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pour la sécurité de l'aviation civile

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"Preparing the Next Generation of Investigators"

Aeroplane State Awareness during Go-around (ASAGA)

INTRODUCTION

Towards the end of the 2000's, the BEA observed that a number of public air transport accidents or serious incidents were caused by a problem relating to "aeroplane state awareness during go-around" (ASAGA). Other events revealed inadequate management by the flight crew of the relationship between pitch attitude and thrust, with go-around mode not engaged, but with the aeroplane close to the ground and with the crew attempting to climb.

Moreover, these events seemed to have some common features, such as surprise, the phenomenon of excessive preoccupation by at least one member of the crew, poor communication between crew members and difficulties in managing the automatic systems.

A study was thus initiated with a view to:
- Determining if this type of event is associated with a particular type of aircraft;
- Listing and analysing the factors common to these events;
- Suggesting strategies to prevent their recurrence.

More than fifteen international organisations, with a wide range of competence in terms of aviation safety, were invited to take part in the study. The complete study is available on the BEA website and includes 34 recommendations.

METHODOLOGY

The study focused on evaluating the robustness of the safety model for go-arounds by using four complementary approaches.

I - Statistical Study

Twenty-one ASAGA-type events were selected among more than twenty thousand on the ICAO, BEA, NTSB, TSB and FAA databases. They mainly involved Boeing and Airbus aeroplanes.
These events were quite infrequent but their consequences were serious.

About 4 % of public transport accidents that led to casualties over the last 25 years were ASAGA-type. However, in 2009 and 2010 this rate rose by over 20%.

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II- Selection of Events

16 accidents or incidents characteristic of those found by statistical means were studied.

The events studied involved only twin-engine aeroplanes, except for one event which involved a four-jet aeroplane, and they happened with all engines running, with one exception.
With the exception of two events, very large speed and pitch attitude excursions occurred, leading to excursions in climb speed and altitude.

In all these events, disruption occurred soon after a higher level of thrust was ordered and generated potentially hazardous manoeuvres. In some cases this disruption was aggravated by other factors, and surprised the crew. The reports brought to light the following factors:
- Poor external visibility;
- Inadequate monitoring by the PM;
- Nose-up pitching moment generated by the engines, at low speed;
- Unexpected or overlooked operation of AP and/or pitch trim;
- Involvement of spurious parasitic sensations (somatogravic illusions);
- Focusing of attention ;
- Difficulties in reading the FMA ;
- Disturbance caused by ATC's role ;
- Lack of CRM ;
- Engagement of the incorrect mode during go-around.

III - Survey

A survey was circulated amongst flight crew from various French and British airlines.

The objective was to draw from their experience to:
- Gain a better understanding of the difficulties associated with a go-around;
- Collect accounts of their go-around experiences in flight and on a simulator;
- Determine, statistically, any contributory factors revealed by the survey.

Many pilot accounts thus directly confirmed the same factors and revealed the same precursors as those brought to light during investigations into ASAGA-type events. However, accident investigations have had difficulty in proving these limitations due to a lack of factual data.

IV - Visual scan and simulator sessions

The BEA undertook a series of simulator sessions in order to:
- Validate the hypotheses established from the factual data collated during the study;
- Increase the size of the data sample and obtain additional data that cannot be provided by incident reports or interviews[1].
- Understand the process involved when malfunctions are triggered, notably by studying the visual scan of the two flight crew members.

[1] *In order to fully understand an activity, when this understanding cannot be obtained by study of the partial accounts provided by the various individuals involved, information must be collected during the actual execution of this activity (Guérin et al, 1997).*

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All the sessions were filmed. HD cameras were used. Both crew members wore an eye-tracking system.
The simulations took place on B 777 and A 330 FFS training simulators.
The results can be seen on video on the BEA website and are available in the study.
They mainly show:
- A higher workload for the PM in comparison with the PF, and the PM's non-homogeneous visual scan;
- A high workload when time was short and a surprise effect during the go-around ;
- Difficulties associated with automatic systems and reading and understanding the FMA ;
- The influence of ATM when a clearance is given that is different from that in the published procedure;
- The difficulty of applying the go-around procedure;
- Excessive focusing of attention, in particular on the autopilot control panel.

ANALYSIS

General scenario

An ASAGA-type event is a go-around characterised by a loss of control of the flight path during the go-around. This loss of control results from loss of situational awareness by the flight crew, leading to significant speed and pitch attitude excursions. The pitch attitude excursions are significant when compared with those recommended by the SOP's and speeds are often close to VFE, or even greater.
The initial flight path of the GA is often climbing then, progressively and without any obvious reaction from the crew, it begins to descend and ends up either as a serious incident or an accident.
Most ASAGA-type events involve twin-engine aircraft. At the end of the flight, the aircraft is light and has a very high thrust/weight ratio.
ASAGA-type events are often associated with some disruption that surprises the flight crew before or during thrust increase (e.g.: unexpected ATC constraints, engagement of automatic systems that are not in accordance with the GA, unfavourable meteorological environment). Crews thus find themselves confronted with a situation where they must perform a large number of crucial tasks (gear retraction, flight path management) under severe time pressure. These GA's are generally performed manually. However, some of the ASAGA scenarios show that the flight crew can engage the AP in an inappropriate mode.
Collisions or near-collisions with the ground generally occur less than one minute after the start of the go-around.
In addition, in the majority of ASAGA-type accidents, CRM between crew members – which was not generally subject to specific remarks during the pre-GA phases – became dysfunctional at the time of the go-around. The lack of monitoring by the PM is another commonly identified factor.

