

REDAC Human Factors Subcommittee
Findings and Recommendations and Actions from Winter/Spring 2018 Meeting

Findings and Recommendations

Finding 1: Important areas for continued research and development

The subcommittee was pleased to learn the FAA FY2020 Human Factors Core and NextGen research requirements include the areas of:

- Certification criteria for advanced avionics technologies and vision systems such as Combined Vision Systems and head worn displays.
- Evaluation of fatigue mitigation in flight operations.
- Evaluation of training effectiveness including new training paradigms such as distant learning and virtual/augmented reality, and training methods for the next generation of pilots.
- Validation of pilot training and procedures for Next Gen integration.
- Human factors guidelines for advanced instrument procedure design.

These areas were identified by the subcommittee as significant areas of research in either their emerging issues list or areas that require continued early stage research.

Recommendation:

The subcommittee believes these are high priority areas that should remain consistently funded despite the proposed budget reductions. The subcommittee recognizes the FAA has many competing priorities to balance, however if any of these areas are not funded the sub-committee would like to review the rationale for those decisions.

Consequences:

The consequences of not funding research in these areas would overly constrain industry in implementing features and functions. Many of these features promise to enhance safety or operational efficiency, hence overly constraining their introduction could negatively impact safety and operational efficiency. Without thorough evaluation of these new features and functions new safety concerns may arise. It is important when evaluating new technologies, training, or procedures that there is an adequate balance of allowing for innovation versus maintaining safety. Without adequate research into how to perform that evaluation, the FAA is at risk of either over or under constraining the introduction of important features, functions, and concepts. The consequences of not funding training research would potentially result in delaying evaluating new training technologies, such as AR/VR, and training methods, such as distance learning, for their effectiveness. Implementation of standards that define the effectiveness of these approaches use for training would also be delayed and potentially impact safety. The pilot demographic continues to change and research is needed to identify how the knowledge and skills of the next generation of pilots maps to expected knowledge and skills implicit in training today so that recommended adjustments can be made to improve effectiveness.

Finding 2: Research gaps that are not well represented in the current funded portfolio

A number of very important Human Factors research areas were identified by the Subcommittee that have not been included as part of the proposed FAA FY2020 Human Factors Core and NextGen research requirements. However, in order to provide the insights and guidance necessary to achieve the intended improvements in safety and efficiency promised by future developments in the operation of the NAS, there are a number of additional research areas that must be supported.

The following three areas are considered particularly urgent:

1. *Understanding and addressing Human Factors issues associated with integration of UASs into the NAS.* This includes defining standards to ensure safe and efficient integration with other air traffic and needs to encompass both small and larger than small UAVs. There are a number of unique challenges that such vehicles introduce, including support of situation awareness, piloting and decision making by remote pilots, coordination with visual observers, and new ATC paradigms to manage rotorcraft, as well as contingency planning and interactions with the automation providing sense and avoid functions.
2. *Managing increased complexity in airspace operations.* This introduces a number of Human Factors issues due to the need to integrate and transition to new NextGen concepts, technologies and procedures within and across domains. This is made even more challenging by the expected variations in the performance capabilities of old and new vehicles and the introduction of new types of operations such as increased reliance on performance based navigation and the use of remote towers.
3. *Supporting effective information management.* Access to information is accelerating at an increasing rate. Some of this information is embedded in certified systems and is managed by information automation, while some is available through less formally controlled resources. This applies across the board to information access by all operational staff, including air traffic controllers, pilots, dispatchers, ramp controllers, traffic managers, maintainers, etc. Without Human Factors research to guide decisions regarding certification, design and training in terms of information access and use, intended improvements in safety and efficiency simply will not be realized. Information overload, cumbersome and inconsistent interface designs, stove-piped information sources (such as the use of an electronic flight bag as a source of information rather than displays integrated with the flight management system), and poorly conceived interactions with information automation are all potential barriers to achieving desired improvements.

In addition to these three broad topics, two other very important Human Factors research focus areas requiring attention were identified by the Subcommittee.

1. *Increased introduction of automation and autonomous systems/subsystems.* This topic touches upon a number of important topics fundamental to human-machine teaming and software mediated human-human coordination and collaboration. Human Factors research is essential to understand how different underlying technologies such as machine learning can be successfully integrated into safe and effective human-machine systems that can respond effectively to both routine and anomalous scenarios. This includes consideration of interaction design as well as guidance on how to assign roles and responsibilities to both humans and machine agents.
2. *Transition to Trajectory Based Operations (TBO) and Performance Based Navigation.* A basic assumption underlying NextGen is that the NAS will evolve into a system based on the 4-D

management of aircraft trajectories. The importance of this evolution is further supported by the central role that TBO plays for the U.S. to comply with upcoming ICAO requirements for trajectory synchronization in 2025 and beyond. The assumption is that this transition will safely enable increased throughput through better organized flows with significantly reduced vectoring or holding, and will better condition and support the use of RNAV SIDs and STARs with Optimized Profile Descents (OPDs) in order to increase efficiency. Experience to date with the introduction of TBO into enroute operations, as well as with the introduction of RNAV SIDs and STARs, has been mixed. While there are examples of the successful introduction of these new procedures and supporting technologies, some facilities have struggled with their introduction. In order to successfully transition to TBO in a timely and safe manner, the Human Factors issues associated with the management of such significant changes and the associated design decisions regarding operational integration need to be addressed.

