C-FOQA takes root

Foundation introduces a powerful corporate aviation safety tool.

BY MARK LACAGNINA

Following the completion of a successful demonstration project, Flight Safety Foundation has implemented a program to enable corporate aircraft operators to receive the safety and economic benefits of flight operational quality assurance (FOQA).

FOQA, also called flight data monitoring outside the United States, involves the collection and analysis of data recorded during flight operation to detect unsafe practices or conditions outside of desired operating procedures early enough to allow timely intervention to avoid accidents and incidents.[1] Among other benefits, FOQA also allows the identification of maintenance issues and the improvement of operational efficiencies.

British Airways and TAP Air Portugal pioneered flight data monitoring (FDM) in the early 1960s. The more descriptive term, FOQA, was coined by the Foundation in the early 1990s when it led efforts to encourage greater use of the program by airlines in the United States.[2] Today, more than 100 airlines worldwide have FDM/FOQA programs.

"There is no question that FOQA is one of the most powerful safety tools available to the airlines," said Bob Vandel, FSF executive vice president. "FOQA brings previously unknown problems to light before they can cause accidents or incidents, and it helps the air carriers to confirm and quantify problems that they had only suspected. Tremendous savings — in maintenance and fuel costs, for instance — also are achieved through the use of FOQA."

The FSF Corporate Advisory Committee (CAC) in 2002 began to study the feasibility of

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using this tool to help improve corporate aviation safety. With the help of the National Business Aviation Association (NBAA) Safety Committee, the CAC launched the corporate FOQA (C-FOQA) demonstration project three years ago. The results, announced at this year's Corporate Aviation Safety Seminar (CASS), were a resounding thumbs-up: C-FOQA works and shows great promise for making corporate aviation even safer.

Teething Pains

The demonstration project was challenging. Operators of 22 airplanes signed up to participate, but most decided not to proceed because of hardware and installation issues, unresolved questions about data protection and resistance by pilots (*ASW*, 8/06, p. 45). Not coincidentally, these are among the factors that have impeded even greater voluntary use of FOQA by airlines, especially in the United States.

The C-FOQA demonstration project ultimately was launched with the participation of the aviation departments at Altria Corporate Services and Merck & Co. "We were disappointed by the number of operators that dropped out," said Ted Mendenhall, CAC vice chairman and C-FOQA program coordinator. "But even with a small sample, our two operators saw some items of great interest to them, which indicates that they benefitted from the opportunity to look at that data."

Adapting a basically airline-oriented program for use in corporate aviation was difficult. "Certainly, we were new to the game," Mendenhall said. "We learned a lesson that we had been told by the airlines, that it takes longer than you expect to get things up and running. Just due to the multiple parties involved, the legal agreements that we had to work out — that took time. Finding the right people to talk to at the manufacturers took us a while. We are in a better position now because we have some good contacts at the manufacturers, which will help operators get QARs installed in their airplanes."

A QAR — quick access recorder — facilitates data collection and retrieval by tapping into the airplane's digital data stream and recording data similar to the parameters gathered by the digital flight data recorder (DFDR). Total cost for the equipment required to participate in the FSF C-FOQA program is about US$10,000 to $13,000. This includes a QAR with a one-gigabyte storage capacity; an installation kit consisting of a wiring harness and supplemental type certificate (STC); and software to convert the QAR data to a format suitable for downloading. Installation performed by an outside avionics shop costs about $2,000.

Both demonstration project participants found QAR installation and certification to be time-consuming. "Installation actually is very simple, requiring only about four man-hours per airplane, with half of that time dedicated to paperwork," said Jeff Sands, director of flight operations and financial and administrative services for Altria Corporate Services. Altria had two of its three airplanes, a Gulfstream GIV-SP and a G300, in the demonstration project.

Steve Thorpe, assistant chief pilot, airplanes, and C-FOQA program manager for Merck & Co., said, "Our maintenance folks had to work closely with the Duncan Aviation avionics installers to get the QAR installed and running properly." Merck operates a Dassault Falcon 50EX and 900EX, and three Sikorsky S-76 helicopters. The company equipped the 900EX, which has a DFDR, for the demonstration project. "It did take a while to get things running properly," Thorpe said. "Our QAR was the first, or at least one of the first, installed on a Dassault airframe."

