**Podcast 36, Talk, Thomsonfly GA incident**

Hello everyone and welcome to another Talk where this episode we will be discussing an incident which occurred back in 2007 but is certainly relevant today when we talk about stable approaches and Go Around technique in the 737. Because of the aviation landscape over the last couple of years nearly all of us have seen fewer flights making the already remote two engine go-around possibility even less experienced. A lot of airlines have put some good training into place around this manoeuvre to try and mitigate risks involved and thought and discussion by us as crews on the day will of course help. We'll give a couple, of what we hope are, useful tips later but for now let's take a look at the incident flight.

The incident occurred on the 23rd of September 2007 at 2350 local time at Bournemouth Airfield in the UK. The flight was a scheduled passenger flight back from Faro in Portugal with the First Officer as PF who had a total of 845hrs on type. The captain was experienced as a first officer on the 757/767 fleet with over 11,000hours but only 420 of those were on type after a combined type conversion and command upgrade course in 2006. The aircraft, G-THOF, was a 737-300 manufactured in 1995 which last had an A check on 20th September with no relevant deferred defects or tech log entries.

Due to the possibility of inclement weather at Bournemouth, a prob40 of a wind of 200/15 G 25 as well as reduced visibility and a 300ft cloud base, the crew sensibly decided to take fuel enough for a second approach and discussed using flap 40 for landing. Both crew were based at Bournemouth and commented after the event that Flap 40 landings were not normally conducted there and this flap setting was only normally used at one of their normal destinations, perhaps a bit of a distractor. Bournemouth were using runway 26 at the time which has a LDA of 1970m.

The First Officer briefed the approach during the cruise reiterating the intention to use flap 40 with a final approach speed of Vref 40 being 129kts agreed by the crew. With the weather obtained in the cruise, a surface wind of 220/14, the final approach speed of 135kts was intended.

With no other traffic in the area the crew were cleared to self-position for the ILS26. At 2345L the aircraft was 11nm out, level at 2,500ft at 180kts with flap 5 set. The autothrottle was engaged in speed mode and AP B was in command with VOR/LOC and ALT HOLD modes engaged.

Level flight was achieved for 90 seconds prior to GS capture. The First officer then called for gear down flap 15 and the landing checklist. All actions were carried out although neither pilot could recall who moved the speedbreak lever which was placed at 12° which is slightly beyond the armed setting of 9°. As expected, the PF then selected a lower speed on the MCP and the AT accordingly retarded the thrust levers to Idle to reduce the speed.

As the aircraft descended on the glideslope, about 20 seconds after the AT retarded the levers, the autothrottle disconnect warning was triggered and the autothrottle disengaged. By this warning we mean the flashing red autothrottle P/RST light on the autoflight status annunciator. The arm switch will also release to OFF and the associated green light on the MCP will extinguish as well as the thrust FMA blanking.

The disengagement was not noticed by the crew and no manual disengagement was recorded. The levers remained at idle and were to do so for the remainder of the approach. The Autopilot however, remained engaged and continued to track the loacliser and glideslope. As you can imagine speed began to decay at about one knot per second which is perfectly in line with what we'd expect at this stage of the approach while configuring. As speed decreased below 150kts flap 25 was selected and after a check of flap placard speeds using his maplight flap 40 was called for with the commander setting flap position and the first officer selecting a speed of 135kts on the MCP.

Flaps 40 was indicated, and the commander completed the landing checklist accordingly. The data recorder showed flaps reached the 40 position at an airspeed of 130kts with the aircraft still decelerating at approximately 1.5kts per second. Perhaps there was a little distraction here with the commander watching the flap indicator in order to complete the landing checklist then having to stow the checklist too. On then looking down at the IAS the commander saw 125kts. He called "SPEED" and the FO made a small movement of the thrust levers after which the commander called "I have control" then moving the thrust levers full forward and calling "Go around flap 15, check thrust"

The recorded data showed that at a CAS of 110kts at an altitude of 1540ft the autothrottle manual disconnect was pressed and the thrust levers moved forward slightly. Within 1.5 seconds of this the stick shaker activated and in the following 2 seconds the thrust levers were advanced full forward. LOC and GS modes changed to CWS P and CWS R, and the aircraft pitch attitude, which had been steadily increasing under the influence of pitch trim, reached 12° nose up. The automatic pitch trim stopped at 4.9° or 7.9 units of stabiliser trim.

