Search for the Lurking Glitch

Flight data monitoring case studies provided by Flight Data Services, with permission of the operators concerned.

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Valuable insights can be gleaned from an examination of operational data from numerous flights over a period of time. Multiple deviations from approved procedures of the same sort are a strong indication of a previously hidden operational glitch that has the potential, should other factors line up, to increase the risk of an accident.

When these glitches are revealed, pilot behavior can be modified by embedding corrections in training programs, modifying checklists, changing standard operating procedures and implementing other intervention techniques.

This is why one of the cornerstones of a program to improve flight safety is the introduction of flight operations quality assurance (FOQA), also known as flight data monitoring (FDM). These FOQA/FDM programs use analysis of recorded flight data from routine operations to identify safety issues in a non-punitive environment and, where they have been introduced, have made significant improvements in the safety of operations.

The best way to illustrate what these systems can do is by example. Flight Data Services (FDS), a FOQA/FDM service provider and member of the Foundation, has provided three case studies which show how FOQA/FDM can be used to improve safety and provide some useful safety lessons for us all to think about. FDS works with both airline and business aviation operators; Flight Safety Foundation provides a corporate FOQA program of its own.

Case Study #1: Low Speed After Takeoff

The Events

Not long after the start of operations with a new aircraft type, an FDS customer realized that there were a notable number of low-speed-after-takeoff events. Some of these involved a significant loss of airspeed and excessive pitch attitudes.

Investigation

Checking the facts, Flight Data Services verified the aircraft weight, and confirmed that the calculated V_2 speed[1] was in accordance with the aircraft flight manual and that the airspeed and attitude indications were valid.

Next, the analyst set out to determine how this operation compared with that used by other operators to gauge the severity of the problem and to identify the cause. It was found that while the subject operator was experiencing low-speed events on many flights, other FDS customers had far fewer low-speed events. This was a significant difference, and a comparison highlighted the different experiences in the early stages of the climb.

Typical takeoff data from another operator (Figure 1) show the airspeed increase during the takeoff roll to the 20-second mark, when the aircraft rotates. The 15-degree nose-up attitude in the initial climb ensures the climb-out is at about V_2 plus 15 kt, before the nose is lowered and the aircraft accelerates.

Data from the operator with the speed loss problem, however, create a far different speed/pitch plot (Figure 2). As the pitch attitude passes 15 degrees nose-up, the airspeed is beginning to fall, but the nose continues to rise to more than 20 degrees while the airspeed slows to V_2 minus 15 kt.

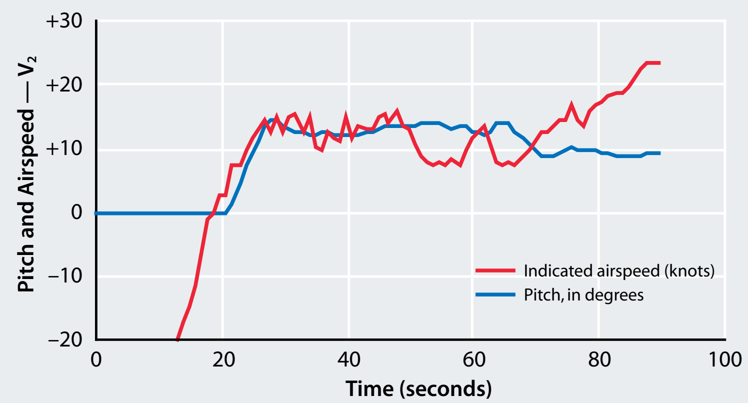
While it might be suggested that the aircraft was not being flown correctly, the flight path modelling work undertaken by FDS demonstrated that the technique described in the training manual was being followed. In fact, the pilots who followed the flight director slavishly and without reference to other instruments were most likely to experience this problem.

The investigation was documented and sent to the operator, who then forwarded the report to the aircraft manufacturer.