Any airplane with a data bus that provides a recordable digital data stream theoretically can be

Data are downloaded from a quick access recorder by a direct or wireless PC connection, or by removing a storage device.

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depends on the operator's Internet connection; typically, transmission of four months worth of data takes about 20 minutes.

equipped for C-FOQA, but unless the airplane already has a DFDR installed, the process might be cost- and time-prohibitive. U.S.-registered multiengine turbine airplanes with 10 or more passenger seats built since 1991 are required to have DFDRs.

"It would have been preferable to have both of our airplanes in the program, but it looked like it would have involved a lot of downtime for the Falcon 50EX, which does not have a DFDR, and significant cost just to put a QAR in," Thorpe said. "We decided to put a QAR in the airplane that was equipped for it and to see how it goes."

Mike DelMastro, director of flight operations for Merck, said, "We plan to have any subsequent aircraft we purchase equipped to participate in the FSF C-FOQA program."

Ones and Zeros

Collecting flight data is one thing; making sense of the data is quite another. "All you get from a QAR is a bunch of ones and zeros," Mendenhall said. "To make sense of this data, you need what is called a data map."

Simply stated, a data map shows what parameters are recorded on each channel of the DFDR, the sequence in which they are recorded and the frequency at which each parameter is recorded. Depending on when they were manufactured, DFDRs record either 57 or 88 parameters, including time, airspeed, altitude, heading, vertical and longitudinal acceleration, roll and pitch attitude, engine power, rate of climb/descent, and flight control position. Many other variables can be derived through analysis of these parameters.

The data map for each DFDR installation is developed by the airplane manufacturer and is essential for FOQA data processing. Some corporate airplane manufacturers consider their data maps as proprietary information and initially were reluctant to provide them to the Foundation. "They thought it was a secret we could not have," Mendenhall said. "For the airplanes used in the demonstration project, Austin Digital, the data-processor that we chose for the project, had to sign releases [nondisclosure agreements] for the manufacturers saying that it would not do anything with the data maps other than the intended purpose of processing the data for C-FOQA." Austin Digital is among several data-processing vendors that will be available to participants in the FSF C-FOQA program. Aerobytes, Flight Data Services and Sagem are among other data processors with FOQA capability.

The operator periodically downloads data from the QAR by removing a storage device or by using a cable or wireless connection to a personal computer. Software provided by the data-processing vendor for the operator's personal computer compresses and encrypts the downloaded data and manages the transmission of the data to the vendor's secure server. Mendenhall says that transmission time

Spotting Variations

Data analysis is highly automated. Basically, the data-processing vendor's software is programmed to detect variations from normal parameters established by regulation, the airplane flight manual or industry best practices. In reference to the latter, Mendenhall said that among industry best practices of primary concern during the demonstration project was approach stabilization.
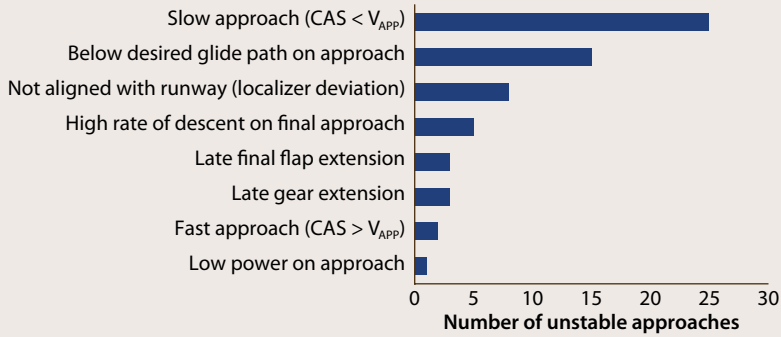
Figure 1 and Figure 2 (p. 14) are hypothetical examples of what an operator might find in a quarterly report provided by a data-processing vendor. The examples were among several in a presentation on C-FOQA by Sands at this year's CASS. Figure 1 shows hypothetical deviations from stabilized approach criteria. Figure 2 shows a hypothetical breakdown of deviations from the target approach speed.