The commander then moved the control column forward in anticipation for pitch power couple reducing the pitch to 5° nose up. The stick shaker stopped with a minimum airspeed of 101kts reached. There was also a small unintended bank to the right through application of aileron.

Four seconds after the thrust levers reached fully forward, with N1 increasing through 81% on both engines, TOGA mode became active. As we would expect the AP disengaged and pitch attitude started to then increase again causing the reactivation of the stick shaker. Wings were rolled level and although PF had the control column fully forward the nose-up pitch increased to 22°.

Airspeed increased to 118kts, and pitch attitude appeared to stabilise at 22° nose-up. N1 was now up at 96-98% N1, which was above the 94% rated go-around thrust. Flaps 15 was selected and the stick shaker ceased but, as the flaps retracted past the 25 position, the nose began to pitch up at an increasing rate and a small continuous amount of left rudder input started a left roll. As the flaps reached 15 the nose up pitch angle was increasing through 27° with an increasing left roll through 7°. Stick shaker again reactivated and although full nose down elevator was being held the airspeed began to decay. The first officer called "High Pitch" with a response from the commander of "I have full forward stick".

Although the FO was now PM he also held full forward stick with both pilots reporting they had no pitch authority and with the startle and surprise effects neither were fully aware of the airspeed.

As nose up pitch increased above 36° TOGA mode disengaged and left roll increased beyond 13° with speed decreasing below 107kts. A small sharp right rudder input recovered the roll from a max of 22° to wings level as the aircraft stalled with maximum pitch reaching 44°. With elevator position unchanged pitch rate reversed from positive to negative, although angle of attack continued to increase as the aircraft started to descend. For a further 5 seconds the airspeed continued to decrease reaching a low of 82kts at which point the pitch was 33°.

The pitch angle reduced to 20° over the next 10 seconds and airspeed began to rise rapidly leading to a thrust reduction to 86%. The nose down pitch rate increased with the pitch reducing a further 15° in two seconds. With a 5° nose attitude and speed increasing the commander regained control of the aircraft and reengaged TOGA mode as airspeed reached 147kts.

An uneventful second approach was made by the commander with both auto systems performing as would be expected. There were no injuries to crew or passengers and no damage to the aircraft itself.

We thought a quick refresh of the autothrottle system on the 737-300 would be useful here so here goes. Our AT system positions the thrust levers to maintain a computed engine thrust level. There is a digital AT computer, 2 AT servo mechanisms, 2 thrust lever synchros and of course our selection controls as flight crew. The servomechanisms are the interface between the system and the throttle opening linkages with thrust lever position fed back via the synchros.

We arm the autothrottle by putting the solenoid held paddle switch to ARM and the switch is held in this position until the AT is disengaged. We have talked about the red flashing light when the AT is disengaged, which incidentally can be cancelled by a second press on the thrust lever disengage switch or by pressing the switch light itself, so now let's just revise what it means when that annunciator light flashes amber.

There are three conditions when this light will flash amber:

1. The airspeed is 10kts above the target speed and not decreasing
2. The airspeed is 5kts below the target speed and not increasing and
3. The airspeed has dropped to alpha floor during a dual channel AP approach

AT disengagement can result from:

1. Moving the AT arm switch to off
2. Using the thrust lever disengage switches
3. Fault detection within the AT computer from a BITE test. Unfortunately, due to a reporting delay of the incident the BITE test history from the incident had been overwritten.

4. Two seconds after touchdown where the red flashing lights are inhibited
5. Thrust levers are separated by greater than 10° during a dual channel approach with FLARE ARMED annunciated and
6. AP roll control requiring significant spoiler deployment and thrust levers becoming separated, when flaps are less than 15° and the AT is not in take-off or go-around mode.

Manual positioning of the thrust levers does not normally cause AT disengagement.

Both pilots reported that they hadn't seen the AT disconnect warning and the AAIB became aware there had been a number of other events possibly with similar precursors making the efficacy of the AT warning an interest to the investigation.

