44505(b)	Research on Human Factors and Simulation Models The Administrator shall conduct or supervise research— (1) to develop a better understanding of the relationship between human factors and aviation accidents and between human factors and air safety; (2) to enhance air traffic controller, mechanic, and flight crew performance; (3) to develop a human-factor analysis of the hazards associated with new technologies to be used by air traffic controllers, mechanics, and flight crews; (4) to identify innovative and effective corrective measures for human errors that adversely affect air safety; ... (6) to develop a better understanding of the relationship between human factors and unmanned aircraft system safety
*44505(c)	Research on Developing and Maintaining a Safe and Efficient System —The Administrator shall conduct or supervise research on— ... (3) human performance in the air transportation environment; (4) aviation safety and security; (5) the supply of trained air transportation personnel, including pilots and mechanics; and (6) other aviation issues related to developing and maintaining a safe and efficient air transportation system
*44513(b)(1)(A)(iii)	Regional Centers of Air Transportation Excellence, Responsibilities. -- Conducting research on— ... human performance in the air transportation environment...

Statutory Basis for Human Factors Research (cont.)

49 US Code Section	Title
44506(a)	Research on Effect of Automation on Performance To develop the means necessary to establish appropriate selection criteria and training methodologies for the next generation of air traffic controllers, the Administrator of the Federal Aviation Administration shall conduct research to study the effect of automation on the performance of the next generation of air traffic controllers and the air traffic control system. The research shall include investigating— (1) methods for improving and accelerating future air traffic controller training through the application of advanced training techniques, including the use of simulation technology; (2) the role of automation in the air traffic control system and its physical and psychological effects on air traffic controllers; (3) the attributes and aptitudes needed to function well in a highly automated air traffic control system and the development of appropriate testing methods for identifying individuals with those attributes and aptitudes; (4) innovative methods for training potential air traffic controllers to enhance the benefits of automation and maximize the effectiveness of the air traffic control system; and (5) new technologies and procedures for exploiting automated communication systems, including Mode S Transponders, to improve information transfers between air traffic controllers and aircraft pilots.
44506(b)	Research on Human Factor Aspects of Automation The Administrators of the Federal Aviation Administration and National Aeronautics and Space Administration may make an agreement for the use of the National Aeronautics and Space Administration's unique human factor facilities and expertise in conducting research activities to study the human factor aspects of the highly automated environment for the next generation of air traffic controllers. The research activities shall include investigating— (1) human perceptual capabilities and the effect of computer-aided decision making on the workload and performance of air traffic controllers; (2) information management techniques for advanced air traffic control display systems; and (3) air traffic controller workload and performance measures, including the development of predictive models

Statutory Basis for Human Factors Research (cont.)

49 US Code Section	Title	
44516	Human Factors Program	
	<p>(a) HUMAN FACTORS TRAINING.—</p> <p>(1) AIR TRAFFIC CONTROLLERS.—The Administrator of the Federal Aviation Administration shall—</p> <p>(A) address the problems and concerns raised by the National Research Council in its report “The Future of Air Traffic Control” on air traffic control automation; and</p> <p>(B) respond to the recommendations made by the National Research Council.</p>	
The Future of Air Traffic Control: Human Operators and Automation © 1998 The National Academy of Sciences, Washington, DC: National Academy Press	<p>49 recommendations over 21 topic areas:</p> <ul style="list-style-type: none"> • Levels of automation • Adaptable automation • Recovery • Locus of authority • Teamwork • Cross-cultural issues • Communication: Data Link • Flight Management System • Flight data • Traffic Alert and Collision Avoidance System • Converging Runway Display Aid 	<ul style="list-style-type: none"> • Precision Runway Monitor • Avoiding collisions on the ground • Center TRACON Automation System • Conflict Probe and interactive planning • Four-dimensional contracts • Surface Movement Advisor • Support functions • The future National Airspace System • Development and installation of advanced systems • Long-range planning