Not Worth Being UPSET

BY WAYNE ROSENKRANS | FROM ORLANDO

Recent U.S. law influences specialists' proposals for simulator upgrades and limited use of all-attitude, all-envelope training airplanes.

Refinements to airplane upset prevention and recovery training (UPRT) for airline pilots will reduce the risk of accidents involving loss of control in flight (LOC-I), panels of specialists predicted during the World Aviation Training Conference and Tradeshow (WATS 2011). In the hands of well-prepared instructors, flight simulation training devices (FSTDs) already in use worldwide adequately reinforce stall awareness and avoidance, several said at the April 19–21 event in Orlando, Florida, U.S.

The international working group they represent, however, almost literally has stepped "outside the box" as they have been drafting a recommendation for UPRT in all-attitude, all-envelope training airplanes at an intermediate stage of airline pilot preparation. Other proposals still in development call for simulation enhancements that, in the long term, would enable airline flight crews to experience — in FSTDs — correct control inputs and responses of specific types of aircraft in the post-stall region of the aerodynamic lift curve.

Sunjoo Advani, chairman of the International Committee for Aviation Training in Extended Envelopes (ICATEE) and president of International Development of Technology, joined the panelists in presenting results of the committee's assessment of airline industry needs compared with the capabilities of existing training infrastructure. The 80-member committee was created in June 2009 by the Flight Simulation Group of the U.K. Royal Aeronautical Society.

ICATEE has gained significant momentum in the context of LOC-I accidents, Advani said. Early work has included products for the U.S. Federal Aviation Administration (FAA) Stall and Stick Pusher Working Group and advice to an FAA aviation rulemaking committee on airline training.

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"The mission of ICATEE is to deliver a comprehensive, long-term strategy to reduce the rate of LOC-I incidents and accidents through enhanced UPRT," Advani said. "There is no single solution or tool in UPRT. Safety is enhanced when training is integrated through proper academics, aircraft-based training and simulator-based training. The key element to that whole process is the qualified instructor."

Although upset scenarios can include atmospheric disturbances, icing, spatial disorientation and flight control system failures, aerodynamic stalls persist as a major precursor. "We haven't dealt with stalls very systematically," he said of previous industry-government initiatives.

"Pilots who might find themselves in a roll upset at 100 degrees of bank or more — yet have been provided [only] with the normal paradigm of unusual attitude training, where they have not seen anything beyond 60 degrees of bank — are probably not well-equipped [to recover]. From anecdotal experience in providing [all-attitude] training, we have seen that most pilots who did not have this training were not able to 'fight their way out of that box.'"

ICATEE so far has specified the training objective of each proposed maneuver, the appropriate method to provide corresponding training and a quality-controlled delivery process, he said. The committee strongly advocates scenario-based, crew-oriented training — adding unexpected conditions — rather than exclusively maneuver-based training.

Training errors of the past also must be rectified without delay. These have included instructors teaching a stall recovery technique that begins with selecting full power and prioritizes minimum loss of altitude rather than immediately reducing angle-of-attack (*ASW,* 11/10, p. 41). Pilot errors have included mismanaging automation and applying techniques of upset recovery that work in the FSTD but would not be effective in the airplane. "All of these have led to a degradation of skills in UPRT," Advani said.

Pilots' academic study of relevant aerodynamic principles, airline indoctrination and recurrent UPRT in simulators can be improved significantly, he said, noting that "simulators have replaced aircraft for most advanced training [and] most of our UPRT training can be completely done in the simulator."

A Fresh Start

The *Airplane Upset Recovery Training Aid, Revision 2* (November 2008) — available at <flightsafety.org/archives-and-resources/airplane-upset-recovery-training-aid> (*ASW,* 2/09, p. 34) — remains "excellent resource material that provides very thorough academic training," Advani said. This 443-page, multimedia tool has not been adopted as widely as first envisioned in 1998, however, he added.

"The book has some limitations: It applies to swept-wing jets of 100-plus passengers and … is perhaps too large and too difficult to absorb and recall at that very critical time of need [for a flight crew]," Advani said. "It's also non-regulatory, not mandated and primarily for airline operations. … ICATEE is developing UPRT manuals, based on this training aid, for pilots, instructors and regulators. We also already have proposed the [simulation] model validation standard and revisions to the simulator qualification manual."

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Advani, left, and Burks.

