Case Report

Human factor analysis of Alliance air crash flight CD-7412

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ABSTRACT

Human error is a causal factor in a large number of aircraft accidents and incidents. In civil aviation, as much as 60-80% of accidents are attributable to this malady. On 17 Jul 2000, a perfectly serviceable, Alliance Air Boeing 737-200 crashed in a populated area of Patna city, while on approach to the airfield. In this accident, the entire crew of six and 49 passengers were killed. In addition, five persons on the ground lost their lives. This paper revisits the accident to determine what really happened to Flight CD 7412. In the final analysis by the court of inquiry, it is seen that the accident was the outcome of a number of human factor errors, including pilot error, gross violation of laid down procedures, failure of crew coordination and lack of situational awareness.

IJASM 2002; 46(1): 66-74

KEY WORDS: Human error, Accidents, Human factors, Aircraft accidents

Cicero, the roman orator once said - "it is in the nature of man to err." [1]

Human error has been a common and accepted element of behavior throughout history. It is widely agreed upon that human error is a causal factor in a large majority of aircraft accidents and incidents. [2, 3, 4] The FAA has identified human error as a causal factor in 60-80% of air carrier and general aviation accidents and incidents. [2] Other sources, perhaps more bold in their methodologies place the figures even higher. [3] Because of the role that human error plays in so many accidents, it could be argued that, if properly conducted, almost any accident investigation in essence is a human factors investigation. Almost all accidents have causal links to human error.

An Alliance Air Boeing 737-200 crashed at Patna on 17 July 2000. The news media were on the scene of the accident within the hour, beaming live coverage of the burning wreckage, rescue efforts and the events as they unfolded. Reporters and TV anchor personnel propounded theories, eyewitness accounts were related and debated and speculation was rife as to what caused a perfectly serviceable aircraft to go into the ground.

What really happened to Flight CD 7412? What caused an aircraft to drop from the sky? Did the pilots get incapacitated? These were some of

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the questions requiring urgent answers. It was only as the investigation got underway and the evidence collected, that the signatures of human error began to emerge and the truths unfold.

Flight CD-7412

On 17 Jul 2000 Alliance Air Flight CD 7412 a Boeing 737-200 ADV aircraft VT - EGD departed Netaji Subhash Chandra Bose international airport Kolkata at 0650h and was on a scheduled flight to Delhi via Patna and Lucknow. Both the pilots were reasonably experienced, the Commander was 35 years in age with a flying experience of 4072 h of which 1489 h were as PI. The copilot was 32 years in age with a total of 3536 h of which 2844 h were on type. Both pilots were medically fit and had valid medical assessments and current flying licenses.

Prior to the flight, all 6 crewmembers i.e. two pilots plus four cabin attendants, underwent pre-flight medical examination including breath analyzer tests and were found fit. The pilots were briefed about the weather at destination, alternate and at Kolkata. The pilots were also briefed about Patna ILS glide slope being restricted to 300 feet as per communication NOTAM.

After a normal departure the aircraft climbed to FL 260 on track to Patna. The aircraft was under control of Kolkata Radar from 0625 to 0659 h. Thereafter it changed over to Kolkata Area Control Centre. The aircraft reported position SAREK at FL 260 at 0712 h and changed over to Patna control with information that there was no reported aircraft for descent. The aircraft contacted Patna ATC at 0713 h and gave its ETA at Patna as 0736 h.

Patna ATC cleared the aircraft to PPT VOR ILS\DME ARC approach for RAV 25. The ATCO communicated that Patna METAR originated at 0650 h stating: "Winds calm, visibility 4000m, weather haze, clouds broken, 25000 feet, temp 29 degrees C, dew point 27 degrees, QNH 996 hPa, No sig". The aircraft was cleared to descend to 7500 feet and report 25 DME from PPT VOR. The aircraft reported DME at 0726 h. The aircraft then descended to 4000 feet on QNH 996 hPa and was asked to report 13 DME for JESYDME ARC approach R\W 25. The aircraft reported commencing the ARC at 0728 h. The aircraft reported crossing lead radial 080 at 0731 h and coming on to the localizer. The aircraft was then asked to descend to 1700 feet on QNH 997 hPa with instructions to call established on localizer.

