The idea for a joint industry working group to produce an Airplane Upset Recovery Training Aid* was first proposed by ATA in June 1996. It was in response to increasing interest by the NTSB in aircraft loss of control accidents which, together with Controlled Flight Into Terrain, cause a large proportion of all accidents. They were putting a lot of pressure on the FAA to produce new regulations covering this subject.

The working group was a voluntary industry initiative to see what could be done within the existing regulations to improve the situation.

The joint industry team consisted of representatives of all sides of industry: aircraft manufacturers, airlines, governmental authorities, and pilots’ unions. It was a good example of how the entire industry, designers, users, and regulators can co-operate on safety issues that are common to everyone. It also marked a “first” in showing that the “Big 3” aircraft manufacturers could and will work together on technical, non-commercial issues. More than 80 persons coming from all around the world, but principally from the USA, participated from time to time.

The end result of two years work is a training package including a video and a CD-ROM, giving an airplane upset recovery training aid. This package is on free issue to all our customers, to use as they wish. However, all members of the joint industry group agreed that the package is aimed at preventing loss of control accidents on conventional aircraft. It is not aimed at protected Fly-by-Wire aircraft.

There is no need for this type of continuation training on protected aircraft, although a general knowledge of the principles involved is useful for every pilot.

The content of the package is not the subject of this article, but there are a few issues of general interest which I gained from my experience as a member of the working group which I would like to mention.

* The Training Aid itself was the basis of the article entitled “AERODYNAMIC PRINCIPLES OF LARGE AIRCRAFT UPSETS” that appeared as a Special Edition of FAST in June 1998.

THE BEGINNING

The issue of upset training was not new; major airlines around the world, and in particular in the USA, had already produced Upset Recovery Training Programmes, or were using one produced by another company. Amongst the members of the group were training pilots from American Airlines, Delta, and United who were already running such training programmes in their simulators. Since this was essentially seen as a training issue. Initially the Flight Test Departments of the three main manufacturers were not involved. Airbus was represented by Larry Rockliff, Chief Pilot at Airbus Training Centre in Miami. Right from the beginning there was a conflict between the technical advice given by the manufacturers’ training pilots and that expressed by those of the principal airlines already practising upset training. They naturally considered themselves to be the experts on this subject, based on the many hours of training that they had already conducted on a large number of pilots in their simulators.

At the beginning of 1997, the Flight Test Departments were asked to come in to support their training pilots. From then on, the chief test pilots of the three major manufacturers became members of the working group. But the conflict over the different opinions on aircraft handling and recovery techniques continued for a long time until we finally achieved agreement at the last meeting in January 1998. The reasons for these differences of opinion are the subject of this article.
To recover from a stall, the angle of attack can cause excessive sideslip, which could lead to departure from controlled flight. Inability to arrest descent rate. Lack of roll control. Excessive rudder. Lack of pitch authority. Buffeting, which could be heavy at altitude permits, flight tests have shown that an effective method to get a nose-down pitch rate is to reduce the power on underwing-mounted engines.

The differences of opinion were mainly concentrated in the following areas:
- Procedures versus general advice
- Ease of training versus failure cases
- Stalling
- Use of rudder
- Use of simulators.

It is worth saying that there was never any difference of opinion between the three test pilots in the group. Although we come from different backgrounds and have worked in different organizations with different work cultures, we always agreed on our technical advice.

The airlines wanted simplified procedures which were common to all aircraft in their fleets and which were easy to teach and easily reproducible. This is understandable because everyone is interested in having a standard product at the end of his training program.

And this is what they already had with the Airplane Upset Recovery Training that they were already doing.

For the training managers from American Airlines, Delta, and United, the only thing necessary was to give an overall industry approval to their existing programs; they already worked, because the many pilots that had undergone training all came out of it with the same standardized experience as to the standard upsets. For them, this was the necessary proof that their training program worked.

Where we differed was in our conviction that there is no such thing as a standard upset and our reluctance to endorse simplified procedures for recovery from an upset.

