Name: Muhammad Anees Khan
Age: 19 Years
Topic: Air Accidents

Introduction:

Air Crashes are the most frequently discussed topic in Aviation Industry. The reason for the prevalence of this subject is it's enormous importance. The motive for this presentation was to instill in the audience a strong desire to study and read as many accident reports as possible because that is the only way to prevent a future Air Accident.

Agenda:

The following was the planned agenda for the presentation:

- Introduction
- Crash of Flight 585
  - Chain of Events
  - Investigation
  - Cause of the accident.
  - Final Report
- Crash of Flight 3142
  - Chain of Events
  - Investigation
  - Cause of the Accident
  - Final Report
- Conclusion
- Question/Answer Session

In order to fully grasp the cause behind the crash every technical term related to the crash was explained in a comprehensive yet easy to understand fashion.

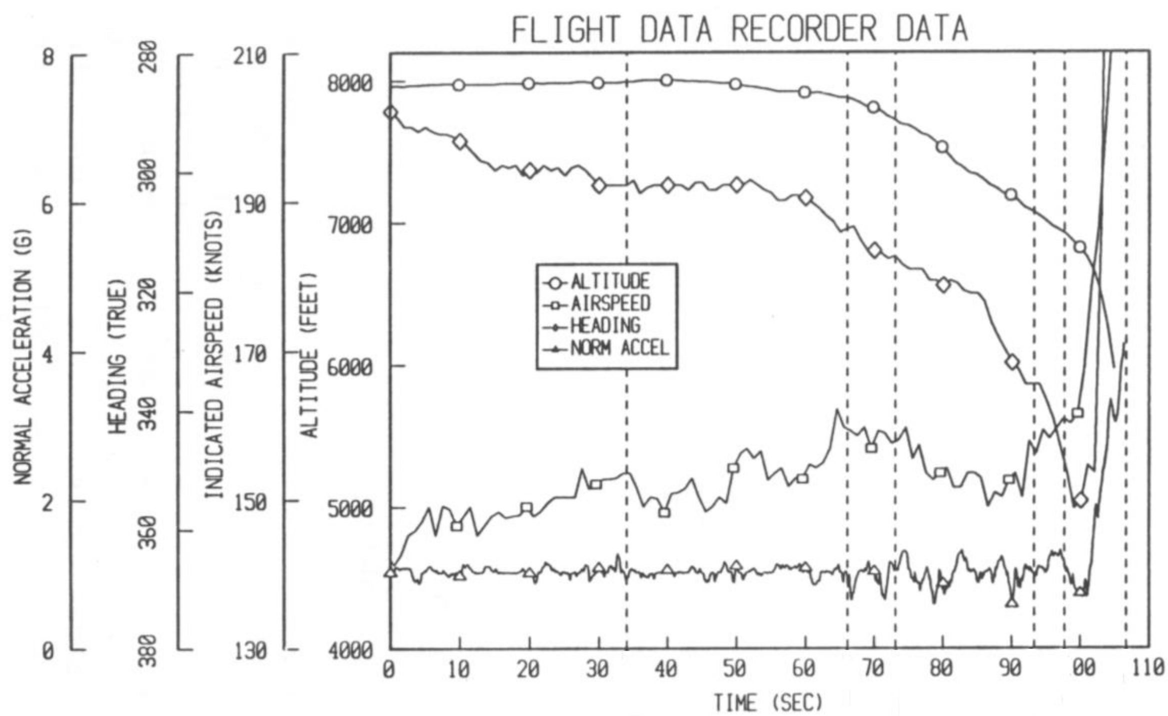
United Airlines Flight 585:

Operated by a B737-200, registration number N999UA, United Airlines flight 585 was a scheduled passenger flight from Denver, Colorado, to Colorado Springs, Colorado. The airplane departed from Denver without any technical difficulty and there was nothing out of the ordinary as observed from the Flight Data Recorder and the Cockpit Voice Recorder. The CVR tape revealed that at 0930:37, the flightcrew received automated terminal information service (ATIS) information, version "Lima," that was about 40 minutes old. ATIS "Lima" stated, in part:

Wind three one zero at one three gust three five; low level wind shear advisories are in effect; local aviation wind warning in effect calling for winds out of the northwest gusts to forty knots and above.

According to the CVR and FDR, the flightcrew added 20 knots to the approach landing reference target airspeed based on the ATIS information.

