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THE FAA’S HUMAN FACTORS AIR TRAFFIC CONTROL / TECHNICAL OPERATIONS STRATEGIC RESEARCH PLAN

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The Federal Aviation Administration (FAA) Air Traffic Control (ATC) / Technical Operations (TO) Human Factors Team completed development and publication of a ten-year strategic research plan. This effort was endorsed by the FAA Research Engineering and Development Advisory Committee (REDAC) and sponsored by the FAA Human Factors Division. The intent of the strategic plan is to define a clear pathway for the ATC / TO Human Factors Team to improve and integrate human factors research in ATC applications. The strategic plan also serves as a communication tool to engage the community of practice and promote the implementation of products that yield the greatest operational results—which will support the achievement of the Team’s mission as well as the FAA’s transition to a future, automated National Airspace System (NAS).

The FAA is engaged in an extensive effort to modernize the NAS. This phased, incremental transition involves the introduction of new ATC automation, technologies, and procedures to replace legacy equipment and services. The modernization to an automated NAS aims to achieve the system-wide benefits of increased safety, capacity, and efficiency. However, “understanding the human factors work that is being or needs to be done” to transition to an automated NAS “is a fundamental challenge to the practice of program management in research and development” (Krois et al., 2010). In response to this challenge, the Air Traffic Control (ATC) / Technical Operations (TO) Human Factors Team developed the ATC / TO Human Factors Strategic Research Plan. The Plan provides the ATC / TO Human Factors Team and community of practice with a clear, ten years strategic direction, and measurable success criteria that support the transition to an automated NAS. The strategic plan was developed in alignment with Destination 2025, the FAA Advanced Concepts and Technology Development Directorate mission, and operational needs identified by internal FAA sponsoring organizations. Execution of the strategic plan supports achievement of the ATC / TO Human Factors Team’s mission (FAA, 2012a):

“Provide human factors research, engineering, and leadership to enhance operational human performance in the NAS. Our findings and products will enable the FAA to achieve its mission to provide the safest, most efficient airspace system in the world”

Strategic Plan Content

Strategic plan content was defined through the execution of a requirements analysis to determine the current state of human factors in the NAS, a high level gap analysis, and the

identification of opportunities for future research advancements based on industry needs and Agency level direction. The strategic plan is composed of five research categories that are defined by related objectives and lower level strategies. A summary of document categories, objectives, and strategies are listed below in Table 1. The remainder of this document will detail strategic materials generated as a result of the aforementioned activities.

Table 1.
Research Categories, Objectives, and Strategies

Category: Research for Operations	
Objective 1: Provide In-Service / Post Implementation support to the AT and TO Organizations to enhance fielded systems, procedures, and operations	Strategy 1.1: Develop a Change Management strategy for the ATO to transition from current operations to an automated future NAS
	Strategy 1.2: Integrate HF into day-to-day operations to improve human performance and safety in the NAS
Category: Human Centered Design	
Objective 2: Implement human centered design concepts to achieve operational human performance objectives, reduce the likelihood of human error, and increase the availability of AT systems	Strategy 2.1: Develop an integrated ATM philosophy for service-oriented workstations
	Strategy 2.2: Develop HF system standards and guidelines to improve human-system performance
Category: Human Systems Integration	
Objective 3: Lead the development and incorporation of the human systems integration concept into an automated, future NAS	Strategy 3.1: Integrate applied human factors into the development of a human centered automation philosophy
	Strategy 3.2: Further develop the Air-Ground Integration concept to improve controller-pilot situational awareness and decision making abilities
Category: Selection and Training Process Improvement	
Objective 4: Strengthen the FAA's personnel selection and training process to improve the hiring and maintaining of a qualified, diverse, workforce of the future	Strategy 4.1: Improve existing AT selection tests to reduce Agency costs of hiring ATCSs through refined selection
	Strategy 4.2: Improve applicant placement by facility type to increase training efficiencies and decrease developmental attrition rates
	Strategy 4.3: Expand technical and personal development training to improve skills and abilities of the workforce to perform job functions and maintain the safety of the NAS
	Strategy 4.4: Improve Technical Operations workforce selection, training, and workforce maintenance
	Strategy 4.5: Proactively assess AT and TO job-tasks to identify emerging KSAOs during the transition to an automated NAS for future selection process improvement
Category: Increase Human Performance and Safety	
Objective 5: Maintain a high level of human performance and safety within the current and future NAS as new technologies and operations are introduced to the AT system	Strategy 5.1: Improve NAS actor performance so the probability of human error within the AT system is reduced
	Strategy 5.2: Support the use of Safety Management Systems to proactively identify, manage, and mitigate human factors risk(s) to the NAS and identify contributing AT incident and accident causal factors to promote the future optimization of ATC and TO performance
	Strategy 5.3: Improve AT system availability through the reduction of unplanned AT system outages as a result of human error

