ACT ARC Recommendation 19-3

Training Information Automation Systems in the Operational Context

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-20, August 14-15, 2019. The ACT ARC Steering Committee adopted the recommendations, and they are submitted to the Federal Aviation Administration as ACT ARC Recommendation 19-3.

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 to support pilot tasks, improve flight crew awareness, and inform decision making. IA systems in modern flight decks have enhanced safety and supported pilot decision making and situational awareness, however they also introduce unintended vulnerabilities that flight crews need to know how to manage. Information is the commodity that is processed, controlled, and output by IA systems. 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.

Information automation is different from other kinds of automation such as *control automation* which assists pilots in guiding the airplane through the maneuvers necessary for their safe performance. IA systems are designed to provide information to support situational awareness, reasoning, and decision making as opposed to supporting skill-based behavior like manual flying. For example, the moving map display transforms raw aircraft position information into a graphical format supporting navigation decisions, while the PFD displays direct-sensed data such as airspeed, distance measuring equipment (DME) range, and bearing.

This recommendation addresses the following issues[1] identified through research and operational data:[2]

- IA systems are generally highly complex. Complexity adds to pilot workload and impedes pilots' ability to understand and detect issues such as information degradation, delay, or incompleteness.
- IA systems automate many functions previously performed by pilots and may result in skill degradation, lack of engagement, and lack of understanding.

[1] Future recommendations (Tasks 2 and 3) will address other issues identified in research and operational data, such as compellingness and distraction.

[2] See, e.g., Bill Rogers et al., Flight Deck Information Automation: Analysis and Recommendations, Final Report (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.

- The degree of accuracy, completeness, timeliness, and reliability of information presented and used for the pilot's task is not always transparent, which may lead to confusion, distraction, and error, making it difficult for pilots to assess whether it can be trusted for decision making.

Current training on IA systems focuses on how to use IA systems, but may not sufficiently convey an understanding of how these systems work, and when and why to use IA systems. Although operators vary in the IA system training they provide to flight crews, most address the functional operation of the individual IA systems, but not necessarily in an operational context. Training use of IA systems in an operational context enables pilots to better manage tasks and attention in order to reduce the risk of distraction from FPM. We define training in the "operational context" to mean training the use of IA systems as a part of the overall larger task, rather than as an isolated activity. For example, using the ACARS to get Automatic Terminal Information Service (ATIS) for arrival is not an isolated activity; it is part of the larger task of planning and setting up for an approach. Therefore, when and how to use the IA system (ACARS in this case) requires consideration of the overall picture (*i.e.*, the operational context) of what is going on at the time that system is used. The operational context includes factors such as the aircraft-specific equipment being used, the operating environment where the aircraft is flying, and the phase of operation. The use of an IA system is always a subtask of the larger task of conducting any phase of the flight operation. Training should focus on the operation of IA systems as one part of conducting the whole flight.

In summary, as information automation supports pilots in flight management and decision making tasks, we should train pilots on the best ways to utilize the systems to support FPM. Current training on IA systems focuses on how to use IA systems, but may not sufficiently convey an understanding of how these systems work, and when and why to use them in an operational context. Training use of IA systems in an operational context enables pilots to better manage tasks and attention in order to reduce the risk of distraction from FPM. Flight crews would also benefit from FPM-based IA system training that incorporates common errors and known vulnerabilities. If pilots know the common "gotchas" of IA systems they will be prepared to check for them and anticipate them, and therefore will not be surprised by them and will build time into their workflow to accommodate them.

III. Recommendation(s)

The ACT ARC recommends that the FAA publish guidance to operators advising the following:

(a) Ensuring that the aircraft is on a safe flight path is the highest priority of each pilot on the flight crew.[3] Training should emphasize the pilots' priority is to fly the airplane first and to not become distracted by IA systems.
(b) Operators should establish policies, procedures, and practices to support appropriate use of IA systems in the operational context. These policies, procedures, and practices should be consistent with ACT ARC Recommendation 16-10, Flight Path Management Policy, Philosophy, and Procedures.

[3] See ACT ARC Recommendation 16-10, Flight Path Management Policy, Philosophy, and Procedures, Appendix A.