At 0934:06, the airplane was allowed to descent to 10,000 feet, at their own discretion, and a further descent to 8,500 feet was issued about 3 minutes later. The first officer then reported the airport in sight, and approach control instructed them to maintain "at or above 8,500 until on base, runway 35, cleared visual approach, contact tower 119.9." She repeated the instructions and contacted the tower.



About 20 seconds prior to the crash, the rate of heading change increased, consistent with a 20-degree bank angle and a turn for alignment with the runway. Sixteen seconds prior to the crash, the thrust was increased to about 6,000 pounds per engine. As the thrust was increasing, the first officer made the “1,000 feet” call. Within the next 4 seconds, and about 9 seconds prior to the crash, the heading rate increased to about 5-degrees per second to the right, nearly twice that of a standard rate turn. The first officer said “Oh God,” followed by the captain, in the last 8 seconds, calling for 15 degrees of flaps. This selection of 15-degrees flaps, in combination with increased thrust, is consistent with the initiation of a go-around. The altitude decreased rapidly, the indicated airspeed increased to over 200 knots, and the normal acceleration increased to over 4 G.

The airplane impacted relatively flat terrain 3.47 nautical miles south of the south end of runway 35 and .17 nautical miles to the east of the extended centerline of runway 35 at the Colorado Springs Municipal Airport. All of the occupants on board the flight received fatal injuries. The airplane was destroyed by impact forces and postcrash fire.

The accident site coordinates were 38 degrees, 44 minutes and 09.4 seconds north latitude, and 104 degrees, 42 minutes and 42.4 seconds west longitude at an elevation of 5,704 feet above sea level. The accident occurred during daylight hours.

Similar Incidents:

Us Air Flight 427 while approaching Pittsburgh rolls to the left and nose dive into the ground killing all the people onboard.

An Eastwind Airline Flight 517 crew while at cruising altitude momentarily lost control of their airplane. The crew were able to regain control and the aircraft landed successfully.

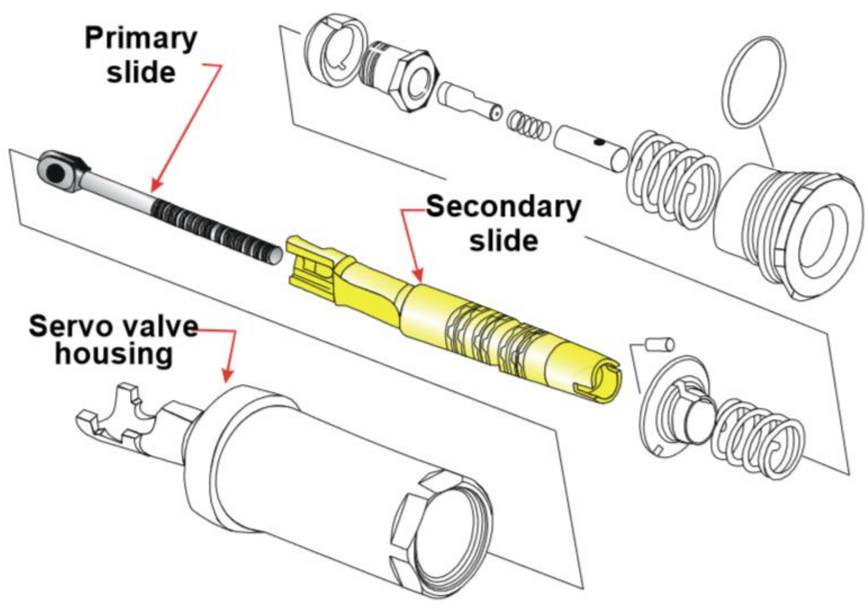
The most frightening thing about these accident was that all of them involved the same kind of airplane. So the pressure was on to solve the mystery behind these accidents otherwise the entire fleet of the 737 would have to be grounded.

Nonetheless the investigation of these subsequent event helped greatly with the previous investigation of the United Airline Flight 585, as the cause behind all of them was the same.

Boeing 737 Rudder Control System:

The rudders on airplanes with fuselage-mounted engines are typically less powerful than the rudders on airplanes with wing-mounted engines. The rudders for fuselage-mounted engine airplanes do not have to be designed to counter as significant an asymmetrical thrust effect in the event of a loss of power on one engine. Therefore a rudder hardover in a 737 (wing mounted engines) would greatly disturb the airplane.