The AAIB approached 737 operators to implement four triggers to see how prevalent AT problems were. These were:

1. An AT warning preceding an AT disconnect
2. An un-commanded AT disconnect
3. An unacknowledged AT disconnect warning and
4. An unrecognised and un-commanded AT disconnect

The unacknowledged AT disconnect warning highlighted any occasion when the warning was active for more than 9 seconds. On a subset of 2,354 sectors this occurred 2.5% of the time. 0.3% had the combination of the AT disconnect without the use of the manual switches and the resultant warning lasting more than 9 seconds. The was classed as a 'first look' study and therefore didn't yield sufficiently robust results to provide definitive occurrence rates.

Boeing's analysis determined that during the event the nose-up pitching moment, generated by the thrust increase and by the stabiliser trim position, overwhelmed the elevator until recovery from the stall. They confirmed a very slight pitch up moment changing from flaps 40 to flaps 15 but this was seen as negligible compared with the trim change due to the thrust increase. A further comment stated that had the flaps remained at 40, and all other parameters remained as they were throughout the event, the aircraft would still have stalled although it would have taken slightly longer to reach maximum nose up pitch.

In similar events another 737-300 going into Belfast Aldergrove in June 2007 experienced an uncommanded and unrecognised AT disconnect on approach with the thrust levers at idle. This aircraft decelerated below its command speed of 170kts. At 112kts with 16° nose-up the N1 was advanced to 96% causing a rapid pitch change to 22° nose up. The aircraft lost 300ft altitude before recovering.

On 22nd October our incident aircraft was subject to another event. Here the AT warning was shown active for 31 seconds. No manual disconnect was recorded at the time the warning stopped, although a manual disconnect occurred 10 seconds later. On this event airspeed decreased to 128kts and the crew applied approximately 75% N1 with a recovery taking place reaching only a maximum of 8° pitch attitude with some forward trim applied. The AT computer was removed after this flight.

Original certification requirements did not require any indication for AT disconnect, with current requirements not stipulating any aural indication, just a caution provided to each pilot. Expanding on that, if these cautions for automatic disengagement are visual only then they must persist until cancelled by flight crew action.

The Ops B manual of the operator at the time required the PM in the event of a GA to:

"Verify that the thrust is sufficient for the go-around or adjust as needed"

The QRH for the approach to stall recovery required as the first action to "Advance thrust levers to maximum thrust". Other actions included not to change Configuration, but the drill didn't mention the use of pitch trim. According to the operator these procedures came direct from the manufacturer and were unmodified.

The upset recovery QRH used the definition at the time of pitch angles exceeding 25° and had the line "If needed, use pitch trim sparingly" but continued to point out that "if the airplane is stalled, recovery from the stall must be accomplished first by applying and maintaining nose down elevator until stall recovery is complete and stick-shaker activation ceases."

Once into the upset recovery procedure the actions did include to apply as much as full nose-down elevator, apply appropriate nose-down stabiliser trim and reduce thrust.

The FCTM had further guidance but with the caveat that the procedures published in the flight crew operations manual take precedence over information presented in the FCTM.

Stall recovery was defined into two parts in the FCTM, the approach to stall recovery and the stall recovery. It stated:

"A stall must not be confused with the stall warning that alerts the pilot to an approaching stall. Recovery from an approach to the stall is not the same as recovery from an actual stall. An approach to the stall is a controlled flight manoeuvre, a stall is an out of control but recoverable condition."

The FCTM approach to stall recovery did include the advice "To assist in pitch control, add more nose down trim as thrust increases" with the stall recovery also referring to the use of "some nose-down stabilizer trim"

FCTM advice for the upset recovery includes the recovery from the stall first caveat but did however state:

"Under certain circumstance is may be necessary to reduce some thrust in order to prevent the AOA from continuing to increase".

The FCTM also went on to say:

'In a situation where the airplane pitch attitude is unintentionally more than 25 degrees nose high and increasing, the airspeed is decreasing rapidly. As airspeed decreases, the pilot's ability to manoeuvre the airplane also decreases. If the stabilizer trim setting is nose up, as for slow-speed flight, it partially reduces the nose-down authority of the elevator. Further complicating this situation, as the airspeed decreases, the pilot could intuitively make a large thrust increase. This causes an additional pitch up. At full thrust settings and very low airspeeds, the elevator, working in opposition to the stabilizer, has limited control to reduce the pitch attitude.'

