

**Federal Aviation Administration
REDAC Human Factors Subcommittee**

**Feedback on Research Landscape Drivers
Winter/Spring 2019**

The FAA should be commended for its efforts to provide strategic research guidance through the development of landscapes and research drivers. The subcommittee recognizes the importance of providing this guidance in a manner that enables prioritization of research activities based on critical aviation needs and FAA's unique ability to address those needs.

The Subcommittee spent a significant part of the 2019 WS meeting discussing and reviewing the 25 drivers, however because the drivers and their associated issues were not clearly described or scoped the Subcommittee asked the FAA to use the HF emerging issues list as the starting point for filling out the workbook.

The Subcommittee consensus was the proposed research drivers are not all drivers, some are technologies, some are capabilities, some are solutions, and recommended the FAA review and clarify the list of drivers. The Subcommittee would request the FAA to refine the list of drivers and present rationale for why those drivers are important over the next ten years. Then the FAA should present their analysis to the Subcommittee for feedback.

The tasking left open several questions about how to productively proceed, so the Subcommittee opted to ask the FAA to use the HF emerging issues list as the starting point for the workbook and then report back at our next meeting. The current HF emerging issues list is attached. The Subcommittee plans to review and update this list at the Summer/Fall meeting in August 2019. The Subcommittee did identify those drivers with HF impact and they are shown below in **BOLD**:

1. Supersonic Flight:
2. **Urban Air Mobility**: various flying taxi type new entrances into the market, implications of how they move around, types of piloting, interfaces with NAS (depending on autonomous, semi-autonomous)
3. **Growth of Mixed Operations (Piloted, Autonomous, Unmanned)**: pilots flying different aircraft; piloted vs. autonomous vs. unmanned flight ops.
4. **New Mission Types**: any novel operations outside current traditional aircraft operations, e.g., ultra long flight, high altitude flight ops.
5. **Non-Traditional NAS Access Points**: any means that aircraft enter the airport other than traditional methods (e.g., from the top of tall buildings)
6. Space Operations
7. **Enable Routine Small UAS Operations Beyond Visual Line of Sight (BVLOS)**: anything larger than Part 107? (regardless of the size of the UAS) Note: big difference between Part 107 (50 lbs) and anything larger than Part 107 (larger than 50 lbs)
8. **Autonomous ground service equipment at airports**: smart airport, autonomous tug, baggage loader, any GSE that is autonomous; autonomous can be different stages (some human interaction; no human interaction)
9. **Aircraft Command and Control Using Automation and Remote Sensing Technology**:

- ATC Command and Control using Automation and Remote Sensing Technology:** ATC more automation, more autonomous aircraft (very different topics)
10. **New Vehicles or their Components Which Make Use of New Technologies, Software, or Materials:** new materials, new technologies, anything that is involved in aircraft itself
 11. **Certification using New Technologies, Standards, or Processes:** cert of new vehicles that use new technologies, including modeling (vs. new technologies)
 12. **Remote/Virtual Technologies for aircraft:**
 13. **Remote/Virtual Technologies for ATC:**
use of sensors, cameras on the aircraft vs. ATC (tower)
 14. Advances in Electric or Hybrid Electric Propulsion
 15. Future Fuel Technologies
 16. **New Technologies to Airport Pavement Infrastructure and Design:** emerging technologies from REDAC-Airport side
 17. Information Assurance and Security for All Operations (cyber-security)
 18. Big Data Analytics and Techniques
 19. **Human-Machine Teaming (roles & responsibilities) and New Technology Interfaces:** new tech interfaces for Human-Machine Teaming; teaming is different from interface/interaction? Technologies play a role in teaming/working together; speech recognition
 20. **Artificial Intelligence:** technologies, machines learn as they evolve; maturity
AI is a solution rather than a driver
New and novel ways of decision making → AI is one method.
Safe and effective decision making through autonomous evolution
 21. Increased Connectivity by Cyber-Physical Systems (Internet of Things Technologies)
 22. Crowd Sourcing Weather Data
 23. Advancement in Position, Navigation, & Timing Technology
 24. Risk-Based Decision-Making techniques and analytics
 25. Infrastructure Resiliency and Continuity of Operations
 26. New Medical Technologies and New Substances (Medications, Drugs, Etc.)

REDAC Human Factors Subcommittee
Human Factors Emerging Issues List
April 23, 2018

At the REDAC Human Factors 2018 Winter/Spring meeting the subcommittee identified emerging issues for research and development. The issues are presented in terms of their timing for need and are all considered high priority and important research and development areas the FAA should consider funding.