Approximately 30 sees before the crash the aircraft informed Patna ATC at 0732 h that it would like to do a 360° turn due to being high on the approach. Patna ATC sought confirmation from the aircraft whether it had the airfield in sight and on receiving an affirmative reply asked the aircraft to report on finals for R\W 25 after carrying out 360° turn. The aircraft acknowledged this at 0732h. This was the last communication from the aircraft. Immediately thereafter, the aircraft was spotted by the ATCO in normal descent aligned for R\W 25. It however appeared to be high on the approach. The aircraft then turned steeply to the left losing height all of a sudden and disappeared from sight behind a row of trees. The ATCO observed a huge column of smoke rising from the Gardani Bagh residential area and initiated crash action.

The ATC tape had 09 calls to the aircraft made by the ATCO from 0734 to 0734:48 h. As per the tape there was no emergency call from the aircraft while losing height.
02 pilots, 04 airhostesses and 52 passengers were on board. All the crew and 49 passengers were killed as a result of the crash. The aircraft was completely destroyed by the crash and post

crash fire. Five persons on the ground also lost their lives. Two residential quarters were destroyed and another on the same side of the road sustained damage to its roof.

Wreckage and Impact Information

Total wreckage of the aircraft was confined to one location covering residential quarters No 6 and 8 on road No 29 and it was primarily spread over an area of 100 feet X 100 feet.

The aircraft prior to impacting the ground had passed through six trees and grazed quarter No 9 with its right wing, indicating right bank impact. On its final flight path the outboard portion of the right wing had broken off when a tree had torn through the wing. This portion separated and fell off. After passing through the trees, the aircraft turned sharply to its right and struck residential quarters No 6 and 8 and the ground. The aircraft hit the ground with the engines contacting first and taking the impact of the wing.

Aircraft tail section was found separated. Both wings were found torn and separated and the engines were separated from their installation. All separated parts were found confined to the wreckage site.

Failures in Rescue Services

The accident site was 5-6 km from the airport. The fire personnel reached the site in 5 to 6 minutes (local residents stated that the tenders reached only after 15-20 minutes). The first Crash Fire Tender (CFT) laid two hoses and began to fight the fire; however it failed in 3 minutes. After failing in their efforts to rectify the fault, the CFT crew had to call a mechanic from the airport and the CFT was put back into operation after an hour. However, after a few minutes of operation it went back to the airport to refill water. On the way it broke down twice.

The second CFT after a few minutes of operation had to return back to the airport to refill water.

The crowd that collected within a short time was unmanageable and definitely hampered the rescue operations. According to witnesses, crowd tempers ran high and there was a general tendency to target anybody in uniform or position of authority with verbal abuse and physicaWviolence. At times there were hundreds of people trying to climb on to the rescue vehicles to get a better view. It was only after the arrival of the Bihar military police jawans and the army contingent that some semblance of crowd control was achieved.

Survival Aspects

Initially seven passengers were extricated alive, of which six were seriously injured. One passenger walked out of the wreckage with only a minor injury. Of -the six seriously injured passengers, four died subsequently.

Human Factors: Analysis of FDR

Patna ILS approach: The procedure connected the W52 track coming from Kolkata to\ a constant radius turn at 11 nm maintaining a height of 2000 feet up to the lead radial at 080. After crossing the lead radial the aircraft had to turn on the localizer beam at a height of 1700 feet and then follow the localizer and GS commands. With this procedure the aircraft would be established on the runway centre line at 6 to 7 nm and with a stable approach for a proper landing.

1. At 0728 h aircraft informed ATC - commencing the ARC call you established localizer. ATC instructed descend to 2000 feet and report crossing lead radial aircraft did not

commence ARC but continued on same heading.

2. The aircraft would have had to turn right through 60-70° to join the ARC and thereafter execute a slow but continuous left turn to 250° to align with RYW 25 -— no such actions were recorded.

