Airbus A321-211, G-JSJX

AAIB Bulletin No: 3/200	**Ref: EW/C2002/03/02**	**Category: 1.1**
Aircraft Type and Registration:	Airbus A321-211, G-JSJX	
No & Type of Engines:	2 CFM56-5B3/P turbofan engines	
Year of Manufacture:	1997	
Date & Time (UTC):	2 March 2002 at 2059 hrs	
Location:	Runway 27 at East Midlands Airport	
Type of Flight:	Public Transport (Passenger)	
Persons on Board:	Crew - 8	Passengers - 217
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Scoring to underside of rear fuselage	
Commanders Licence:	Airline Transport Pilots Licence	
Commanders Age:	37 years	
Commanders Flying Experience:	5,100 hours (of which 3,500 were on type)	
	Last 90 days - 94 hours	
	Last 28 days - 45 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The flight crew were flying a visual approach supplemented by raw ILS data with the autopilot and autothrust disengaged, and without the use of the flight director. The aircraft was initially above the glideslope which led to low power being selected to regain the correct approach path. On regaining the glideslope, insufficient power was restored and the speed decayed during the final part of the approach to 5 kts below VREF at touchdown. As a result, the pitch attitude was higher than normal at touchdown. An appropriate rate of forward sidestick application on touchdown was not applied and the pitch up moment caused by the spoiler deployment combined with an already high pitch angle increased the latter sufficiently to cause a tail strike.

History of Flight

The crew reported to East Midlands Airport at 1100 hrs on the day of the accident and were positioned to Liverpool Airport by coach, from where they operated a flight to Alicante without incident before operating a second flight to East Midlands Airport.

The co-pilot was the handling pilot on this final sector to East Midlands and he briefed the commander for an ILS approach to Runway 27. The threshold elevation of Runway 27 is 282 feet amsl and the pressure altimeters were set to the QNH. The co-pilot was due to undertake his base check the following week and to help him prepare for this, he elected to fly the approach with the autopilot and autothrust disengaged, but using the flight directors. This was done in the knowledge that the weather report for East Midlands at the time of landing was good with the ATIS report giving a light westerly wind of 4 kt, 20 km visibility, a few clouds at 1,800 feet and broken cloud at 7,000 feet. The aircraft landed at 2059 hrs; sunset that day occurred at 1744 hrs.

When level at the platform altitude of 2,000 feet, the crew were cleared by ATC for the approach and the co-pilot armed the localiser before disconnecting the autopilot and autothrust. However it was not until the aircraft was at about 6.5 nm from touchdown that it was slowed below 200 kt and flap extension started. The aircraft was established on the localiser and the crew continued to configure for landing, selecting landing gear down and full flaps. Whilst busy configuring the aircraft, the pilots overlooked the need to arm the flight director approach mode (ie the ILS localiser and the glidepath). It was not until the aircraft had flown through the glide path leaving it about two dots high that the omission was announced by the commander. In order to regain the glide path, the co-pilot, taking note of the good weather, elected to turn the flight directors OFF and to have the azimuth and pitch attitude references on the primary flight displays (PFDs) switched from heading and vertical speed to track and flight path angle. To re-capture the glidepath, the co-pilot reduced engine thrust close to idle (40% N1) and began a descent.

During this descent, the co-pilot continued to fly by a mixture of visual and instrument but at 3 nm from touchdown the aircraft was about 300 feet above the glide slope. The aircraft continued to correct towards the glide path and at 950 feet QNH, with the aircraft still just above the glide path, the co-pilot increased power to about 52% N1. He then reduced power again before once more reselecting about 52% N1 a few seconds later. The power then remained at this setting throughout the remainder of the approach until just before landing. The aircraft continued its descent slightly above the glideslope until at 600 feet agl (900 feet QNH) it passed through the glideslope and began to descend slightly below it. During the approach, the aircraft also diverged from the localiser, first to the right and then to the left by about half a dot. The commander called COME RIGHT after the second divergence and the co-pilot immediately corrected the aircrafts track towards the centre line.

The approach speed (VAPP) computed by the Flight Management Guidance System and displayed on the PFDs was 143 kts (VREF + 5 kt) which was consistent with the prevailing weather conditions and the aircrafts weight. However, the airspeed began to decay slowly below this value from about 580 feet agl until the aircraft was at about 70 feet agl when the co-pilot called out that the speed was low; by then the airspeed had dropped to 134 kt. The co-pilot advanced the thrust levers before retarding them to idle six seconds later, at or just after touchdown. During this period the increase in engine N1 was 20% but the airspeed continued to decrease and at touchdown it was 130 kts.