Research for Operations

One of the most difficult challenges faced by the FAA is meeting the expectations and operational needs of all system users. Simultaneously, safety, capacity, efficiency, and predictability must be increased during operations in a seamless global environment (FAA, 2012b). To address these forward looking challenges, the ATC / TO Human Factors Team has made it a priority to engage in all segments of the FAA Acquisition Management System (AMS) process, with an emphasis on the In-Service Management phase. Within this phase, service organizations are responsible and accountable for operational sustainment activities, corrective actions, and management of personnel as well as technical resources. Numerous research opportunities exist to positively impact ATC / TO systems, operational human performance, safety, coordinated decision-making, and human factors policy inputs.

A future automated NAS will introduce changes to the roles and responsibilities of NAS actors across the various domains as well as the allocation of functions between human operators and automation (Krois et al., 2010). Responding to change, whether it is on a human or system level, may be challenging if systems or procedures are not well presented and received by the user-community. In an effort to streamline the change process from idea to implementation within the ATO, the ATC / TO Human Factors team will engage in change management research. The centralized theme of change management products will be human factors processes to transition individuals, teams, and organizations from a current state to a desired future state. R&D products are intended to assist the ATO in proactively maximizing system and procedural user-acceptance while also reducing potential safety risks.

Successful transition to an automated NAS is dependent on newly implemented systems and procedures meeting post-implementation success criteria that incorporate the end-user. Historically, FAA human factors research has focused on assessing replacement system performance against legacy system performance with limited facility personnel interactions. To better engage the operational community, improve workplace conditions, facility culture, safety, training, and inclusion in the FAA AMS process, the ATC / TO Human Factors Team will conduct exploratory research to integrate human factors personnel on a day-to-day basis at the facility level. Due to the complexity, size, diversity, and number of facilities across the United States NAS, management of human factors resources to accomplish and sustain this strategic objective is one of the primary challenges facing the ATC / TO Human Factors Team.

Human-Centered Design

“A major challenge is integrating human factors” with future “technology and procedures to ensure safety” (FAA, 2012b). Future ATC / TO workstation design must include human factors inputs throughout the design process to achieve operational human performance objectives and reduce the likelihood of unintended operator outcomes. Historically, minimal guidance regarding the definition of human roles and responsibilities, interface development, or the incorporation of emerging technologies in FAA documentation has led to human-centered design shortfalls. To mitigate potential system, human, and automation challenges, the ATC / TO Human Factors Team will partner with industry and other government agencies to develop human factors standards and guidelines to be used as inputs to legacy replacement system acquisition, as well as updates to existing technologies. Uniformity across workstations is intended to improve human performance, system usability, and user efficiencies.

From an air traffic perspective, service-oriented workstations are currently defined via the services provided by air traffic controllers to NAS consumers in one of the three ATC domains: Tower, Terminal Radar Approach Control (TRACON), and En Route. Services provided are constrained to the limitations of facility-specific and domain-specific hardware and software, airspace configuration(s), and the inter-operability of air traffic systems with adjacent facilities. The two radar environments (TRACON and En Route) have similar functions and capabilities but operate on different automation platforms that are being independently modernized. Research opportunities exist to develop an integrated Air Traffic Management philosophy to address the application of successful human performance design elements from one domain to another to optimize human performance in future hardware and software releases. Research philosophy products are multi-faceted. In this specific case, the philosophy is intended to integrate the human-centered design and human systems integration (HSI) concepts into ATC system design. The philosophy will assist operational personnel achieve system level human performance objectives and system developers to integrate independent automation tools.