3. The aircraft was supposed to descend to 2000 feet while flying the ARC approach — the height remained at 4000 feet even 2 minutes after reporting "commencing the ARC".

4. When aircraft reported crossing lead radial it should have been at 11 nm and at an altitude of 2000 feet ------- aircraft was only 3.5 nm at an altitude of 3000 feet.

5. ---------- At 3.5 nm from airfield aircraft altitude should have been 1400 feet ----- it was at 3000 feet.

Meanwhile the aircraft configuration changed from Flaps up - Flaps 1 - Flaps 5 - gear down - Flaps 15 - Flaps 40. Thereafter the decision was taken to go around 360°. This was taken when aircraft was at a height of 1280 feet 1.2 nm away from threshold.

The aircraft which was in a left turn started a right turn which was again reversed to a steep left turn and then again a right turns. In approximately 15 sees the FDR recorded bank angle changes from left 21° to right 14° to left 47° to right 30°. The nose down pitch attitude was reversed to nose up of 8° and then to a peak of 16°. The CVR recorded the stick shaker, which is a warning of approach-to-stall. This sound was heard continuously. Within 2 sees of this, the pilots called for retraction of the landing gear. The gear unsafe warning sounded and this was followed by flaps retraction from 40° to 25° (this warning comes on when the landing gear is not locked down and the flaps are in landing configuration). The pilots then moved the flaps to 15°. The GPWS started sounding to pull up and this continued till the crash. Further it was seen from the engine parameters that the engines remained at idle. The speed had reduced to 119 kts (should have been at least 124 kts).

The speed reduction did not appear to be intentional. It meant that the co-pilot flying the aircraft was not concentrating on flying. He was probably looking out for the runway and judging the situation. The Commander was meanwhile busy with the transmissions. The turn was started without realizing that the airspeed had reduced.

16 see before crash ---------- the spooling up of the engine had reduced the rate of descent.

8 sees later -------- the rate of descent increased due to flaps moved to 15. This was caused by loss of lift due to reduction in wing area as the flaps moved from 40 to 15.

6 sees later --------- the rate of descent increased even further. The aircraft had a high nose up pitch attitude, resulting in a 26 deg angle of attack, producing a complete stall.

Approach-to-stall procedure ---------- aircraft would have recovered if the flaps were not disturbed, adequate engine power and reduction in angle of attack was done.

Human Factors : Analysis of CVR

1. On analysis of the CVR it was found through voice recognition by the deceased pilots' wives that the copilot was actually sitting on the left seat. All air to ground

communications were carried out by the Commander. The intra cockpit conversation was mostly in the form of checklists and announcements. There was hardly any conversation between the pilots.

5. The Commander of the flight, who was not qualified as an examiner/instructor/check pilot, was occupying the right hand seat (co-pilot seat). The co-pilot was occupying the left-hand seat and was on the controls at the time of impact.

6. The ATC was given the impression that a standard DME ARC approach procedure was followed as per the manual would be followed while there was no intention to follow the ARC. It was expected that at least the Commander would have briefed his copilot about the procedure. No such briefing was heard.

7. The procedure to carry out a 360° turn was not an authorized procedure as per the Alliance Air Operations Manual.

8. The Commander tried to resolve this issue without any discussion with the co-pilot.

9. The atmosphere in the cockpit was relaxed and tension free till 15 sees before the crash. The first sign of anxiety became apparent only when the copilot called for raising the landing gear.

Final Flight Path of CD 7412

The configuration of the aircraft was changed from Clean Cruise configuration to Landing configuration of Flaps 40 and Gear down approximately 2 min and 20 sees prior to the crash. Thereafter, a 360° turn was conveyed to ATC as the aircraft was too high on approach. The heading change to right seen on the FDR was either for a missed approach or an "S" approach; 2 sees later the aircraft reversed its bank by rolling to the left.

After the stick shaker, the actions of the crew recorded viz full engine thrust, Flaps 15 and landing gear up related to a "go-around" procedure. This along with the nose up pitch attitude of 10-12 degrees indicated that the pilots initiated a go-around procedure to fly out of the situation.