Solution

Ultimately, the aircraft manufacturer issued a software update, stating, "It has been reported that the takeoff crossbar was moving instead of standing still at the desired pitch during rotation and subsequent takeoff. Changes have been made to avoid this pitch guidance

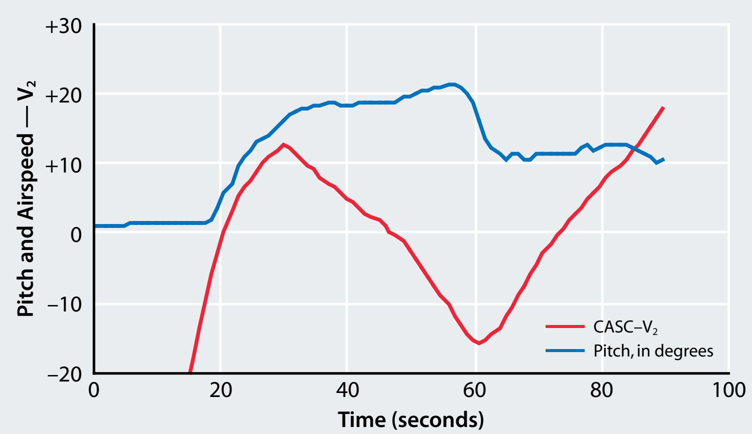
Sample Takeoff Plot



Source: U.S. Federal Aviation Administration

Figure 1

Low Speed After Takeoff



Source: U.S. Federal Aviation Administration

Figure 2

These meetings … were held in confidence and quite informally because the objective was to identify why the pilots delayed flap retraction, and to help them avoid this mishandling of the aircraft.

movement." For the operator concerned, this change, together with training that reinforces the need to maintain scan of all of the flight instruments, has nearly eliminated this sort of event.

Discussion

The advantage of using a third party to analyze FDM results is shown in this case. If the original FDM event data had been observed in isolation, without comparison with other experiences, it might have taken much longer to appreciate the severity of the events. Indeed, the operator may even have doubted the warnings.

In this case FDM, or flight operations quality assurance, alerted an operator to an unexpected quirk in its new aircraft. Training refinements allowed it to operate the new type safely while the manufacturer developed a long-term solution.

Case Study #2: Takeoff Flap Retraction

The Events

Soon after their FDM service began, a new FDM user received reports of "flap altitude exceeded" events, highlighting flap retractions occurring later than recommended during takeoff.

The original data were checked. The criteria establishing when a reportable event occurs were confirmed to meet the specifications, and the analyst could see normal flap movement during the landing phase, indicating that the system was operational, so the events were considered valid. Retraction of flaps from the takeoff setting usually occurs within the first few thousand feet of climb. On two flights, however, takeoff flap was retracted at 16,000 ft and 21,000 ft; during the first 30 monitored flights there were five cases of late flap retraction.

Investigation

The flight safety officer (FSO) for this airline had introduced an FDM system before, and so was aware that in the early stages of FDM it is fairly common to identify abnormal operations that previously had gone unnoticed. The FSO assumed that this probably was the result of a behavior that had existed for some time. Looking for a systematic cause for these events, he met with the flight crews from some of these flights and discussed the operation of the flap controls. These meetings were in no way disciplinary or accusatory, but were held in confidence and quite informally because the objective was to identify why the pilots delayed flap retraction, and to help them avoid this mishandling of the aircraft.

In the interviews, the FSO found that the pilot monitoring made the post-takeoff checks alone and that his check sequence often was interrupted by other tasks, such as operating the radios. Sometimes he would return to the checks; but at other times he would omit part of the checklist and forget to raise the flap lever. In these cases, the climb progressed with takeoff flaps set until one of the pilots noticed the position of the lever. The handling characteristics of this aircraft type were not significantly affected by takeoff flaps because the aerodynamic cues were weak.