Nearer term issues that are urgent and need to be addressed in the next 5 years:

1. HF research will facilitate safe and efficient implementation of UAS in the NAS.
Understanding and addressing Human Factors (HF) issues associated with implementation of UAS in the NAS such as:
 - a. Defining standards for safe and efficient operations
 - b. Implementation guidance for all sizes of vehicles
 - c. Integration with other air traffic
 - d. Sense and avoid considerations
2. Increasing complexity of the airspace introduces several human factors issues such as integration of NextGen concepts, operational capability variation in the mix of old and new vehicles, growth of vehicle and operations types, distributed responsibility, remote towers, and smart ground and air distribution.
 - a. The HF issues challenges associated with implementation of these complexities requires research at the front end to ensure a successful implementation
 - b. Research is needed for adequate consideration of operational integration, otherwise advances will not show the expected safety and efficiency benefits
3. Information management (operationally approved information vs. certified avionics systems, EFB, maintenance tasks and maintainers)
 - a. Pace of adoption and demand are increasing
 - b. Rapid, continued growth is expected
 - c. Cognitive demand it may place on pilot in terms of workload, confusion, and distraction
 - d. Determining what may create a lack of information integrity
 - e. Inconsistent user interface and interaction with the flight deck interface
4. Training and qualification methods and technologies
 - a. New training methods and technologies for the various user groups (pilots, air traffic controllers, technical operations, maintenance technicians, etc.)
 - b. Measure effectiveness of new training methods and technologies and develop standards to account for changing pilot demographics, distance learning, assessment, and operational validation of procedures.
 - c. FAA may be able to leverage industry for the training design itself but will need to set standards for effectiveness.

5. Trajectory based operations
 - a. Initial TBO is expected to be implemented through 2022; important additional caps are proposed beyond 2022. Because TBO implementation is under implementation it is difficult to determine what research will need to be planned for 2020 and beyond.
6. Increased automation and autonomy to enable operations with a reduced crew, decision support, distributed responsibility, and human machine teaming.
 - a. This is an important emerging area that is also being pushed in adjacent markets (Urban Air Mobility, Self-driving cars, etc.
 - b. The enabling technologies, certification of them, and their integration into the system all need to be addressed immediately.
 - c. HF aspects of integrating UAS into the NAS which would include distributed teaming and machine learning is an urgent emerging issue that should be considered in coordination with issue #1.

Longer term issues that are important and need to be addressed in the next 5-10 years:

7. Development and deployment of new and novel interfaces (such as advanced vision systems, speech, AR/VR, etc.)
 - a. The FAA may come to rely on industry to develop these, but the FAA should be setting standards and facilitate efficiency of the certification process.
8. Cybersecurity (HF protection and detection, wireless, training for detection)
 - a. Data safety and security concerns while performing maintenance tasks with wireless technologies (e.g., potential hack into airplane operational data).
9. Data collection and analysis to enable big data analytics, data fusion, real-time assessments, failure precursors, and human performance monitoring.
 - a. These capabilities will be needed to support large-scale safety assurance systems that monitor conditions, assess potential issues, and mitigate risks through alerting and decision support. Such systems may support operations ranging from an individual flight to the entire National Airspace System.
 - b. Research is needed on the collection and application of human performance indicators that may affect system-level performance.

Consequences of not funding research for these emerging issues:

- Failure to strategize and plan for the above important emerging issues will result in unpreparedness in dealing with increased automation and autonomy, underutilized available and emerging technologies, vulnerability in data safety and security, and underutilization of available data and real-time assessments and monitoring (i.e., not harnessing the power of information).
- Lack of regulatory certainty for large number of diverse operators wishing to implement UAS in the NAS. Operational limitations that prevent realization of potential benefits. Potential suppression of rapidly emerging markets.

- Airspace system that is not capable of handling some novel operations and vehicles. Lack of airspace access or stringent operational limitations may limit realization of new markets. Without adequate consideration of operational integration, advances will not show the expected safety and efficiency benefits. The HF issues challenges associated with implementation of these complexities require research at the front end to ensure a successful implementation.
- Failure to research HF issues related to information management will result in information and cognitive overload of human operators, which will consequently affect human performance and overall system performance.
- Failure to examine training and qualification methods and technologies will exacerbate the shortage of qualified personnel in the various user groups, as well as leave available technologies unleveraged and underutilized.
- Lack of regulatory framework to accommodate increasingly autonomous systems. Insufficient awareness of operational risks and potential mitigations arising from implementation of these systems.
- Difficulty identifying, collecting, or applying human factors data that can impact system-level safety and operational performance. Failure to consider data from human operators and service providers will adversely affect capabilities of system-wide safety assurance systems.