What can be gleaned from C-FOQA data analysis is limited only by the user's imagination. Data-processing vendors can, for example, provide computer animations of an event to help the operator understand what happened (photo, p. 15).

The results of the automated analyses of flight data must, however, be screened for "false positives." Sands provided an example. One of the quarterly reports he received during the demonstration project indicated that a flight crew might have climbed above their assigned altitude. This was detected from data showing that the indicated altitude overshot the selected altitude. Looking at other data recorded
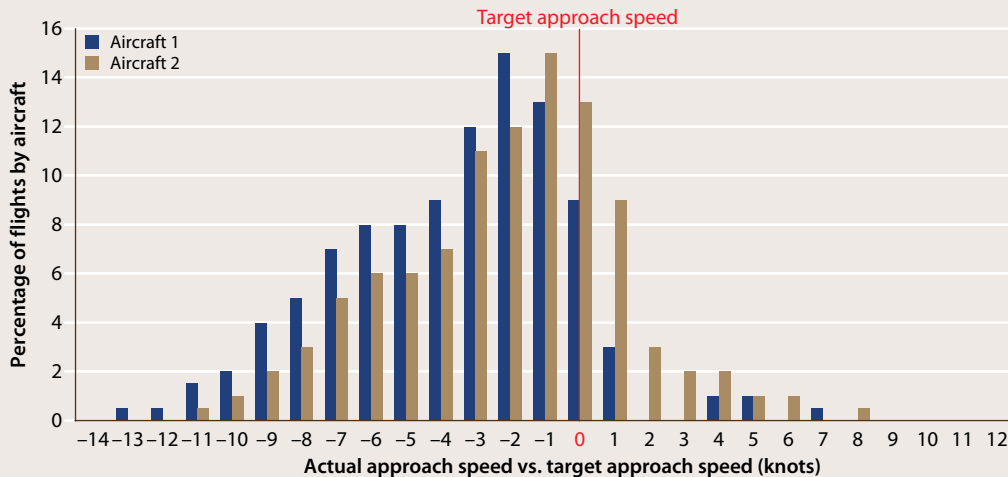
Deviations From Stabilized Approach Criteria

Slow approach (CAS < V_{APP})
Below desired glide path on approach
Not aligned with runway (localizer deviation)
High rate of descent on final approach
Late final flap extension
Late gear extension
Fast approach (CAS > V_{APP})
Low power on approach

0   5   10   15   20   25   30
Number of unstable approaches

CAS = calibrated airspeed V_{APP} = target approach speed

Figure 1

Distribution of Deviations From Target Approach Speed

Target approach speed

Aircraft 1
Aircraft 2

16
14
12
10
8
6
4
2
0

Percentage of flights by aircraft

−14 −13 −12 −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6 7 8 9 10 11 12
Actual approach speed vs. target approach speed (knots)

Figure 2

having less than the proper flap setting for take-off," he said. "It turned out that the departures were from Toluca, Mexico, where the field elevation [8,458 ft] makes that flap setting the normal procedure for takeoffs."

False positives also can be triggered by faulty sensors and other hardware problems in the airplane. During the demonstration project, Mendenhall screened all reports for false positives before they were sent to Altria or Merck. "We will continue to have a review process," he said. "But, quite honestly, the review team could miss something that will be picked up by the operator, who might have a better understanding of the event."

Thus, screening for false positives is also one of the duties of the operator's *gatekeeper*. The gatekeeper, typically a pilot with operational experience in the airplane(s), has overall responsibility for the aviation department's C-FOQA program. Because the gatekeeper has access to non-deidentified data for a specific period — to enable him or her to talk to the flight crew, if necessary, to gain a better understanding of an event — he must be trusted by his colleagues.

during the event, Sands found that the selected altitude was changed at or near the time of the reported altitude bust. "It was apparent that the airplane was proceeding as cleared to the assigned altitude when the controller amended the crew's climb clearance to a lower altitude; because of the late altitude-clearance revision, what appeared to be an overshoot was, in fact, a non-event," he said.

Thorpe provided another example of a false positive. "We had a few departures flagged for

Shutting Out Big Brother

Pilot support is essential for the success of any safety-improvement effort. As administrator of the C-FOQA program, the Foundation secures legal agreements that specify the data-processing vendor's responsibilities and prohibit the operator from using the data for punitive purposes.