The ICATEE consensus on pilot exposure in an airplane to the all-attitude, all-envelope flight environment is ground-breaking. "We need a psychological component: the startle factor, the reality factor," he said. "Physiologically, we need to give pilots the experience of the [positive/negative] 'g' environment [i.e., accelerations unlike standard gravitational acceleration (g)]." G-awareness and accurate recovery techniques that will not cause in-flight structural breakup of a large commercial jet are essential, he added. Despite using airplanes certificated for upset maneuvers, this should not be described as aerobatic pilot training, Advani said.

In the future, to expose pilots entering airline careers to "accelerated-g maneuvers and some of the extreme maneuvers, we really see no replacement for aircraft training," explained Bryan Burks, a Boeing 737 captain for Alaska Airlines. This concept reflects the reality that the global airline industry now lacks an infrastructure to use such airplanes in recurrent training of about 300,000 pilots.

"There are pros and cons to the use of the aircraft for UPRT," added Kip Caudrey, senior manager for simulator evaluation, standards and regulatory compliance at Boeing Training. "It also has been quite important to pilots who are currently flying commercial aircraft that there wouldn't be any requirement for them to go back and find some kind of an aerobatic aircraft to become qualified in upset prevention and recovery." ICATEE expects to recommend that UPRT in airplanes be required for all commercial pilot licensing — and that certification level only — and for those in multi-crew pilot license programs, he said.

Full-flight FSTDs thus will remain the principal tool for UPRT among the airline industry's resources. "We must respect the limitations of simulators in terms of the aerodynamic model limits," Advani said, especially the lack of realism of g-cueing and the motion-cueing limits. "ICATEE's tasks are to provide better feedback to the instructor and the pilots; to avoid negative training; and to migrate more toward the scenario-based training approach [*ASW*, 8/10, p. 30]."

ICATEE panelists agreed with several attendees that information presented at instructor/operator stations (IOSs) ideally would include displays of g-loading, angle-of-attack and the validated aerodynamic envelope for the airplane type — but raw data presented to pilots in an FSTD must match the airplane flight deck. "New instrument displays on the IOS would give the instructor more awareness and more ability to provide critical feedback to close the training loop," Advani said.

Today, airlines already conduct stall training in FSTDs with "great accuracy and with the airflow perfectly attached" to the wing until the point of stall warning. Within the so-called amber region beyond the warning point on the lift curve, stall training also is being conducted successfully with an imperfect but acceptable level of fidelity (*ASW*, 11/10, p. 45), he added.

"However, if we talk about training in the [post-stall] red region, more modeling work would be required," Advani said. Research shows that a significant benefit of such training with validated envelopes would be to mitigate the pilot startle factor. "If we can do this effectively, we can significantly reduce the [LOC-I] incidence rates," he said.

Surprising Shortcomings

ICATEE's survey of FSTD operators and follow-up work revealed an unexpectedly high prevalence of negative training, said Alaska's Burks, citing examples such as organizations operating a simulator outside the validated envelope, lack of feedback about the simulation fidelity and false assumptions that demonstration (demo) modes are part of the validated envelope and suitable for training. Practicing a maneuver in an FSTD demo mode can lead the pilot to apply more aggressive flight control inputs than the airplane would require, or even to improvise "alternative control strategies, which can be very negative," he said. Similarly, the high fidelity of current simulators in 98 percent of normal maneuvers has given instructor pilots, line pilots, training providers and airlines false confidence about

realism outside the validated envelope. "Sometimes, extremely aggressive flight control inputs in the simulator are actually rewarded by getting [the simulator] out of the maneuver earlier [yet] the pilot actually would have caused damage to the aircraft," Burks said.

ICATEE research also discovered that FSTDs can momentarily disable flight controls during resets by instructors without awareness by the pilots. "As the simulator is slewed from the normal attitude [at the IOS] to begin the maneuver … it 'washes out' or inhibits flight control inputs by the pilot. … The instructor and the pilot [must] understand that those flight control inputs are not going to be honored," he said.

Consistent Standards

"Competent studies have shown that pilots can do almost all of the maneuvers in the training aid with today's simulators," said Jeff Schroeder, chief scientific and technical adviser, FAA. "Most of what we do, or are required to do, today is train pilots to the first indication of stall, which is often the stall warning. … One [ICATEE-recommended addition] is checking each simulator's performance for high-altitude cruise stall."

ICATEE members so far have spent the most time on advancing simulation in the red region for two reasons. "The first reason is the U.S. law that requires Part 121 air carriers to provide flight crewmembers with ground training and flight training, or flight simulator training, to 'recognize and avoid the stall' … or 'if not avoided, to recover from the stall,'" Schroeder said.