When properly installed and rigged, the 737-200 main rudder PCU can command a maximum deflection of 26° to the right and the left of the rudder's neutral position (under no aerodynamic load conditions); the rudder can travel to those limits at a maximum rate of 66° per second. (The 737 main rudder PCU is capable of producing about 5,900 pounds of output force to move the rudder when both hydraulic systems are operating at their normal operating pressure—2,950 psi each.) The rudder pedals move about 1 inch (from their neutral position) for every 6.5° of rudder surface travel (under no aerodynamic load conditions) until the rudder pedals reach their maximum travel of about 4 inches (backward and forward) from the neutral position. The rudder pedal stops at the pilots' forward rudder control quadrant are set to provide a mechanical stop at 28° of rudder travel (exceeding the rudder's travel authority) because compliance in the cable system (cable stretch) may require rudder pedal travel beyond the 4-inch limit to achieve the full travel rudder movement of 26°. With the aerodynamic loads encountered in flight, the available amount of rudder surface travel is reduced. **The maximum amount of rudder travel available for an airplane at a given flight condition/configuration is referred to as the rudder's "blowdown" limit.**



Boeing 737 main rudder PCU servo valve.

Main Rudder PCU Servo Valves Tests:

A series of tests were performed on the servo valve of the Boeing 737. Those include

- Chip Shear Test
- PCU Thermal Testing
- Baseline Test Condition
- Simulated Hydraulic System Failure Condition
- Extreme Temperature Differential Test Condition

Some of these test were performed on the servo valve of the Us Air Flight 427 as the PCU of the United Airlines Flight 585 was severely damaged due to impact.

Rudder Reversal:

After the Safety Board's October 1996 thermal tests, Boeing engineers began an independent detailed examination of the test data. Their review of the data indicated that the PCU servo valve responded slowly and erratically to the input commands when the secondary slide was jammed to the housing by the thermal shock and an input was applied to the external input arm. Boeing subsequently conducted tests using a new-production PCU that had been modified to simulate a jam of the secondary slide to the servo valve housing at various positions and then to simulate the application of a full rudder input to the PCU.

These tests revealed that, when the secondary slide was jammed to the servo valve housing at certain positions, the primary slide could travel beyond its intended stop position because of bending or twisting of the PCU's internal input linkages (compliance). This deflection allowed the primary slide to move to a position at which the PCU commanded the rudder in the direction opposite of the intended command (reversal). Specifically, the tests revealed that, when the secondary slide was jammed at positions greater than 50 percent off neutral toward the extend or retract position and a full-rate command was applied to the PCU, the rudder would move opposite to the commanded position. So anytime the pilot tries to correct the rollover by applying the opposite rudder the condition only became more and more worst.

This phenomenon was found to be **the cause** for the crash of United Airlines Flight 585.

Aftermath Of United Flight 585:

In the after math of the crash the servo valve of the Boeing 737 was found guilty.

- The dual-concentric servo valve used in all Boeing 737 main rudder power control units is not reliably redundant.
- A reliably redundant rudder actuation system is needed for the Boeing 737, despite significant improvements made in the system's design.
- The results of this investigation have disclosed that the Boeing 737 rudder system design certificated by the Federal Aviation Administration is not reliably redundant.

Boeing redesigned and replaced the servo valve on every 737 around the globe to reduce the threat of rudder reversal.

- Pilots would be more likely to recover successfully from an uncommanded rudder reversal if they were provided the necessary knowledge, procedures, and training to counter such an event.
- A neutral rudder pedal position is not a valid indicator that a rudder reversal in the Boeing 737 has been relieved.
- The training being provided to many Boeing 737 flight crews on the procedures for recovering from a jammed or restricted rudder (including a rudder reversal) is inadequate.

Better Training is provided to the pilots to handle the rudder hardover, if the pilots of the doomed airplane had this information they might have recovered their airplane.

LAPA Flight 3142:

On August, 31st 1999, A Boeing 737 operated by an Argentinian Airline was hurtling down the runway of Aeroparque Jorge Newbery, Buenos Aires, Argentina. The first sign of danger appeared in the form of the Takeoff Warning System. Which alarmed the cockpit crew that they are not correctly configured for the takeoff. The captain seemed undisturbed by the warning and believed that their airplane was good to takeoff. Only after the failed attempt of rotating the airplane that he sensed that something was not right with his airplane. He decided to abort the takeoff but it was too late he overshot the runway and collided with a road construction machinery.