Specific case of go-arounds with pitch trim set close to the nose-up stop

Some ASAGA-type serious incidents or accidents are characterised by a loss of control of the aircraft. First, the final approach is generally performed under AP. Following a specific event (for example auto-thrust or auto-throttle disengagement, a speed or altitude selection error), the speed falls. The automatic system then

compensates for this loss of speed by progressively increasing the pitch-up of the THS until the AP disengages and/or the stall warning is triggered.
The flight crew perform a low-energy GA. The pitch attitude increases towards excessive values due to the application of full thrust while the position of the trim is close to the full nose-up position and the aircraft has a low initial speed. When automatic trim management is not or no longer available, inputs on the control column/wheel to the nose-down pitch trim stop do not make it possible to counter the nose-up pitching moment generated by maximum thrust coupled with the full nose-up trim position. The pitch attitude and the angle of attack then continue to increase until the stall. The actions that allowed a few crews to recover control of the aeroplane before the stall were a decrease in thrust during the GA then a nose-down trim input.

Definition of the problem

Conditions relating to ASAGA-type events are difficult for flight crews to detect and correct. There are, however, several common causal and contributing factors. The simulator debriefing sessions and analysis of the survey showed that pilots perform very few real GA's during their careers. Management of the GA can thus lead to many errors. During recurrent training, crews are trained in the simulator with scenarios that are not representative of ASAGA phenomena and often with a single-engine condition (i.e. with an engine failure). ASAGA-type events almost always occurred while both engines were running.
Flight crew start the GA by pitching up, followed by application of full thrust. Acceleration due to this rapid and significant increase in thrust can create the sensation that pitch-up trim is too high. In the absence of external visual references and visual monitoring of instruments, somatogravic illusions may lead the PF to decrease the aircraft's pitch attitude towards inappropriate values. These illusions are little known by crews and current simulators do not make it possible to recreate them to train pilots to recognise them.
Management of automatic systems also poses problems. Engagement of initial modes that are different from those expected for the GA, when they are neither called out or checked, leads the aircraft to follow an undesirable flight path. Thus, in addition to reading the FMA, monitoring the primary parameters – pitch attitude and thrust – is a guarantee for the flight crew of ensuring that the automatic systems take the aircraft on a climbing flight path on the GA.
The succession of mode changes is difficult to detect, to call out and check during the GA. Time pressure associated with limited human cognitive abilities - and thus of flight crews – is the major issue in ASAGA. Flight crews must perform a large number of actions and cross-checks in a short time. The cognitive overload induced can prevent the detection of possible deviations by the PF, who is mainly focused on the PFD, and by the PM, who is ensuring various tasks that may divert his/her attention. Thus, a deviation, even of a significant parameter or the flight path, may not be detected by the flight crew.
In ASAGA-type events, the PM has a primordial role and a sudden high workload, greater than that of the PF. In addition, it is difficult to organise and manage. Any shortfall in monitoring can have catastrophic consequences.
In the conclusions of accident reports, the lack of CRM often appears as a contributing factor. Nevertheless, CRM often works nominally and is not the subject of major comments before it becomes a disturbing element during or after a GA.

Equally, in the case of an incident, CRM can operate again after the flight crew has taken control of the flight path.
Analysis of incidents and accidents, the results of simulator sessions and the data from the survey show that it is not possible to simply limit responsibility for not following the principles of CRM to the flight crew. It is essential to find additional means to help crews to recover some synergy. This "lack of CRM" appears, at the present time, to be a normal consequence when there is a situation that associates surprise, cognitive overload, time pressure and high stress. Evaluation of loss of situational awareness should thus include corrective measures both in terms of training and in aeroplane certification rules.

ATC constraints must also be taken into account:
- Flight paths can be different from those in the published procedure prepared during the approach;
- Aeroplane performance may not be entirely compatible with some published GA procedures.

In any case, the failure to take into account the notion of flight path stabilisation in a GA can increase difficulties for crews (see § 6.2).
Thus, the success of a GA requires giving crews time to perform it and to simplify their actions.
In addition, whether it be to determine the circumstances of an accident, in a discussion following a simulator session or during an evaluation of crew members' monitoring abilities, a video recorder is an indispensable tool to avoid any analytical errors (retrospective bias) during an investigation.

Finally, there is the problem of fatigue at the end of a long-haul flight, which can play a role in decision-making – crews are in a psychological condition that pushes them to want to land and not perform a go-around - and the performance of the go-around.

CONCLUSION

The ASAGA study put into perspective and partially confirmed many factors that were dispersed among many different safety investigations. However, this grouping together of factors also brought to light some new contributory factors that had never been proven before. By using meta-data, the study was undertaken like a major safety investigation and contributed to partially overturning some analytical elements that gave the flight crew excessive responsibility in accident causality. Being based on the analysis of the safety model, the study was able to show that the latter was not robust enough and that it needed to be strengthened. The study contains a large number of recommendations, which are well supported as they take into account a large number of accidents and, in addition, also involved a very wide range of those involved in the issue.

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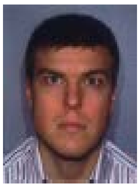

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