The second is markedly different flight dynamics. "The worry that we have in simulation, potential training or demonstration is that the [startle factor] might contaminate or harm the proper recovery technique," he said. "The pilot then might be paying attention to the roll axis, getting the wings level, instead of reducing angle-of-attack."

From a stall-modeling point of view, another ICATEE concern is: "What's the availability of flight test data on which to base any model improvements?" said Bob Curnutt, senior technical fellow, Boeing Training. "We are looking for a more representative model in the red region, but to get as close as we reasonably can requires [finding valid] flight test data. … There will be a number of airplanes, particularly smaller airplanes, for which we will have the stall speeds and so on, but perhaps no data [that goes] as far as we might like."

Advani said, "We do not necessarily need perfection of the data … especially in the regions around the stall," citing ICATEE's efforts to specify the minimum set of data good enough to achieve the UPRT purpose.

Several panelists and attendees urged caution, conservatism and appreciation for the time involved in introducing airline pilot training in the red region. "For the moment, we really don't believe that we need to go into the red region [where] it is going to be difficult to get the correct data," said Jacques Drappier, a captain and senior training adviser, now retired from Airbus.

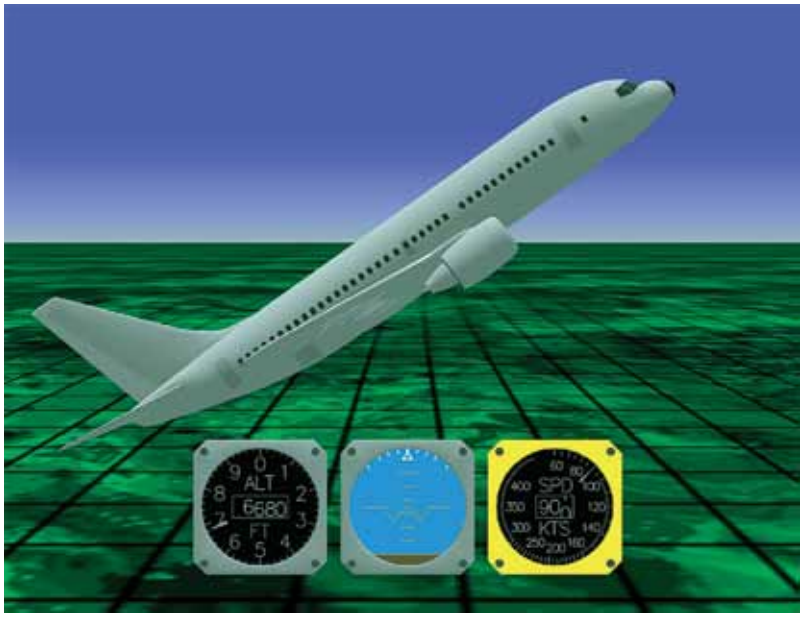
Lou Nemeth, chief safety officer, CAE, concurred in part. "We can certainly get good stall training without going into the red region, but we [already] are finding often that there does not seem to be an appreciation for the dynamics of the vehicle in that region," he said. While considered extremely rare, the issue is that the pilot's excursion in the red region will be "almost an 'Oh, my God!' moment … although I have no idea how often that happens," Nemeth said.

Panelists and attendees also discussed diverse perspectives of the relationship between periodic manual handling during line operations and UPRT. "We need to be very careful and conservative about any intuitive answer to the question of whether manual-handling skills benefit UPRT," Advani said. "[Some people are] assuming that manual-handling skills translate to recovery skills — that is not the case. … Some upset recovery skills are actually counterintuitive."

Drappier, the Airbus representative, added, "Airbus does not recommend encouraging airline pilots to fly the airplane manually [during line operations] because the airline passengers have paid to get the maximum level of safety. Most of the time, the autopilot is the best route." That makes FSTDs the most appropriate practice environment, he said.

Some airline representatives pointed to specific exceptions in their training policies. Session participants especially agreed, however, that an FSTD is the only place that pilots should be exposed to high-altitude manual handling to be proficient, as a backup to recovery with automation.

'A stall is characterized by any, or a combination, of the following: buffeting, lack of pitch authority, lack of roll control [and] inability to arrest the descent rate,' says the *Airplane Upset Recovery Training Aid, Revision 2*.



Upset Recovery Industry Team