(c) In addition to conventional training on the functions of individual IA systems and their applicable limitations, operators should train pilots on the use of IA systems (individually and collectively) in the operational context. This should include training pilots to integrate the use of IA systems into the operational workflow, considering timing and workload demands. For example:

- Requesting landing performance data prior to the top-of-descent (TOD) point for use in briefing versus requesting it while being vectored for an approach.
- Setting up primary and contingency approach charts prior to the TOD point as opposed to while flying the approach.
- Crews should understand circumstances under which using an alternative to an IA system is appropriate. For example, using voice communications instead of ACARS can be more efficient/effective.

(d) Automated flight plan uploads reduce flight crewmember engagement with the planned route of flight, and without diligent verification, risk of reduced navigational awareness is increased. Therefore, operators should train flight crews to anticipate, recognize, and recover from applicable common errors or IA system vulnerabilities related to the operational use of IA systems and emphasize the use of reasonableness checks. (See ACT ARC Recommendations 18-1, Reasonableness Checks; 16-4, Training the Pilot Monitoring and 17-1, Unintended Autoflight States.) For example:

- Accepting a CPDLC “load” clearance on departure drops any previously entered departure, requiring reentry, and adding to workload at an already workload-intensive portion of the flight.
- Aircraft performance computers may display the landing distance associated with a maximum tailwind component of 5 knots for poor braking action, even if the computed tailwind component exceeds that limit.

(e) If the operator has an alternative procedure the pilot is expected to use as a backup in the event of an IA system failure, training should be provided on the use of the backup procedure. Training and remaining proficient in a backup method in the event of an IA system failure will mitigate the negative consequences of skill degradation. For example:

- If weight & balance (W&B) is normally received via ACARS, but ACARS in inoperative, some carriers procedures require that W&B data be manually calculated by the pilots. If this is the case, then pilots must receive training on manual computation of W&B data.

IV. Rationale and Discussion

Previous ACT ARC recommendations have emphasized the importance of FPM and that ensuring the aircraft is on a safe flight path is the flight crew's highest priority. Recommendation 18-1 addressed the importance of training and accomplishing reasonableness checks on the outputs of IA systems that are critical for FPM. This recommendation complements 18-1 by focusing on training on use of IA systems in the operational context.

As an example of what is meant by operational context, when setting up an approach, the IA systems used include ACARS to obtain both Automatic Terminal Information Service (ATIS) information for arrival and performance data for landing. On some aircraft (*e.g.*, the A320/330 series), the flight crew may need to program information from these sources into the FMS. The act of programming these parameters into the FMS (on some aircraft) causes a recalculation of the TOD point. Appropriate training should ensure that pilots understand how much time is needed to execute all these tasks (obtain ATIS, obtain performance data, program FMS) and the effect of completing each task (*i.e.*, entering the data forces the FMS to recalculate the vertical profile). Proper training should put all of the subtasks into a workflow that makes realistic operational sense. This is in contrast to simply training the pilot *how* to do each subtask (*i.e.*, how to request ATIS and performance via ACARS).

IA systems collectively provide information on which the flight crew relies in managing the aircraft flight path. Although operators may vary in the training they provide to flight crews on IA systems, many programs address how to work the individual IA systems, as opposed to how the system works. These programs may not address why and when to use (or not use) such systems. IA systems training should focus on which IA systems or combination of systems contribute to flight crew decisions on FPM. IA systems support pilots in FPM and decision-making tasks; pilots should be trained in the best ways to utilize available tools to support those tasks. Flight crews would also benefit from operationally-relevant training that is reinforced by policies and procedures for IA system use on the respective equipment being operated. Understanding how to use the systems collectively and individually in the operational context helps pilots maintain a reasonable level of overall workload and facilitate the appropriate distribution of attention to IA systems by both pilots.

Flight crews would also benefit from FPM-based IA systems training that incorporates common errors and known "gotchas." If pilots know the common "gotchas" of IA systems they will be prepared to check for them and anticipate them, and therefore will not be surprised by them and will build time into their workflow to accommodate them. Training the most common pitfalls may increase the practical experience level of the flight crew while in a safe training environment. (See ACT ARC Recommendation 15-5, Using SMS to Address FPM Issues.)

V. Background Information

ACT ARC Recommendation 19-3 addresses Paragraph 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.

Source Reports

- Bill Rogers et al., *Flight Deck Information Automation: Analysis and Recommendations, Final Report* (September 2014)
- NTSB, *Runway Overrun and Collision,* Southwest Airlines Flight 1248, Boeing 737-7H4, N471WN, Chicago Midway International Airport, Chicago, Illinois, December 8, 2005

Relevant Prior ACT ARC FPM WG Recommendations

- 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