Recommendation:

The FAA should review the Human Factors areas identified above for inclusion in its research portfolio in order to ensure that these issues will be addressed in a sufficient and timely manner. The Subcommittee further requests that the rationale for the resultant decisions regarding these research areas be presented to the Subcommittee at its next meeting, along with an analysis of the expected consequences if they are not supported.

Consequences:

The consequences of not addressing these Human Factors research issues in a proactive manner will introduce a major barrier to achieving the goals of NextGen in a safe, timely and effective manner. Without this research, lessons will have to be learned the hard way, with frequent missteps that will introduce significant delays in the improvement of the NAS. One result of such missteps will be economic and environmental impacts, as planned increases in efficiency and capacity will not be achieved in a timely manner. A second result will be an inability for the U.S. to comply with expectations established by ICAO. And finally, while we can hope that the safety nets that exist in the NAS prevent actual accidents as these lessons are learned, without Human Factors research in these areas, we can expect an increase in operational errors and near misses.

Finding 3: Flight Crew Information Management

One of the issues the sub-committee has identified is the area of information management by the flight crew. While this is a broad area, a specific area of concern entails the integration of operationally approved information with information contained in certified flight deck / avionics systems. The flight crew has historically been presented with information from both the operationally approved and flight certified arenas. However, in today's environment there is an increasing integration of these various sources of information. It is important from a safety aspect for the flight crew to understand both the accuracy, integrity, (i.e., trustworthiness), and timeliness of all information. From an economic and efficiency standpoint, the increased integration of operationally approved information on the flight deck will facilitate the uptake of new features that will enhance overall operations as well as improve safety. There are currently gaps in understanding how the FAA can effectively evaluate appropriate means to ensure that the flight crew understands the accuracy and integrity of various pieces of information on the flight deck. The traditional methods of using current workload assessments and of using device or location differences to differentiate and communicate the general trustworthiness of information are insufficient in evaluating the emerging ways information is being presented and integrated in today's and future flight decks.

Recommendation:

Include the following areas of needed research in the Flight Deck research portfolio:

- 1) How to evaluate the integration of operationally approved information into certified systems, i.e., generate appropriate ways to evaluate means of compliance for various ways in which information is provided to the flight crew.
- 2) Identifying the limits of the flight crew in understanding the important characteristics of information (e.g., accuracy, integrity, and timeliness) and determining how to evaluate the acceptability of new ways of presenting that information.
- 3) Understanding how pilots manage and use the information effectively/ineffectively in the conduct of their work.

Consequences:

The consequences of not performing adequate research in this area will result in one of two options: 1) The FAA may be overly conservative in applying current evaluation methods that will result in inhibiting industry innovation in bringing new features and functions to the flight deck that promise to increase both operational efficiency and safety, or 2) the FAA may under constrain the implementation of emerging mechanisms of information integration that may lead to safety issues where the integrity or completeness of presented information may be misunderstood by the flight crew resulting in unintentional misuse of data that can lead to inappropriate actions and/or decisions on the part of the flight crew.

Actions

Action 1: Mixed Capability in the NAS

The Subcommittee was pleased to receive a briefing outlining a methodology for the FAA to identify and coordinate HSI issues that span across the multiple domains and capabilities being developed for implementation, in order to mitigate human factors risks associated with the scale and rate of changes, and mixed-capability environment, anticipated for NAS operations in the coming years. However, the results of this preliminary study were not ready to share at the February 2018 meeting. The subcommittee requests a briefing at the Fall 2018 meeting to provide insight regarding the results and findings of the study.

Action 2: Research Priority

Given the significant reduction to FAA's RE&D budget, the subcommittee recognizes the importance of FAA developing and articulating a clear strategy to prioritize its research portfolio. This strategy should reflect Administration priorities, identification of the most important human factors research needs, and FAA's unique ability to address those needs. In developing this strategy, FAA should consider any planned changes to its partnership approach as noted in Action #3. FAA may also wish to consider how this strategy may affect its current process for evaluating human factors research proposals from its constituent offices. FAA should provide an update on this strategy and its implementation at the Summer/Fall 2018 meeting.

Action 3: FAA-Industry Partnerships

FAA should work with industry and other government agencies to develop a partnership strategy for identifying the most important human factors research needs and the role of major partners in addressing those needs. Given the current budget environment, it is expected that FAA will need to rely more on its partners to complete the necessary research. FAA may wish to consider a "Lead, Leverage, or Watch" framework in defining its role for each research area. Criteria for determining the appropriate role should be developed. The subcommittee recommends that FAA limit its role as research leader to those areas where it has an appropriate and unique role in conducting the needed research. In areas where FAA will rely on industry contributions, the strategy should consider ways to address intellectual property, proprietary information, and other related issues. FAA should provide a briefing on the interim status of this partnership strategy and its planned implementation at the Summer/Fall 2018 meeting.

Continuing Actions from our previous meetings:

1. Receive briefing on the updated UAS research plan and provide feedback
2. Receive briefing on the updated NARP and provide feedback
3. Receive briefing on status of Remote towers research