The airline industry has flown into some dark clouds - is it finally navigating its way out?

Aircraft Loss of Control - a test pilot's view

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The following article has been written by Captain. Dominik Waser, a Director of Resource Group and our UPRT subject matter expert with responsibility for developing our UPRT eLearning and practical training curriculum. Dominik has more than 30 years of experience as a commercial pilot, test pilot, engineer, instructor and senior manager working for major airlines, aircraft manufacturers and latterly VIP operations. He also holds a current EASA category 2 flight test licence amongst his other flying qualifications and ratings.

As the responsible SME for the Resource Group UPRT training curriculum I would like to highlight certain items and to add to the discussion surrounding the critical topic of Loss of Control inflight, LOC-i. Critical because it has to be clearly stated that LOC-i in most cases leads to a significant departure from an aircraft's certified envelope and unfortunately all too often to the loss of material and life.

A measured and risk averse approach

The definition of an aircraft's flight envelope, its margins and all the devices preventing the pilot from actually losing control are subject to extensive testing during the envelope opening phase of the flight test program. This testing is conducted by a team of subject matter experts on the ground and in the air focussing on handling qualities, performance and adjacent workload analysis. The safety assessment carried out before flying at the edges of an aircraft's envelope (or beyond) is extensive and the approach to the limits careful and thoughtful. Any deviations from predicted values leads to an abort until the root cause can be determined.

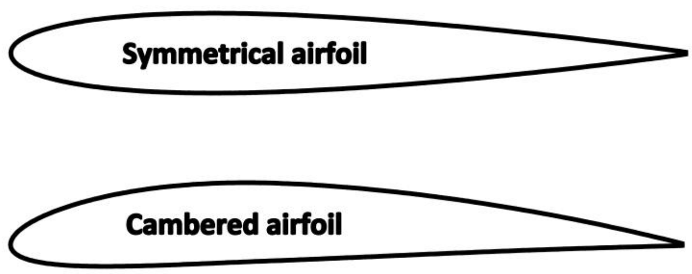
And still surprises can and do occur, and will always occur since gas law does not provide reliable empiric conclusions. Technical margins and flaws contribute to the fact that results may differ from predictions. Due to the in-depth evaluation and preparation before any actual flying takes place (including full scale simulations) there is very little startle effect once the aircraft departs from pre-set values. Mitigation and recovery procedures as well the abort criteria are known, defined and trained for prior to the event. Only thereafter a relatively safe operation beyond certified operating limits is possible. A key objective is reducing exposure to high risk situations, this being a crucial task for flight test engineers and pilots, no matter that the test community is paid to this job, it doesn't have a death wish.

Unwelcome surprises – the startle effect

An analysis of accidents and incidents indicates quite clearly that being in a full LOC-i situation will result in loss of life in a large proportion of cases. Since the outcome of such situations depends largely on psychological factors such as the startle effect, spatial disorientation and with little time being available to implement crisis management tools such as DODAR etc. when they do occur, practical training alone is insufficient to mitigate risk. This is especially so if training carried out in inadequate FTDs or other category aircraft. Additionally, degradation of handling skills due to insufficient time spent hand flying aircraft will only exacerbate startle effect if automation suddenly disconnects in an upset.

Light aircraft training = transferable skills?

Although from a skills perspective it is no doubt beneficial to have been through spin training, the execution of spiral dives, etc. in the early stages of pilot training (or even later in a pilot's career), for those pilots who have been operating heavy metal for decades it is doubtful that such training reduces the risk of LOC-i when this occurs on the periphery of a normal flight envelope. The dynamics, the lag in reaction and possible interference by the stall protection systems (or indeed the FBW) may cause a totally different sensation and consequently a totally different reaction to cope with the situation may be required. Therefore, if not carried out correctly with a suitable instructor it can have an adverse effect if practical UPRT for pilots of transport category aircraft is carried out in light aerobatic aircraft, especially if these aircraft have symmetric airfoil profiles and hence behave differently to a transport aircraft. So there needs to be careful consideration of choice of aircraft and a full understanding of the limits and differences of this type of training. One thing it will give pilots is exposure to G forces and the effects of spatial disorientation in a high stress environment. Understanding the limits of this type of training is important because LOC-i at high altitude with the corresponding low damping characteristics of thin air and at night is a different animal altogether and that is where flight crew get caught out when things go dramatically wrong. The other edge of the LOC-i envelope involves unfavourable thrust/drag combinations at low altitude such as missed approaches or wind-shear recovery. Losing control below 10,000ft AGL especially reduces the chances of survival to an unacceptably low level.



The difference between a cambered airfoil such as found on a transport category aircraft and a symmetrical airfoil common to modern high performance light aerobatic aircraft.