At the time there was a Boeing produced, in collaboration with other manufacturers, pilot associations, training associations, operators, government agencies and suppliers "airplane upset recovery training aid". The basic package included a DVD with two short videos and a powerpoint presentation. The operator commented that:

'With regard to the Boeing CD "Upset Recovery" training aid we believe that the contents of the CD have not been verified to be the correct technique for all events and does not form part of their officially reviewed training material, therefore it has not been issued as a Thomson Airways training document. Pilots are trained according to requirements in early recognition and counter measures on approaching stall in all configurations and recovery from full stall or after activation of stall warning device in all phases of flight, in all configurations.'

In the report Analysis the probable cause of the AT disconnect is attributed to an internal fault in the AT computer, purely through ruling out of the other disconnect conditions. An uncommanded disconnect however was found not to be an unusual event with it occurring on 0.4% of sectors analysed. The maintenance history of G-THOFs AT system showed 5 defects in the 9 months prior to the incident with the system being checked and no fault found.

The crew did not respond to the warning, either because the system did not work, or if it did work it went unnoticed. The subsequent event on 22nd October showed a possible wider issue of the warning system not alerting flight crews.

The fact that the AT warning light will flash amber routinely for extended periods on the approach during deceleration may have the effect of the crew subconsciously filtering the light erroneously when it is red during the same period. This combined with the high reliability of modern automation could lead to a lack of awareness of autoflight modes.

When the commander took control and called for the go-around the aircraft was approximately 20kts slow and decelerating with idle thrust. The stall warning was not active at that point or the "approach to stall recovery" would have taken priority. Remember too here that a change of control had just happened more than likely adding further startle to the mix, certainly on the FO's side.

Immediately after the go-around was commenced the stall warning activated which should then become the highest priority, the commander had already initiated maximum thrust which at the time was the first line in the approach to stall recovery. Pitch control was attempted using full forward control column, but this was insufficient to control the pitch-power couple in the as-trimmed condition.

As the pitch-up decayed briefly around 22°, maximum thrust was selected, and configuration had not yet been changed thus adhering to the ‘approach to the stall recovery’ drill. We can assume from that that whatever the decision made between the GA and approach to stall recovery at the point of take over the aircraft was going to pitch to at least 22°. The only way to avoid this would have been a lower thrust setting or to trim forward during thrust application.

In the statement “maximum thrust” Boeing recognised there may be some confusion. On the older engine control system of the classics an overboost will be allowed if maximum thrust lever movement is selected and as such Boeing planned to change the wording for Classic models to mean go-around or take-off thrust unless ground contact is imminent.

With trimming not mentioned in the operators Go-around or approach to stall recovery drills at the time it was understandable that the commander did not consider trimming the aircraft in the incident. The FCTM did mention trimming in both the approach and the stall sections, but it is a generic document not tailored to individual airlines.

Flaps were retracted in the incident despite the approach to stall recovery stating there to be no change in configuration. Boeing however was of the opinion that on this occasion it made little difference to the outcome.

Once the nose angle reached 25° the crew were now into a defined upset recovery with that caveat of recovering from the stall first by applying and maintaining nose down elevator until stall recovery is complete and stick shaker activation ceases. Stall recognition is defined by continuous stick-shaker activation plus one of, buffeting which could be heavy at times, lack of pitch authority and or roll control, the inability to arrest a descent rate. From that the crew were facing a stall first and were the into actioning the stall recovery as opposed to the approach to stall recovery.

Had those actions and the following upset recovery actions been done the extreme angles and low speeds encountered would have been recovered to controlled flight sooner.

A delay in the ASR reporting process due to company procedures and perhaps that the commander should have phoned the incident in - according to the company, meant a loss of some safety critical data and led to changes in the company’s safety department including two full time data analysts with access to a pilot representative available daily.

Contributory factors according to the report were that the AT warning system, although working as designed, did not alert the crew to the disengagement of the AT system and that the flight crew did not recognise the disengagement of the AT system and allowed speed to decrease 20kts below Vref before recovery was initiated.