The low airspeed, combined with a reduction in the rate of descent from about 450 feet agl to position the aircraft back towards the glideslope, led to an increase in the pitch attitude from about 2.5° nose up at 500 feet agl to 5.0° nose up at 100 feet agl. During the landing flare, the pitch attitude increased further and at touchdown, it was between 7.7° and 8.0° nose up. The spoilers then deployed and the pitch attitude increased still further to about 10.2° nose up.

The co-pilots side stick was aft of centre at touchdown as expected. It was then moved forward as the pitch attitude continued to increase. By the time his stick position was forward of neutral, the aircrafts pitch attitude was close to its maximum. In response to the increasing pitch attitude the commander had called watch watch which was acknowledged by the co-pilot; the commander also applied a small forward control input to his own side stick. This was done without using the sidestick priority button, resulting in the two sidestick pitch inputs being summated.

The commander and co-pilot suspected they may have scraped the tail of the aircraft and whilst taxiing to their stand, the commander spoke to the cabin crew by interphone. The cabin crew confirmed that they had heard a scraping noise during landing. As a precaution, the commander elected not to start the APU and on reaching the stand, ground power was applied before the aircraft was shut down.

Aircraft Damage

Examination of the aircraft confirmed evidence of tangential scoring damage to the underside of the rear fuselage, extending longitudinally from just forward of frame 64 to just aft of frame 67 and laterally across three stringer positions. This area is within the tapering section of the pressure hull, beneath the aft end of the rear baggage hold. The A321 is not equipped with a tail-bumper and in a number of places the skin had been worn through with slight damage present on supporting structures. There was, however, no heavy deformation of stringers, clips, struts, cleats or frames, and no loosened fasteners were present on the internal structure. The aft drain mast had been damaged and an indication of mast heat failure was logged on the automated maintenance printout.

Examination of the eastern end of the runway revealed a light scrape mark, approximately 12 metres long, slightly to the right of the centre line, commencing approximately abeam the PAPIs.

The extent of the aircraft damage presented, in itself, no immediate hazard. However, it is possible that such a light tail strike might pass undetected by the flight crew and, especially should a night turn-round take place, remain undetected by a departing crew or ground staff. The possibility of a subsequent sector with skin damage present in the pressure hull would present an airworthiness issue.

Sequence of events

The tail scrape was caused by excess pitch attitude during the landing resulting from a chain of events.

The high workload which was generated by configuring the aircraft for landing whilst intercepting the glidepath left less opportunity for the non-handling pilot to notice the next significant event, the omission to arm the approach. Although the commander noticed the omission, by that time the aircraft had already flown through the glide slope. The co-pilot considered the most expeditious way to recapture it was by dispensing with the flight directors and flying a visual approach supplemented by raw ILS data; this was done in the knowledge that the good weather enabled the commander to monitor the aircrafts flightpath visually. Whilst they had not briefed for such an approach, both pilots agreed between themselves on two separate occasions during the subsequent approach that they were happy to continue.

In order to regain the glide path, engine power was set initially to idle. The co-pilot pointed this out to the commander who acknowledged that he was happy with the situation. The power was then

adjusted when the aircraft regained the glide slope. However, subsequently, the power remained at 51% N1 until just before touch down. This activity pattern suggests that airspeed was temporarily omitted from the handling pilots instrument scan.

At 700 feet agl the co-pilot confirmed he was visual with the runway and would carry out a manual landing but he continued to refer to the flight instruments. It was after this VISUAL call that the aircrafts deviation to the left of the localiser was announced by the commander. This then led the commander to revert to the standard instrument approach calls at decision altitude, at which point the co-pilot reported that he was BACK VISUAL NOW.

The next significant event was an insidious decrease in airspeed which had begun to reduce below VAPP from about 350 feet agl. This trend was not noticed by either pilot until the co-pilot called out that the speed was low at about 70 feet agl. By then it had dropped to 134 kts (9 kt below VAPP). Although the co-pilot applied power to try and correct the low speed, this was insufficient over such a short time to have any marked effect. At touchdown the airspeed had dropped to 130 kts. and the pitch attitude was between 7.7° and 8.0° nose up.

The final event in the chain was automatic deployment of the spoilers. Despite the co-pilot relaxing the back pressure on his sidestick, insufficient forward sidestick was applied to prevent the aircrafts pitch attitude rising still further to about 10.2? nose up, provoking the tail strike.

Operators procedures

Company standard operating procedures stated that in instrument conditions an approach should be stabilised by 700 feet agl, and in visual conditions by 400 feet agl. A stabilised ILS approach requires the aircraft to be on the correct approach path, at VAPP, in the landing configuration, and with the thrust above idle. If these conditions are not achieved, a go around is mandatory.

In the case of a visual approach, the aircraft should be on the correct approach path, at VAPP with the appropriate thrust applied. The document states that if these conditions are not achieved, a go around should be strongly considered. The procedures also state that any speed reduction greater than 5 kt below target speed should be called out.

