ACT ARC Recommendation 20-1

Managing Attention and Workload Related to Information Automation

I. Submission

The recommendation(s) below were submitted by the Flight Path Management Workgroup (FPM WG) for consideration by the Air Carrier Training Aviation Rulemaking Committee (ACT ARC) Steering Committee at F2F-22, March 4-5, 2020. The ACT ARC Steering Committee adopted the recommendations, and they are submitted to the Federal Aviation Administration (FAA) as ACT ARC Recommendation 20-1.

II. Definitions

Flight Path Management (FPM) is the planning, execution, and assurance of the guidance and control of aircraft trajectory and energy, in flight or on the ground.

Information Automation (IA) refers to systems that automate information-related tasks such as acquisition, calculation, management, integration, and display of information to the flight crew. IA systems may act on, process, and manage the content and format of presented information. IA systems integrate data from multiple sources, convert data to information, and summarize, distribute, format, abstract, prioritize, categorize, calculate, process, and display information in a variety of ways to support flight crew tasks. Using this definition, IA systems used to support FPM could be considered to include:

- Flight Management System (FMS)
- Moving map (MM)
- Primary Flight Display (PFD)
- Head-up Display (HUD)
- Data Communications (Aircraft Communications Addressing and Reporting System (ACARS), Controller-Pilot Data Link Communications (CPDLC))
- Electronic Flight Bag (EFB)
- Crew-alerting Systems (Engine Indicating and Crew Alerting System (EICAS), Electronic Centralized Aircraft Monitor (ECAM))
- Traffic Collision Avoidance System (TCAS)
- Enhanced Ground Proximity Warning Systems (EGPWS)

However, for the purpose of this recommendation, the scope of consideration is restricted to those systems that support pilot tasks, improve flight crew awareness, and inform decision making, but are not generally intended to control the aircraft or its systems. Systems intended primarily to assist pilots in guiding the airplane through the maneuvers necessary for their safe performance (control automation), and systems that essentially display directly-sensed information (*e.g.*, Electronic Attitude Direction Indicators) will not be considered for this recommendation. With this narrowing, the following systems are not included in the discussion:

- PFDs, HUDs, multifunction display panels (MFDP)/Navigation Display (ND) Moving Maps (except for multi-sensor, highly processed and interpreted display components, such as trend vectors or top of descent (TOD) indicators)
- TCAS, EGPWS

Therefore, the revised list of systems includes:

- Flight Management System (FMS)
- Data Communications (ACARS, CPDLC)
- Electronic Flight Bag (EFB)
- Crew-alerting Systems (EICAS, ECAM)

III. Statement of the Issue

Information Automation (IA) systems automate the flow of information used by pilots on the flight deck. IA systems integrate data from multiple sources, convert data to information, and summarize, distribute, format, abstract, prioritize, categorize, calculate, and process information. IA systems then display information in a variety of ways to support flight crew tasks, improve flight crew awareness, and inform flight crew decision making. IA systems in modern flight decks have certainly provided valuable assistance to pilots and have enhanced safety. However, research and operational data have shown that these systems also introduce unintended vulnerabilities that flight crews need to know how to manage. This recommendation addresses the following issues:

- IA systems are highly complex, which may increase time, effort, and activity needed to request, find, access, and interpret information used to support FPM tasks.
- IA systems present information in a compelling manner with high information density, which may increase the attention required to interact with the IA system. Therefore, the attention and engagement an IA system demands may compel pilots to spend more time using the system than is appropriate for the situation.
- IA systems may increase the number of information management tasks needed to support FPM, resulting in increased workload and distraction.
- The compelling nature of IA systems may increase the potential for distractions and heads-down time associated with the use and management of IA systems.

Many IA systems are highly complex and employ interfaces that require focused attention. Because information automation systems support pilots in flight management and decision-making tasks, we should train pilots on effective ways to utilize the systems to support FPM. This recommendation addresses training needed to enable pilots to better manage tasks and attention to reduce the risk of distraction from FPM. Although pilots receive basic instruction in task- and attention-management during their primary instrument-rating training, these skills are no less important, yet perhaps underemphasized, for effective flight path management in air carrier operations.