Human Systems Integration

“Human systems Integration intends to ensure the effective and efficient interaction between aviation actors and other system elements in the NAS to enhance safety and performance” (Krois, et al., 2010). Specific to the ATC / TO domain, factors comprising HSI include: Human Factors Engineering, Safety, Training, and Personnel Selection. Each of the four factors build off of the human centered design concept and support the identification of inter-related research needs to yield comprehensive, higher quality products for operations.

As the FAA transitions to an automated NAS, the Agency is moving from a cognitive-based aviation control system to one with automated decision support tools (DST) requiring a collaborative work environment (FAA, 2012b). Future ATC system design may increase levels of automation and DSTs. Automation will be instrumental in increasing safety and capacity only if the operator can effectively utilize the automation and DSTs. Therefore, the ATC / TO Human Factors Team will engage in research that supports the development of a human-centered automation philosophy. The automation philosophy will be oriented by the operation of domain-specific systems utilized by air traffic controllers. This perspective will promote human centered system design and act as a barrier for unintended designer errors leading to unintended operator outcomes. Additionally, the philosophy will provide standardized methods of proactively testing automation for human performance risks prior to implementation. As new automation and technologies are introduced, it is critical for there to be a formal definition of human roles and responsibilities, as well as human-automation interactions as NAS actors and automation continue to evolve to meet future needs.

Selection and Training Process Improvement

The ATC / TO Human Factors Team is responsible for proactively identifying changes in the roles and responsibilities of air traffic controllers and system maintainers that lead to updates in workforce selection and training processes. The FAA is delivering “aviation access through innovation” by “ensuring that airport and airspace capacity are more efficient, predictable, cost-effective, and matched to public needs” by having “the right people with the right skills in the right positions at the right time” (FAA, 2012b).

As the FAA transitions to an automated NAS, the Agency needs to build upon past achievements and continue to strengthen its personnel selection and training processes, while maintaining methods of selection that are valid, reliable, legally defensible, and fair. Benefits to refined selection, such as decreased costs, attrition rates, and improved training efficiencies, can be further realized. To advance the research and development of products to improve selection, the ATC / TO Human Factors Team will engage in the following activities:

- Improve applicant placement by facility type to increase training efficiencies and decrease developmental attrition rates
- Expand technical and personal development training to improve skills and abilities of the workforce to perform job functions and maintain the safety of the NAS
- Improve ATC and TO workforce selection, training, and workforce maintenance
- Proactively assess AT and TO job-tasks to identify emerging Knowledge, Skills, Abilities, and Other Characteristics (KSAOs) during the transition to an automated NAS for future selection process improvement

Increase Human Performance and Safety

Maintaining a high level of human performance and safety as new technologies, procedures, and policies are introduced to the current and future NAS is a priority to ATC / TO Human Factors Team. This will be accomplished through the prioritization of research that improves safety event data collection, development of new analytical methods to enable a better understanding of safety event causal factors, derivation of human factors interventions to prevent undesired events, and the proactive detection of emerging human error hazards. Additionally, human factors support is needed to support the FAA's continued growth of the Safety Management System (SMS). Integration of human factors into SMS will assist in streamlining the SMS process, reduce the likelihood of isolated ATC safety decisions, and provide the opportunity to incorporate human performance hazard assessments to mitigate risks associated with procedures, technologies, and policies.

Conclusion

The ATC / TO Human Factors Strategic Research Plan is the ATC / TO Human Factors Team's commitment to provide the FAA, its operational workforce, and flying public with the highest quality human factors research products that yield the greatest operational results. Achievement of the ATC / TO Human Factors Team mission is dependent on the effective execution of the strategic plan. Therefore, the plan is intended to serve as a communication tool for the Team to further engage the human factors community of practice in its ten year strategic direction and crosscutting accomplishments.

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Disclaimer

The opinions expressed are those of the authors and do not represent the Federal Aviation Administration (FAA).

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