At around 700 feet agl the approach instantaneously fulfilled all the criteria but the aircraft had been deviating from the localiser and glideslope shortly before this point and it continued to deviate from them after this point. Therefore, the approach was not truly stabilised at 700 feet agl. By 400 feet agl, the aircraft was below the glideslope and the airspeed began to reduce below VAPP from about 350 feet agl. This latter trend was not noticed by either pilot until the co-pilot called out that the speed was low at about 70 feet agl.

Airbus Industrie advice to pilots

Airbus Industrie FCOM Bulletin No 22/3 relates to tail strikes and their avoidance. It states that a tail strike will occur at a pitch attitude of 11.2? with the gear oleos fully extended, and at 9.7? with the oleos fully compressed.

The aircraft touched down with a pitch attitude of 7.9? which then decreased to about 7.5?, however on spoiler deployment this increased again to 10.2?. This pitch up effect caused by the spoilers is mentioned in the Bulletin which advises that the pilot should fly the nosewheel

smoothly, but without delay, on to the runway. It notes that the main part of the spoilers pitch up effect is compensated for by the flight control laws.

To reduce the risk of a tail strike, the FCOM Bulletin instructs that the non-handling pilot should call pitch once the aircrafts pitch angle exceeds 7.5?. The commander did indeed call a warning about the aircrafts pitch, acknowledged by the co-pilot, but not until the pitch up at spoiler deployment. There is no head up indication of aircraft pitch angle in the Airbus sidestick aircraft types so to announce excess pitch with some accuracy would require the non-handling pilot to look down at his PFD during the flare and touchdown phase of the landing. This would be both unnatural and unwise during this critical phase which is largely reliant upon visual cues for its proper execution.

Having called out a warning and despite getting an immediate response, the time required to provide an appropriate input is extremely short if a tail strike is to be avoided. Thus it would be a natural reaction of a non-handling pilot to instinctively wish to put in a control input as well. It is likely that the commanders action in putting in a forward control input on his sidestick without use of the sidestick priority button prevented the tail strike being more severe, as both pilots inputs would have been summated.

Human factors

Both pilots were ex-military. The co-pilot had been with the company for less than a year having previously gained considerable experience flying single-seat fast-jet aircraft. The commander considered his decision not to order a go around or to take control himself had been directly affected by his judgement of the co-pilots experience. The company also made reference to this experience in discussion subsequent to the accident. Whilst indeed the co-pilot had proved himself to be a capable military pilot, his military flying experience was so markedly different both in terms of the type of flying and the aircraft flown as to make any comparison with his current flying somewhat tenuous. Indeed his previous flying had all been done without the use of autothrust whereas since joining the company, he could not recall ever having flown without the use of the autothrust, except during his initial training. This had inevitably lead to a decrease in his speed control skills through a lack of practice.

Discussion

As aircraft become ever safer through the use of increased automation, pilots are still expected to be able to fly them safely with this automation removed. Simulators provide an opportunity for pilots to practise these skills but these opportunities are infrequent (about once every 6 months) and they usually coincide with a test of the pilots proficiency. Consequently, through a desire to demonstrate high standards it is understandable that a pilot might wish to practise such skills before going into the simulator. The only opportunity most line pilots will have to practice manual flying skills is during normal commercial flights. However, this and many previous comparable occurrences, indicate that such practice must be undertaken with great care and diligent monitoring by the non-handling pilot so that overall safety is enhanced rather than compromised.

In a six-month period, flying one manual approach just before going to the simulator seems inappropriate. What might be far more appropriate is reasonably frequent practice in suitable light, weather and airport conditions; properly monitored by the non-handling pilot, who must be empowered and willing to intervene if the practice instrument approach is unsatisfactory. Secondly, the relative workload for both pilots rises markedly as automation is withdrawn and so the fully

manual raw data approach should be treated with caution and respect. A fully manual stick and throttle ILS approach without flight director is a challenge that should be approached incrementally.

Root cause

The root cause of this accident was the co-pilots desire (and perhaps need) to practice an instrument approach technique shortly before his ability to perform it satisfactorily was assessed in the simulator. He had not intended to fly the ILS approach without the benefit of the flight director, but once he had allowed the aircraft to fly through the glidepath at relatively close range to touchdown (about 5 nm), if he wished to retain the use of the flight director, he had little choice other than to discard that approach and attempt another. Thus, the earlier oversight of omitting to arm the approach mode of the flight director subsequently robbed him of its value in reducing workload and he never succeeded in regaining a properly stabilised approach. The direct cause of the accident was the decision to continue the approach when it was not properly stabilised. The co-pilots call regarding low air speed at 70 feet agl was the flight crews final chance to extricate themselves from the deteriorating situation by performing a go around.