Case Study - American Airlines Flight 965 Controlled Flight into Terrain

On December 20, 1995, American Airlines Flight 965, a Boeing 757 flying from Miami, Florida, to Cali, Colombia, crashed into a mountain near Buga, Colombia. The flight was delayed departing Miami due to winter storms and seasonal congestion. Of the 163 occupants on board, 159 perished, leaving only four passengers and a dog as survivors of the initial impact.

The crash occurred during the aircraft's descent into the mountainous Valle del Cauca. Because the local air traffic control radar had been destroyed in 1992 by the FARC terror group, pilots relied entirely on radio beacons and the plane's Flight Management System (FMS). To make up for lost time, the crew accepted an offer from air traffic control to execute a non-precision, straight-in approach to Runway 19.

This sudden change disrupted their planned route. While executing the change, the pilots inadvertently cleared the approach waypoints from the FMS. Tasked with reporting when they passed the Tulua waypoint, they struggled to find it in the computer. They then attempted to program the "Rozo" beacon, denoted as "R" on their physical charts. However, typing "R" into the FMS brought up a different beacon near Bogotá, 150 miles away.

The autopilot executed a sharp turn east toward Bogotá, steering the plane into a parallel valley and on a direct collision course with a 3,000-meter mountain. Though the crew eventually noticed the directional error and turned south, they lacked situational awareness of the terrain. Twelve seconds before impact, the Ground Proximity Warning System (GPWS) sounded. The crew initiated an escape climb but failed to retract the deployed speed brakes. The aircraft struck trees near the summit at 8,920 feet.

Key Findings

The official investigation by the Colombian Special Administrative Unit of Civil Aeronautics, with NTSB assistance, highlighted a fatal chain of human and systemic errors:

- **Automation Over-Reliance & Confusion:** The flight crew suffered a total loss of situational awareness. They failed to revert to basic radio navigation when the FMS became confusing and demanding, creating an excessive workload during a critical flight phase.
- **Database Inconsistency:** A critical naming discrepancy existed between physical charts and the FMS database. The chart used "R" for Rozo, but the FMS required "ROZO." Compounding this, Colombia had duplicated the identifier "R" for a beacon near Bogotá, violating ICAO standards.

- **FMS Logic Flaws:** The FMS automatically dropped all intermediate fixes from the pilots' displays the moment a direct routing command was executed, leaving the crew visually blind to landmarks they had already passed.
- **Failure to Discontinue Approach:** The crew rushed to avoid further delays, continuing a highly unstable, rushed approach despite numerous cues that they were lost.
- **Language Barrier:** The air traffic controller realized the pilots' routing requests did not make sense but lacked the non-aviation English fluency needed to clarify the danger.
- **Improper Escape Maneuver:** When the terrain alarm sounded, the crew failed to retract the fully extended speed brakes. Performance data suggested that retracting them might have allowed the plane to clear the mountain summit.

Subsequent Safety Mitigations

The disaster became a watershed moment for aviation safety, driving massive technological and regulatory reforms:

- **Introduction of EGPWS:** In 1996, the Enhanced Ground Proximity Warning System (EGPWS) was introduced. Unlike the original GPWS, which only looked straight down using a radio altimeter, EGPWS combines GPS location with a worldwide digital terrain database to look ahead and predict terrain conflicts minutes in advance.
- **Mandatory Terrain Awareness Systems:** Regulatory bodies codified these updates into law. By 2002, the US mandated that all newly manufactured turbine-powered aircraft capable of carrying more than six passengers must be equipped with an advanced Terrain Awareness and Warning System (TAWS/EGPWS).
- **FMS and Chart Alignment:** The accident forced global standardization regarding navigational databases. Aviation authorities introduced rules against duplicating single-letter identifiers near each other and ensured that FMS naming conventions perfectly mirrored physical Jeppesen charts.
- **Revised CFIT Training:** Training protocols for Controlled Flight Into Terrain (CFIT) escape maneuvers were completely overhauled. Pilots are now rigorously trained to automatically clean the aircraft (retract speed brakes and adjust flaps) simultaneously with applying maximum thrust.