We wanted a general knowledge based approach, as opposed to a rule based one. For this, after proposing some initial actions, we talk about “additional techniques which may be tried”. This obviously is more difficult to teach.

Where we reached a compromise was in the order of presenting the various actions that might be considered to recover the situation. For us, the order of presentation is for guidance only; it represents a series of options that should be considered and used as appropriate to the situation. It is not meant to represent rigid procedures that must be followed in an exact sequence. However, the order can be used in training scenarios if a procedural approach is needed for training.

The airline instructors also wanted procedures which would apply to all the aircraft in the group. As an example, the thrust effects of underwing-mounted engines were being ignored, whereas it has a significant influence on recovery. Again, we reached a compromise by using the following words: “If altitude permits, flight tests have shown that an effective method to get a nose-down pitch rate is to reduce the power on underwing-mounted engines.”

A stall is characterized by any, or a combination of the following:
- buffetting, which could be heavy at times
- lack of pitch authority
- lack of roll control
- inability to arrest descent rate.

To recover from a stall, the angle of attack must be reduced below the stalling angle. Apply nose down pitch control and maintain it until stall recovery. Under certain conditions with under-wing mounted engines, it may be necessary to reduce thrust to prevent the angle of attack from continuing to increase.

Remember, in an upset situation, if the airplane is stalled, it is first necessary to recover from the stall before initiating upset recovery techniques.

Remember, in an upset situation, if the airplane is stalled, it is first necessary to recover from the stall before initiating upset recovery techniques. This is something that we are well aware of in testing, but it was either being totally ignored or misunderstood. I consider the inclusion of this note to be one of our most important contributions.

We also spent a lot of time discussing the use of rudder. The existing training courses all emphasized using rudder for roll control at low speeds. It is true that the rudder remains effective down to very low speeds, and fighter pilots are accustomed to using it for “scissors”.

We finally got the training managers to agree to play down the use of rudder in their existing courses. But we do not say never use the rudder at low speed. We say that, if necessary, the aileron inputs can be assisted by coordinated rudder in the direction of the desired roll. However, we also caution that “excessive rudder can cause excessive sideslip, which could lead to departure from controlled flight”.

But why did we have so much difficulty in convincing the training pilots that it is not a good idea to go kicking the rudder around at low speed?

Their reply was always the same: but it works in the simulator! This leads me on to my last point.
We manufacturers were very concerned over the types of manoeuvres being flown in simulators and the conclusions that were being drawn from them. Simulators, like any computer system, are only as good as the data that goes into them. That means the data package that is given to the simulator manufacturer. And we test pilots do not deliberately lose control of our aircraft just to get data for the simulator. And even when that happens, one isolated incident does not provide much information because of the very complicated equations that govern dynamic manoeuvres involving non-linear aerodynamics and inertia effects.

The complete data package includes a part that is drawn from actual flight tests, a part that uses wind tunnel data, and the rest which is pure extrapolation. It should be obvious that firm conclusions about aircraft behaviour can only be drawn from the parts of the flight envelope that are based on hard data. This in fact means being not far from the centre of the flight envelope; the part that is used in normal service. It does not cover the edges of the envelope. I should also add that most of the data actually collected in flight is from quasi-static manoeuvres. Thus, dynamic manoeuvring is not very well represented. In fact, a typical data package has flight test data for the areas described in Table 1.

In other words, you have reasonable coverage up to quite high sideslips and quite high angles of attack (AOA), but not at the same time. Furthermore, the matching between aircraft stall speeds and the simulator concentrates mainly on the longitudinal axis. This means that the simulator model is able to correctly reproduce the stalling speeds and the pitching behaviour, but fidelity is not ensured for rolling efficiency.

Simulators should not be used to develop techniques at the edges of the flight envelope.

Simulators can be used for upset training, but the training should be confined to the normal flight envelope. For example, training should stop at the stall warning. They are “virtual” aircraft and they should not be used to develop techniques at the edges of the flight envelope. It is work for test pilots and flight test engineers using their knowledge gained from flight testing the “real” aircraft.

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