IV. Proposed Recommendations

The ACT ARC recommends the FAA publish advisory information to operators that includes promoting the following learning objectives for pilot training:[1]

1. Pilots should understand that attention is a limited resource and that each individual pilot should deliberately allocate appropriate attention to relevant tasks with appropriate priority given to FPM. For example:
   - Pilots must not allow themselves to become distracted or consumed by an IA system and fail to recognize an inappropriate aircraft configuration or flight path.
2. Pilots should understand that allocation of crew attentional resources between the pilot monitoring (PM) and pilot flying (PF) should be deliberately managed, as appropriate for flight demands. For example:
   - During critical phases of flight, both pilots should be focused on FPM. In other, less critical phases, one pilot should remain attentive to the flight path while the other may attend to non-FPM systems and tasks, such as using ACARS to get weather information.
3. Pilots should understand the vulnerability that some IA systems may be particularly demanding of pilots' attention. Pilots should be trained to recognize the signs of attentional capture in themselves and fellow pilots. For example:
   - Signs of potential attentional capture include: not communicating, missing checklist items, and failure to verify Flight Mode Annunciator (FMA) modes.
4. Pilots should be able to prioritize tasks, divide workload, and plan for high workload phases of flight in advance, as focused attention required by many IA systems increases cognitive workload. For example:
   - The approach phase is high workload, therefore IA tasks that demand attention should be intentionally scheduled earlier in the flight, so as to be avoided during the approach phase.

V. Rationale and Discussion

Because attention is a limited resource, pilots must make choices about when and where to dedicate their attention throughout the flight. This applies both to each pilot individually and to the flight crew collectively. Pilots must divide attention between flying the airplane and completing other tasks. During training for an instrument rating, a pilot had to learn how to manage attention and how to allocate focus to certain information and systems (comm radios, nav radios, enroute charts, approach plates, *etc.*) at appropriate times, while also assuring flight path management remains primary at all times. It is important for air carrier training programs to keep these "first principles" in mind as additional systems, functions, and tasks are added in modern air carrier flight decks. Because IA systems have become essential tools for flight operations, pilots need guidance and training on how to manage their attention, tasks, and time while using the systems. The output, interaction, and interface of these systems are often very compelling and attention demanding. This results in the potential to complicate task management and distract from FPM.

[1] These recommendations are based on the assumption that the operator has an existing FPM philosophy or policy and associated procedures.

VI. Background Information

ACT ARC Recommendation 20-1 addresses item 4 in the FPM WG Scope of Work and ACT ARC Initiative #36 (see below):

FPM WG Scope of Work:

4. Develop or enhance guidance for training information automation systems or functions (e.g., performance management calculations, multi-function displays), including FMS use, to ensure information systems policies and procedures support, and do not detract from, flight path management.

ACT ARC Initiatives:

- Initiative #36: Develop or enhance guidance for training information automation systems or functions (*e.g.*, performance management calculations, multi-function displays), including FMS use, to ensure information systems policies and procedures support, and do not detract from, flight path management.

References

- Bill Rogers *et al.*, Flight Deck Information Automation: Analysis and Recommendations, Final Report, Federal Aviation Administration ANG C-1, (September 2014).
- National Transportation Safety Board (NTSB), Runway Overrun and Collision, Southwest Airlines Flight 1248, Boeing 737-7H4, N471WN, Chicago Midway International Airport, Chicago, Illinois, December 8, 2005.
- Flight Safety Foundation, A Practical Guide for Improving Flight Path Monitoring, Final Report of the Active Pilot Monitoring Working Group (November 2014).
- Operational Use of Flight Path Management Systems, Final Report of the Performance-based operations Aviation Rulemaking Committee/Commercial Aviation Safety Team Flight Deck Automation Working Group (September 5, 2013).

Relevant Prior ACT ARC FPM WG Recommendations

- 15-5: Using Safety Management System (SMS) to Address Flight Path Management (FPM) Issues in 121 Air Carrier Training
- 15-10: Intervention Strategies
- 15-11: Auto Flight Mode Training
- 16-3: Operational mode awareness
- 16-4: Academic and Flight Training Elements for training the role of Pilot Monitoring
- 16-9: Manual Flight Operations
- 16-10: Flight Path Management Philosophy, Policy, and Procedures
- 17-1: Manual Recovery from Unintended Autoflight States
- 18-1: Reasonableness checking