The scenario in the final moments was as follows:-

2. The aircraft had not followed the approved approach procedure but intersected the extended runway centre line with lateral separation of about 3 to 3.5 nm and then tried to align with the centre line at a very short distance from the runway.

3. The engines were at idle thrust throughout the descent profile and the speed was continuously reducing.

4. When it was realized that the aircraft was too high to affect a landing, a 360° orbit was requested. The speed at this time was 119 kts VREF that was the landing speed.

5. The aircraft was maneuvered sharply and the stick shaker activated.

6. A go-around was initiated by retracting the flaps to 15, opening throttles, retracting landing gear and holding a nose up pitch attitude of 10-12°.

The retraction of flaps, together with high pitch attitude and insufficient speed caused further loss of lift and the aircraft entered into a full stall regime from which it could not recover and impacted the ground.

7. Approximately 8 seconds before impact the stick shaker warning was activated. At initiation of warning the configuration of the aircraft was - Flaps 40. Engine thrust at 1.5 EPR, speed at VREF 119 kts, pitch attitude 10 degrees nose up, left bank at 20 degrees (just out of a rapid bank reversal). This increased to a high rate of descent and a very high angle of attack of the order of 26 degrees. The aircraft had completely stalled and even though the thrust had been increased to the maximum possible on both engines, recovery was not possible.

8. On its final flight path the outboard portion of right wing had broken off when a tree had torn through the wing. This portion of the wing separated and fell near the trees next to the crash site. The rest of the aircraft with landing gear in retracted position hit the ground, with the engines contacting the ground first and taking the impact of the wing. The aircraft also brought down two brick houses and the wings were buried under the earth.

Verdict of Court

The COI determined that the aircraft was fully airworthy and was properly maintained. There was no evidence of any in-flight fire, pre-impact failure of the aircraft structure or malfunction of the flight controls or any other aircraft system. There was no evidence of bird strike. Both engines were operating and developing thrust at the time of impact. Accident took place during day light in fair weather conditions. The COI also commented on Patna airport, which had several operational constraints resulting in erosion of safety margins for operation of aircraft.

The COI determined that the cause of the accident was loss of control of the aircraft due to human error (aircrew). The crew had not followed the correct approach procedure, which resulted in the aircraft being too high on the approach. They had kept the engines at idle thrust and allowed the air speed to reduce to a lower than normally permissible value on approach. They then maneuvered the aircraft with high pitch attitude and executed rapid roll reversals. This resulted in the actuation of the stick shaker stall warning indicating an approach to stall. At this stage the crew initiated a go around procedure instead of an approach-to-stall-recovery procedure resulting in an actual stall of the aircraft, loss of control and subsequent impact with the ground.

Human Factors

Flying is a coordinated activity and involves a host of different categories of personnel besides the pilots who fly the aircraft. Any failure, acts of omission and commission by any one or more of these personnel could result in an air crash. However the lapse of others could be overcome at times by the skill and experience of the pilot but a lapse on the pilot's part could have a fatal outcome. [4] Flying is also a closed loop system with man as a component in the loop. The aircraft has tremendous capabilities with a high deal of accuracy and in-built safety features. However man has remained unaltered and tuned to terrestrial life. He therefore remains the weakest link in the system. [5]

In India there have been a number of major air disasters. The chronology of these civil and military air crashes is listed in Table 1. [6]

7] Looking at these psychological factors it can be appreciated that a number of them were Involved in this accident, e.g. faulty technique in