Awareness, Recognition and Recovery (ARR)

The proposed approach for dealing with UPRT/LOC-i is to allow pilots to go through an extensive academic refresher, covering all aspects, from performance, technical and procedural items to weather. The next step is to provide the crew the necessary tools to raise their awareness of what could happen to your their afternoon CAVOK flight. These tools are packed into a 3 stage approach, ***awareness, recognition and recovery (ARR)***. The first two elements will save the lives of the flight crew and their passengers in virtually 100% of cases if applied properly. This is explained in our course in great detail, also backed-up using case studies. If the third element (recovery) becomes necessary then things have already gone dramatically wrong, even if he or she is a highly skilled pilot. There are too many variables for a successful recovery from a LOC-i at high altitude and/or unfavourable environmental conditions to achieve the same high level of safety precaution versus early awareness and early recognition before the drama really starts to unfold.

Practical training and synthetic device limitations

When it comes to practical training pilots will need correct recovery techniques demonstrated and opportunities to practice nose low/high recoveries or high altitude stall prevention. In FBW aircraft the demonstration of all law functionality (and also the limits of it) is essential to allow the pilots opportunity for early recognition that they are flying close to limits. This is crucial since vital clues such as trims are often masked by automatics and the indications on the flight deck. For training proper recovery techniques the simulators FDT will have to be modified by an extended envelope to allow flying at or slightly outside certified limits. There is an industry effort to upgrade the devices for UPRT but in most cases additional flight test data is needed for feeding the sim software with appropriate aero models.

The vital importance of frequent manual aircraft handling

Finally, I am a very strong advocate of hand-flying. Pilots should hand-fly their aircraft regularly without auto throttle if conditions permit. This is the most valuable opportunity for pilots to gain a feeling for their aircraft's natural characteristics and performance (and it's free of charge!). This should be done from medium altitudes down to the ground and opposite, and not just the two times per year when you have to circle to land somewhere in mountainous terrain at night.

To summarise the characteristics of a robust UPRT program:

1. Use an extensive training curriculum covering *both academic and practical* aspects, based on the regulatory requirements such as the EASA NPA.

2. Train the trainer so any practical training is delivered properly. This is not a simple task and requires a detailed simulator training schedule for instructors and trainees

3. Use Awareness and Recognition regularly in your daily operations and in LOFT sessions. Apply SOP's.

4. Recovery techniques <u>must</u> be trained. To just startle pilots during a loft session without having provided the proper SOP for recovery will have a negative training effect.

5. Clearly define in your operations manual the conditions, frequency and intervals that pilots have to fly their operational aircraft manually. It is crucial that the seat of the pants "butt" feeling returns to the piloting community and if this leads to an uncomfortable ride for the passengers then the handling pilot clearly needs to brush up on their skills. In such cases recovery training is questionable.

6. If practical aerobatic type training is added clearly state the limits and differences of such a training. The choice of aircraft/instructor used for this is of relevance.

Conclusions

Flying and learning should be fun. A pilot is not just a system operator, there is nothing wrong from taking enjoyment in hand flying your aircraft. The piloting community needs to adopt a strategy where not only good management and communication skills count, but one where the vital importance of knowing your aircraft and the ability to feel how it is behaving is given priority. Only then will there be real hope to improve the industry's safety record and facilitate the transfer of these skills to generations to come, to ensure that in turn they will have the capability and skills to do the job properly. Lives will count on it.

Dominik Waser.

With the input from Dominik in mind how are regulators reacting? Without training are there simple coping strategies that pilots can adopt?

LOC-i, no new accidents, just new victims

2014 would prove to be one of the most tragic recent years in aviation.Early in the morning of on the 24th July 2014 Air Algerie flight AH5017 a scheduled MD83 flight from Ouagadougou, Burkina Faso to Algiers levelled off and entered the cruise at FL310 about 20 minutes into the flight. About 50 minutes into the flight and whilst in Malian airspace, the aircraft disappeared from radar. In the midst of the human tragedy what investigators started to piece together once again was a chain of events culminating in an accident that never should have happened. There was no mechanical failure, no outside interference, the crew were experienced and current on type, the operator reputable and with a good safety record. The basic summary issued by the BEA as to the cause of the accident indicated that to compound an error of the non-activation of engine anti-icing systems, it appears the weather played a factor as the crew were probably distracted by workload associated with flying through a convection zone, leading to a late reaction to decrease in airspeed, a further lack of reaction to tactile, aural and physical stall warnings followed by control inputs not appropriate to regaining control of the subsequent fully developed post stall LOC-i.

And that was not the end of it. In December of the same year Air Asia flight 8501, this time an Airbus A320, disappeared from radar screens over the West Java Sea. Subsequent analysis indicated a chain of events that led the autopilot to disconnect and reduced protection from the aircraft's FBW (becomes passive rather than active) system as it reverted to alternate law. With remarkable similarity to the fate of AF447, after the automatics disconnected and reduction in FBW protection occurred the aircraft climbed rapidly and suffered an aerodynamic stall from which the crew failed to recover. Although the chain of events started with the crew being distracted by a technical fault, this fault in no way should have precipitated the loss of the aircraft. The accident took the lives of 162 passengers and crew.