A former chairman of the NBAA Safety Committee, Sands is a longtime advocate of FOQA and began discussing the program with his pilots years before the C-FOQA demonstration project was

launched. "We were fortunate to have one pilot on staff who previously had flown for an airline with a FOQA program," he said. "She was very helpful in describing the safety benefits that such a program offers and its nonpunitive nature."

Said Thorpe, "I am sure there were concerns among our pilots at first. I tried to be very open about the process; it was so important to convince them that the program is a very important safety tool and not a 'big brother' enforcement tool or a means to gather information to send to the FAA [U.S. Federal Aviation Administration]."

Sands and Thorpe said that participation in the demonstration project resulted in substantial safety benefits. For example, Sands noted that some deviations from stabilized approach criteria showed up in the first quarterly report. Following a discussion of the findings with his pilots and minor refinement of the aviation department's training program to emphasize certain points, later reports showed that deviations from stabilized approach criteria had dropped to zero. "That, alone, was a significant safety improvement," he said.

The More, the Merrier

Compared with the airlines, corporate aviation departments have relatively few airplanes and more widely mixed fleets; thus, the opportunity to identify trends is limited. The solution is for the Foundation to aggregate the data collected under the C-FOQA program.

"With only two operators and two types of airplanes, we could not aggregate data," Mendenhall said. "But that is what we want to do as we go forward. We generated quite a bit of interest in C-FOQA at the CASS, and several operators have expressed serious interest in the program. A number of them have given us verbal commitments to the program and are now trying to acquire QARs."
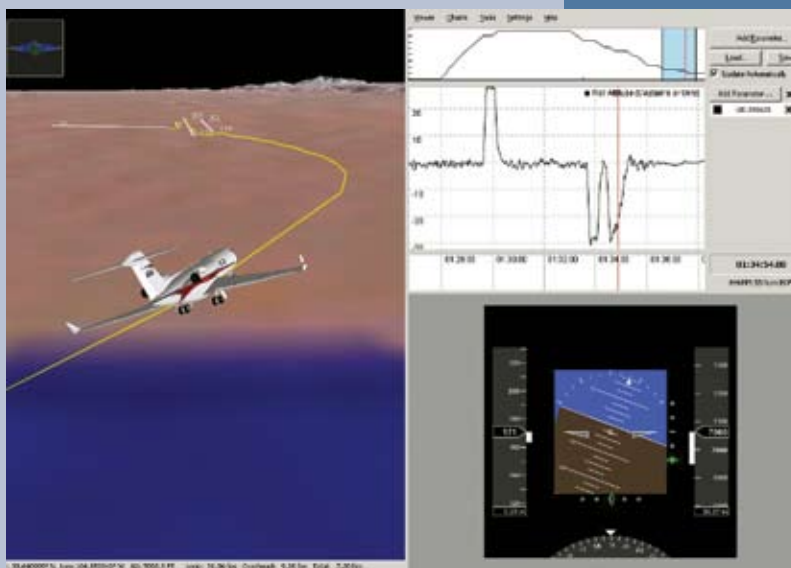
Vandel said that as the program matures, the Foundation also will examine aggregate data to identify trends affecting specific aircraft types, airports, air traffic control procedures, phases of operation — approach and landing, for example — and events such as unstabilized approaches. Information on identified trends will be issued as advisories or alerts to the industry. ●

For more information about the FSF C-FOQA program, contact Bob Vandel at +1 703.739.6700, ext. 110, <vandel@flightsafety.org>, or Ted Mendenhall at +1 936.449.5875, <mendenhe@consolidated.net>.

Notes

1. FSF Editorial Staff. "Aviation Safety: U.S. Efforts to Implement Flight Operational Quality Assurance Programs." *Flight Safety Digest* Volume 17 (July–September 1998).

2. FSF Editorial Staff. "Wealth of Guidance and Experience Encourage Wider Adoption of FOQA." *Flight Safety Digest* Volume 23 (June–July 2004).

> FOQA data can be used to create a computer animation that helps the operator understand how an event occurred.

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