Table 1. Major civil & military air disasters in India

S.No.	*Date*	*Aircraft*	*Event*	*No. Dead*
1	**07.02.66**	**Fokker F**	**Crash near Banihal Pass**	**37**
2	**21.04.69**	**Fokker F**	**.....**	**44**
3	**29.08.70**	**.....**	**Crash near Silchar, Assam**	**39**
4	**26.03.71**	**Dakota**	**Crash near Delhi**	**15**
5	**11.08.72**	**Fokker F**	**Crash at Palam, Delhi**	**18**
6	**31.05.73**	**Boeing**	**Crash at Delhi**	**48**
7	**12.10.76**	**Caravelle**	**Crash near Mumbai**	**95**
8	**04.08.78**	**Avro 748**	**Crash near Pune**	**45**
9	**-.11.78**	**AN 32**	**IAF crash near Leh**	**77**
10	**19.10.88**	**Boeing 737**	**Crash near Ahmedabad**	**131**
11	**19.10.88**	**Fokker F**	**Crash near Guwahati**	**35**
12	**15.12.89**		**Crash near Pune**	**11**
13	**14.02.90**	**Airbus 320**	**Crash at Bangalore**	**92**
14	**25.03.91**	**Avro 748**	**IAF crash near Yelahanka**	**25**
15	**26.04.93**	**Boeing 737**	**Crash at Aurangabad**	**56**
16	**12.11.96**	**Boeing 747 + IL a/c**	**Midair collision at Chakri Dadri (Saudi + Kazakh)**	**351**
17	**24.12.96**	**Avro 748**	**IAF crash in Prakasam**	**22**
18	**30.07.98**	**Dornier**	**Navy crash near Kochi**	**09**
19	**11.01.99**	**Avro 748**	**IAF crash at Arakonam**	**08**
20	**07.03.99**	**AN 32**	**IAF crash at Papankalan**	**22**
21	**17.07.00**	**Boeing 737**	**Crash at Patna**	**55**

implicated here, where the pilots breached flying discipline and performed an unauthorized man oeuvre. Attention failure is also seen when the crew failed to monitor the washout of speed maybe because they were focused on short circuiting the approach. An incorrect decision was taken in the emergency; the crew adopted a pull-out man oeuvre instead of an approach-to-stall man oeuvre. During this period we see that the Commander exhibited supervisory lapses in that he neither briefed his co-pilot on the intended course of action nor did he monitor the co-pilot's actions.

An investigation begins by identifying the errors contributing immediately to the accident. Three types are distinguishable. [7]

a) Errors of perception - in this, an important piece of information is misinterpreted or not detected. In this case the washout of speed went unnoticed.

b) Errors of intention - the crew formulate a plan that entails risks, e.g. deliberate violation of rules. The crew violated the laid down procedure.

c) Action errors - a plan is inappropriately executed or simple slips and lapses. The crew literally stalled the aircraft.

Analysis of the causes of air accidents has shown that factors such as inadequate communication play a major role and have lead to poor crew coordination. Crew members must work together to ensure that no individual has excessive workload, that intra-cockpit communication and decisions making are effective, that performance is resistant to stress and that situational awareness is maintained. [8] This accident highlights the inadequate crew communication and coordination even in the final moments of the flight.

As mentioned earlier situational awareness (SA) is increasingly being recognized as a major

determinant of aircrew effectiveness. [8] SA can be defined as the continuous extraction of environmental information, integration of this information with previous knowledge to form a coherent mental picture and the use of that picture in directing further perception and anticipating future events. In a study of SA related errors, the same could be classified as follows:-

a) Level 1: Failure to perceive information correctly (80.2%). This included factors such as difficulty in detecting data, misinterpretation and failure to monitor.

b) Level 2: Failure to comprehend the situation (16.9%). These errors were related to the inadequacy of the crew mental model.

c) Level 3: Failure to project the situation into the future (2.9%). These factors were related to over projection of current trends.

In this accident there was level 1 & 2 failure of situational awareness.

Conclusion

Flight CD 7412 of Alliance Air was an accident with multiple human factors involved in its causation. Pilot error was the primary cause. The pilots violated the laid down procedure and adopted a wrong approach to handling the stalled condition of the aircraft. There was a complete breakdown in crew communication and coordination, which was further compounded by failures in maintenance of situational awareness. This accident calls for an urgent re-look at the CRM training being imparted to the aircrew. The ground response to the accident was also fraught with a number of failures, which need to be

• addressed at an appropriate level so as to formulate a more effective disaster management response.

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