Incorrect Entries

Bob Baron, Ph.D

The Aviation Consulting Group

In 1995, American Airlines Flight 965, a Boeing 757, impacted a mountain in Buga Colombia. A last-minute change in the arrival caused a rushed descent. The Captain entered ‘R’ for ‘ROZO’ into the flight management system (FMS), however the nearest ‘R’ was ‘ROMEO.’ This input was not verified by the First Officer, and neither pilot verified the effect of the flight path, which resulted in a loss of situation awareness. Once the pilots recognized the error, a recovery was initiated, but unfortunately the recovery was too late. The aircraft impacted El Diluvio Mountain at approximately 8,900 ft. mean sea level (MSL). There were 159 fatalities.

It happens quite frequently—erroneous (or incomplete) data are entered into the FMS resulting in a vertical, lateral, or speed deviation. For the purpose of this article, we will focus on navigation-type (aircraft handling) FMS errors. However, the same principles apply to other types of FMS errors such as weight and balance, thrust settings, etc.

Typical Flight Management System (FMS)

While technology has reduced human error on the flightdeck over the past few decades, it has also presented other pathways for errors. An FMS is only as good as the human who interfaces with it. If a pilot enters a wrong waypoint, without verification, the computer will do exactly what it is programmed to do. And, often, the first time the pilots become aware of the error is when it is pointed out by air traffic control (ATC).

For the purpose of this article, the following error types/definitions are used. Each of the error types include a practical example, which was obtained through either a NASA aviation safety reporting system (ASRS) report or from a line operations safety audit (LOSA) observation. Some examples were redacted for the purpose of brevity:

Slip- When an action is performed incorrectly (error of commission).

> *The FO installed the correct SID but with the incorrect transition. When comparing this to the FMS, the waypoint COREZ was not included...so I directed him to add it because it was the clearance. Simply we were to fly the WLKKR3 RNAV departure COREZ transition not the CSTRO transition. To add to the confusion, our filed flight plan included both SID ending waypoints which almost never occurs* (NASA ASRS Accession #1584377).

Lapse- When an action is not performed (error of omission).

> *Crew received a new clearance and entered it in the FMS, though 'NAV' mode was not selected. The aircraft flew through the desired track in 'HDG' mode; crew noticed the error when the aircraft was 2.4 NM left of the track in controlled airspace* (LOSA observation).

Intentional Violation- *Intentional* action (or inaction) that results in non-compliance with known rules, policies, procedures, or acceptable norms.

> *During pre-departure briefing, the crew discussed the ORD 4 departure procedure with special attention paid by the SIC (pilot monitoring) to the 250 knots until advised notation on the SID. During taxi out, complicated taxi instructions from Ground Control on a large, unfamiliar, air-carrier centric airport led to substantial confusion during taxi and a breakdown in crew communication. Immediately following a normal departure, the*

> *PIC deselected autothrottle and refused the SIC offer to select a vertical mode for climb while he hand-flew the climb out. The crew turned to the ATC assigned heading and acknowledged the climb instructions to an altitude above 10,000 feet. A few minutes later, the crew was handed off to a different Departure Controller who informed the crew "resume normal speed" and assigned a climb to a higher altitude. It was at that point the SIC realized the aircraft was at 300 knots and had exceeded the 250 knots until advised limitation listed on the SID* (NASA ASRS Accession #1586088).

Non-intentional Violation- *Unintentional* action (or inaction) that results in non-compliance with known rules, policies, procedures, or acceptable norms.

> *After a few minutes of setup I briefed the RNAV approach, I confirmed IAF CLFFF at 11,000 FT on the FMS and LNAV and VNAV PTH on the FMA but I didn't properly VVM [Verbalize, Verify, Monitor] the rest of the approach on the FMS. As we crossed CLFFF and did not start descending we realized something was not set up properly* (NASA ASRS Accession #1590629).

In most cases, FMS errors are unintentional. In other words, the pilot did not intend to enter an incorrect waypoint (slip), or omit the waypoint completely (lapse). In other cases, FMS errors are classified as a violation. Not so much as the pilot intentionally entering an incorrect standard instrument departure (SID), or waypoint, to counter an ATC clearance, but rather, the violation occurs due to *how the error is handled*. For instance, failure to *cross-verify,* per the company standard operating procedures (SOPs). In some cases, automation complacency can compound violations and lead to a complete loss of situation awareness, as was elucidated in the following example.

In 2009, Northwest Airlines Flight 188, an Airbus A-320, overflew its destination airport (MSP) by about 150 miles and was out of radio contact with air traffic control for 78 minutes. According to the National Transportation Safety Board (NTSB) report, the pilots were going over crew scheduling using their laptop computers. Neither pilot said he was aware of where the plane was until a flight attendant called the cockpit about five minutes before the plane was to

have landed and asked their estimated time of arrival. Once ATC verified the pilots were in control of the aircraft, Flight 188 was then cleared back to MSP, and landed more than an hour past its scheduled arrival time.

Countermeasures

Automated systems must be managed and monitored by flightcrews at all times. Effective management and monitoring significantly reduces the likelihood of automation events. Yet, completely preventable events continue to occur on a regular basis. Why? And what can be done?

FMS-related errors are typically influenced by environmental (error-provoking) conditions such as stress, pressure, distractions, and high workload. These errors occur during all phases of flight. In fact, some of the most egregious errors occur during the pre-departure phase, before the aircraft even begins to move. Regardless of where and when they occur, the consequences can range from a simple inconvenience, to a controlled flight into terrain (CFIT) event.

Flightcrews are confronted with the aforementioned environmental influences on a regular basis and receive specific training, such as crew resource management (CRM) and threat and error management (TEM), to effectively handle these influences in a crew environment. Unfortunately, in many cases, pilots who successfully complete CRM/TEM training in the classroom or simulator, fail to apply CRM/TEM principles in the practical world.

Flightcrews who do not effectively apply CRM/TEM principles will have a much more difficult time mitigating the effects of pressure, stress, high workload, and distractions. Two common FMS errors that result from poor CRM are *failure to verify inputs* and *failure to monitor.* These errors may occur separately, or in unison, as was elucidated in the American Airlines Flight 965 crash at the beginning of this article.

When it comes to FMS error prevention, you already know what to do. Practice good CRM/TEM and follow your SOPs. That way, when errors do occur (and they will), you will be better able to identify and trap the errors before they become consequential and lead to undesired aircraft states.

Stay sharp. Avoid complacency. Manage your automation; don't let it manage you!

Dr. Bob Baron conducts aviation safety training, consulting, and program implementation for aviation operators on a global basis.

Sensitive and knowledgeable about various cultures, Dr. Baron uses his 32+ years of academic and practical experience to assist aviation organizations in their pursuit of safety and quality excellence. He has extensive experience working with developing nations and island countries. He also provides training and consulting to some of the largest airlines and aircraft manufacturers in the world, as well as civil aviation authorities and accident investigation bureaus.

If your aviation organization is interested in improving its culture, implementing programs such as Human Factors, SMS, or LOSA, or have an external, unbiased safety audit/Gap analysis, please get in touch.

Dr. Baron's company, TACG, provides numerous training and consulting services. For more information, please go to www.tacgworldwide.com.