Discussion

Two issues here are worthy of closer examination. First, this problem had been missed by all the normal flight safety procedures. Crew training, line checks and air safety reporting were all in place, yet none of the normal mechanisms had revealed that the crews were failing to retract the takeoff flap in a timely manner.

Second, the action of the FSO was aimed purely at identifying the cause of the problem, and none of the pilots involved was criticized or reprimanded. The airline management was not told who had flown the event flights, and made no effort to find out.

Solution

Once the FSO had identified the gap in the procedure, he took immediate action to bring this to the attention of the flight crews. The second step was to change the company standard operating procedures (SOPs) to make all checks a cooperative challenge-and-response routine. This event has not recurred.

Epilogue

The FSO knew of a local operator with the same type of aircraft but without an FDM program. In the spirit of improving flight safety, he took his findings about flap retraction to the flight safety manager of this nearby airline. Although both operators were using the same checklists, the other manager denied that this problem could occur on his fleet.

Case Study #3: Go-Around Procedure

The Events

A well-established operator uses Flight Safety Foundation's Approach-and-Landing Accident Reduction (ALAR) Tool Kit to train their crews about the importance of a stabilized approach. In part, the ALAR Toolkit stresses the importance of initiating a go-around if an approach does not meet the airline's SOPs for stability, and this practice was accepted by the pilots. However, in one instance during a go-around, a crew experienced an enhanced ground proximity warning system (EGPWS) "pull up" warning during the climb-out.

Investigation

At the end of an unsatisfactory approach that failed to meet the airline's stability conditions the crew made the correct decision to initiate a go-around. This should have led to a safe climb-out without subsequent warnings. Therefore, investigation of the flight concentrated on the operation of the aircraft following the decision to reject the landing.

It quickly became apparent that full power had been applied on both engines, but the aircraft had not climbed as it should have. Although the flaps had been retracted in accordance with the procedure, the speed brakes had remained deployed. Consequently, the aircraft climbed too slowly and rising terrain led to the EGPWS warning. At that point the crew realized the mistake and stowed the speed brakes.

When the airline's FSO discussed the circumstances of the go-around with the crew, he found that they had correctly followed the SOP. The problem was that there was no reference to the speed brakes on the go-around procedure.

The Solution

As soon as the data were analyzed and the FSO completed his interview with the crews, an e-mail was sent to all pilots reminding them of the importance of retracting the speed brakes and explaining that this was not in the written SOPs. Urgent action was taken to correct this SOP omission and issue updated procedures.

Discussion

As far as we know, the crew in this case simply followed the SOP, which omitted an instruction to retract the deployed speed brakes. However, the investigation also highlighted the fact that some aircraft automatically stow their speed brakes when a go-around is initiated, while others do not. Although this potential source of confusion is not applicable to this specific case, there is a risk that a pilot who has been trained on a type with automatic speed brake stowage may forget the speed brakes after converting to a type with manually operated speed brakes.

Consequently, Flight Data Services developed an algorithm that identifies through the FDM process when an aircraft has been flown with the speed brakes out but climb power applied, and provided it to all FDS customers operating aircraft with manually stowed speed brakes. Such an algorithm is not called for in U.K. Civil Aviation Publication (CAP) 739 or in the Joint Aviation Authorities advisory material.

Since developing this algorithm, FDS has identified numerous cases where aircraft have been flown using climb power with speed brakes deployed. This new class of event ensures that all these cases have been brought to the attention of the operators' flight safety departments. This is a good example of how flight data monitoring must evolve to reflect the hazards of airline operation.

Conclusion

Incident investigation identified a missing checklist item for stowing speed brakes after initiating a go-around. This led to correction of the procedure and development of a new FDM event. Subsequent monitoring of other operators with the new algorithm revealed that failure to stow the speed brakes during go-arounds was found to be occurring with more often than anticipated. ●

Notes

1. V_2 is defined by the U.S. Federal Aviation Administration as the takeoff safety speed, but it also is known operationally as the second segment speed.