Wreckage:

- Cockpit Voice Recorder and Flight Data Recorder was collected from the crash site and sent to the lab.
- The type of damaged sustain by the engine indicated that the engines were working properly to lift the airplane.
- The flaps were at 0° position.
- The Thrust Reversal were deployed.

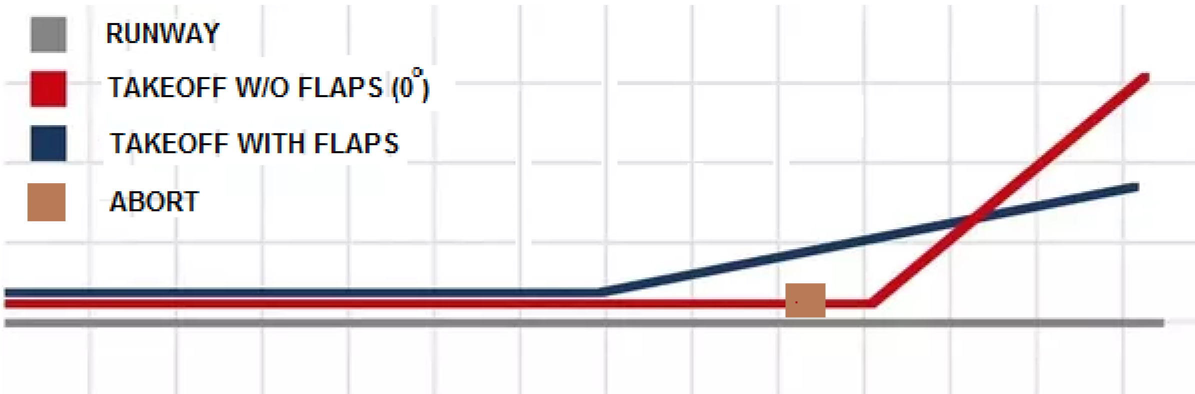
Investigation:

By listening to the cockpit voice recorder it was clear that there were a lot of irrelevant conversation in the cockpit which led the pilots to forgot about the most common takeoff procedure that is to extend the flaps. They were not properly following any checklist.

Flaps and it's Effect on Takeoff Speeds:

Flaps increases the camber of the wing and provide more lift at slower airspeeds. A Boeing 737 can also takeoff without extending the flaps but it would simply require much longer runway.

In the case of LAPA Flight 3142, the speeds V_1, V_r and V_2 were calculated by the pilots prior to flight and in those calculations the flaps were assumed to be set for takeoff. So if the rotation speed is to be calculated with flaps set to 0° it would lie farther ahead on the runway. As illustrated in the Figure.



So the Cockpit Crew did not knew that there flaps were at 0° and they were expecting the airplane to lift of according to their calculations. So when they rotate the airplane it could not leave the ground, because the wing needed more airspeed to provide the necessary lift for climb and they were perplexed by this behavior of the airplane. So they decided to abort the takeoff without developing the necessary airspeed required to takeoff with 0° Flaps Position. The captain tried everything to stop the airplane from overshooting the runway by arming the spoilers, using the reverse thrust at it's max settings and applying the brakes. However the moment they took the decision to abort they had crossed V_1 and it was to late to bring the airplane to a complete stop on the runway.

Alarm System:

The alarm system of the airplane was working properly to warn the pilots of their fatal error. It was ignored by the cockpit crew. The cause of the crash was found to be **Human Error.**

Aftermath:

In the aftermath of the investigation the NTSB investigator stressed upon the need

- To comply with the Sterile Cockpit Rule to minimize distraction in the cockpit.
- Better Training of the Cockpit Crew to respond to Cockpit Alarms.
- Better Training of the Cockpit Crew to maintain Professionalism in the Cockpit.
- Better Training of the Cockpit Crew to follow checklists.

Reference:

https://ntsb.gov/investigations/AccidentReports/Pages/aviation.aspx

Conclusion:

Each Air Accident has something to teach us. It points out the mistake that should never be repeated again. This purpose can only be accomplished if the professional and the students in aviation have an understanding of the previous mistakes that have already been committed so that the same mistake is never repeated again.