In 2014 LOC-i had dealt more deadly defeats to an inadequate industry training system exacerbated by a growing industry culture of dependency on automation that had permeated tracts of the piloting community, bringing fresh truth to the statement aviation is not inherently dangerous but that it is entirely unforgiving of neglect. This is no less true when it concerns aircraft handling skills.

The regulatory response

LOC-i is a problem that is deep rooted and complex, but not complex enough for it to be all too often labelled as a result of 'pilot error' in the matter of fact manner of accident reports. In doing so the piloting community is arguably being dealt a significant disservice. As professionals pilots are trained to control the effects of gravity, combustion and inertia within a certain set of parameters and to fly to a degree of accuracy to attain safety, comfort for passengers and efficiency for operators. They are schooled in the importance of effective communication and have their heads filled with a myriad anachronistic procedures and rules for which they are tested on a regular basis. But it seems that apart from the almost routine practice of well-rehearsed failures in the safe confines of a simulator, what they are not being equipped to deal with are high stress, high disorientation and dynamic situations that has led very experienced pilots to lose complete control of their aircraft from one moment to the next. To compound the matter, many operators actively discourage their pilots from hand flying their aircraft, surely questionable.

Between them the FAA, EASA and GCAA regulate a significant segment of the piloting community. With the FAA originally having taken the lead in 2014 and with EASA and the GCAA following suit in 2016, UPRT training is now a requirement for commercial operators. The basic regulatory requirements for UPRT all derive from ICAO document 10011 'manual on aeroplane upset and prevention recovery training'. This document provides to regulators and training organisations for instituting best practice. The document itself was prepared over a period of 3 years with significant input from industry, experts and pilot representative organisations.

Push, Roll and Recover – a basic survival strategy?

As LOC-i and the need for UPRT increasingly regulated for, what are the options for pilots that have not been through an effective UPRT program if they find themselves in trouble? Is there a simple coping strategy that can be adopted by pilots that provides a chance of survival if the worst happens? One strategy that has been advocated is Push, Roll and Recover.

The biggest risk arising from a developed upset is the stall. If a stall takes place then until the point that an aircraft has reacted to appropriate control inputs, it is out of control. A stall occurs when the critical angle of attack of the wing is exceeded, leading to a separation of airflow and the wing is no longer able to generate adequate lift (and creating significantly more drag). Irrespective of the aircraft's attitude in relation to the horizon (above or below), either upright or inverted, an immediate and positive reduction of angle of attack is required **(PUSH)**. Even in a situation where the aircraft has inverted and has its nose below the horizon following a stall, a reduction of angle of attack is required in order to recover. In what is probably the most extreme of examples the natural inclination will be to pull, so it can be counterintuitive to release back pressure or push. If the aircraft is in a high bank angle upset the effect of pushing will help arrest nose down moment (see below) as unloading improves roll control. The same laws of physics hold true for a Boeing 777 as they do for a Cessna 172, only in a 777 they can be much more frightening as it has much more inertia. Note that throughout this manoeuvre resistance can be significant due to pitch and power settings, especially if the aircraft was being flown on automatics prior to the upset, this can intensify the startle effect. High power settings can create a significant pitch-up moment.

This video provides an example of entry to and recovery from a nose-low high bank angle upset.

The second priority is to orient the aircraft's lift vector upward by returning to a wings level orientation back to the horizon **(ROLL)**. The higher the bank angle the more lift is required to maintain level flight. This is the reason backwards pressure is required on the controls in order to maintain level flight throughout a turn. The higher the bank angle the more the lift vector is off vertical. The natural inclination when faced with a recovery from a high bank angle is to pull rather than roll. In a nose low high bank angle upset rolling wings level will result in less altitude loss than pulling.

The final stage **(RECOVER)** involves a return to stabilized level flight. Power needs to be managed carefully, especially in a recovery from a nose low upset where airspeed can increase rapidly. A 150,000kg aircraft with a high-power setting accelerates very quickly. Speed brakes may be required.

Note recovery can lead to a significant loss in altitude, especially in a heavy aircraft!

Already mandated by the FAA, EASA and now also the UAE GCAA, UPRT is a major contemporary topic and a challenge for airline and other operator training departments that have to implement this into their training cycles. Resource Group's Flight Crew Services business has (in conjunction with a major UK operator) developed a modular eLearning course and practical training syllabus covering all the ground school requirements of the published regulations. In addition it can provide support operators to provide integrated solutions to include in aircraft training.

Please contact **stephan.hickman@resourcegroup.ch** *for more information.*