Since this event we have seen a number of changes to the QRH for stalls and upset recovery and the way we train these in the simulator. Safety studies have shown increasing number of stall incidents occurring during the manoeuvring and approach phases of flight thus this is

now where we tend to practise our stall recovery techniques. We focus on the level off, base turn and final approach to hopefully avoid incidents such as this.
We are to recover at the first sign, but the approach to stall or stall recovery technique are now the same with the initial focus being on unloading the wing with the control column but trimming is part of that recovery if it is needed. The FCTM advises on trim use saying "Pilots should not fly the airplane using stabilizer trim and should stop trimming nose down when they feel the g force on the airplane lessen or the required elevator forces lessen. The use of too much trim may result in loss of control or high structural loads.

We are then to continue the recovery by rolling wings level in the shortest direction, advancing thrust as needed and retracting the speedbrakes all the while maintaining the same configuration unless we are at lift off with the flaps up when we are to select flap 1. The FCTM now also gives guidance on thrust use stating:

'The pilot flying advances the thrust levers as need to accelerate and promptly return the aircraft to the desired energy state. Advance thrust levers smoothly because underwing-mounted engines cause a nose-up pitch moment when thrust is increased. Under certain conditions, where high thrust settings are already applied such as during takeoff or go-around, a reduction of thrust can be needed in order to prevent the angle of attack from continuing to increase.'

This is where our airmanship and situational awareness come in with the amount of thrust required.

The FCTM then goes on to talk about extreme circumstances where the use of control column, trim and thrust have failed to arrest a nose up pitch rate. Here you have the option to change the lift vector and induce a nose down pitch moment by using roll and if that fails then careful use of rudder can be considered with an emphasis on Careful there we think. If control column pressure is insufficient, we like to remember our options as the four T's Trim, Thrust, Turn, Tap with the Tap emphasising that you really wouldn't be wanting to put much of a rudder input in as too much applied too quickly or held too long can result in loss of lateral and directional control.

Upset recovery has also been simplified into Nose High and Nose low recovery with that same caveat of the need to recover from the stall first but we have a whole episode on UPRT for you to review at your leisure.

We mentioned at the start of the podcast we'd have a little discussion on two engine Go-arounds. As we have been doing so little flying it is possible we could get ourselves into a situation where we're not completely comfortable on the approach, or we simply don't meet the company stability criteria, or even ATC haven't handled the increased traffic flow as well as they normally would. Any of these could lead us to a go-around from a point other than DA or MDA that we may practise a little more in the simulator. So how do we mitigate some of the risks involved with this manoeuvre?

We suggest you brief the Go-around actions when you are doing your approach briefing and discuss together a couple of different points on the approach and how you would action the

go-around from them, remembering of course the ways to get out of approach mode if that is what you're using.
Unlike a go around at minimums a go-around from an intermediate point on the approach is unlikely to require an immediate action. This is where your second mitigation can take place. Use the time if it's there to give a mini brief to your PM thus reducing startle and keeping each other at a high shared level of SA. Something along the lines of "OK Mark we'll be going around from this, we're currently Flap 15 and 1,500ft below set GA altitude. I'll call the standard Go-around flap 15 anyway pressing TOGA and rotating manually toward 15° you check my thrust and give me the positive rate call and we'll get the gear up. We're above acceleration so we can start the clean up shortly after that being wary of an alt cap in which case I'll ask for up speed and adjust thrust accordingly. Are you ready?"

Yes I am

Ok Go-around-flap 15.

That took around 25 seconds, or a track mile if we're at 150kts over the ground, so if you have it use it but just brief those initial actions and any immediate threats as you don't want to be writing a book on it whilst continuing down the approach toward the terrain! This really takes the startle out of the manoeuvre and allows you as a PM to actively monitor the PF as you know what to expect.

We won't be bamboozling you with a tech ten this week as we've decided not to do them on incident/accident or interview episodes, so we'll wrap it up here for this week. Please feel free to continue the talk over on our socials @b737talk or contact us through our website b737talk.com if you have any questions or episode suggestions. For now though, from Ian and I, fly well and be safe.