2013

Air Transport Incident and Accidents Caused by Crew Situation Awareness Errors

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AIR TRANSPORT INCIDENT AND ACCIDENTS CAUSED BY CREW SITUATION AWARENESS ERRORS

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This paper examines the various aircrew situation evaluation errors that resulted in one near fatal commercial airline incident and two fatal commercial airline accidents. The incident and accidents involved events that distracted the aircrews from a timely and accurate evaluation of the emergency situations that confronted them. Summary narratives of the incident and each of accidents are provided. Each emergency situation is examined to identify the distractions that caused the crews to misinterpret the nature of the emergencies they faced. Situation awareness as a construct is briefly reviewed. Recommendations for situation awareness training for aircrews are made. Recommendations are also made for improvements in aircraft crew alerting systems and operating procedures.

Situation awareness (SA) as a scientific construct has emerged in human factors research. Durso and Sethumadhavan (2008) provide an overview of SA research and a discussion (p. 444) of the SA component (e.g., *situation assessment*) that I address in this paper. The near fatal incident and two fatal accidents examined in this paper all resulted from inaccurate situation assessments. These inaccurate situation assessments were caused by distracting events that were not immediately relevant to the actions the aircrews had to take to resolve the critical situations they faced. The near fatal incident involved United Airlines Flight 863, from San Francisco, California to Sydney, Australia on June 28, 1998. The fatal accidents include Helios Airways flight HCY522, from Larnaca, Cyprus to Athens, Greece on August 14, 2005 and Air France flight AF 447, from Rio de Janeiro, Brazil to Paris, France on June 1, 2009. The discussions that follow include a synopsis of each of these flights. These discussions examine the inaccurate situation assessments that the flight crews made during the critical phases of these flights. Recommendations are made for improving aircrew situation awareness training. Recommendations are also made for improving air crew alerting systems.

United air lines Flight 863, June 28, 1998

This narrative is based on information obtained from an article(Carley, 1999),(FAA ASR ACN: 406810, 1998), and from my experience flying United Air Lines(UAL) Boeing 747-400s out of San Francisco International Airport(SFO), (1992—1997). Some of the recommendations in this narrative are based on my experience as a flight instructor at the UAL Training Center, Denver, CO (1986-1992). UAL flight 863, weighing 850 thousand pounds, with a flight crew consisting of the Captain and three Captain qualified First Officers(FO), took off from SFO at 11:39 PM on June 28, 1987, on runway 28R. A FO in the right seat made the takeoff and initial climb. The other FOs served as observers. The weather at SFO was clear, but the hills west of the runway were obscured by a fog bank 1000 feet thick. The takeoff roll was normal. Just after liftoff and after landing gear retraction, the aircraft flew into zero visibility conditions and the crew heard a series of loud backfires. They also felt the aircraft severely vibrate. The crew first thought the noise and vibrations were caused by a blown tire, but after a short time, they determined that the number three engine had failed. The aircraft was at about 300 feet at that time. The Captain shut down the number three engine and the vibrations ceased. The Captain and one of the observer FOs started the engine shut down check list. At the same time, the other observer FO noticed that the airspeed was getting too low and told the flying FO to watch his speed. Shortly thereafter the stick shaker activated intermittently and the Ground Proximity Warning System (GPWS) sounded. The FO at the controls raised the nose of the aircraft and the GPWS ceased sounding. The Captain then took control of the aircraft and started to return the aircraft to its prescribed course and establish a safe climb speed. During the time that the crew dealt with shutting down the number three engine and restoring proper climb speed, the aircraft drifted off the prescribed route for engine failures. The aircraft had come within one hundred feet of hitting San Bruno Mountain, located fifteen miles northwest of SFO.

The critical phase of this flight started just after landing gear retraction and lasted about three minutes. The crew was distracted by backfire noises, severe vibrations, engine failure, and the low altitude shutdown of the failed engine. The crews' focus on these distractions caused them to lose track of the aircraft flight path. The FO at the controls was first to identify the engine failure, but he did not recognize the yaw condition caused by the engine failure and did not apply sufficient rudder input to control the turn away from the prescribed course. He tried to control the heading of the aircraft through the use of the aileron controls only. This raised the spoilers which increased drag and caused loss of airspeed. These distractions caused the crews' to make an inaccurate situation assessment concerning the critical task at hand; accurate control of the aircraft flight path. The incident described above revealed the necessity of re-emphasizing the importance of accurate flight path control in the face of compelling distractions. Crew training in flight simulators should include various engine failure situations at very low altitudes, in zero visibility conditions. Training in the use of proper rudder control in engine failure situations should also be included, as well as the use of the slip indicator in the Primary Flight Displays. Pilots should be thoroughly evaluated to insure they are highly proficient in handling a variety of engine failure scenarios. Flight crews that fly747-400s in international operations generally fly about four to five times per month and may not be familiar with one another. Emphasis should be placed on the importance of detailed pre-take off crew briefings concerning the duties of each crew member. These briefings should also include a detailed review of any special procedures for engine failures on departure.

Helios Airways Flight HCY 522, August 14, 2005

This narrative is based on findings from an accident report (Hellenic Republic Ministry of Transport & Communications Air Accidents Investigation and Aviation Safety Board [AAIASB] Helios Airways Flight HCY 522, 2006). Six crew members and 115 passengers were fatally injured in this accident. This narrative summarizes the critical phases of this accident and the situation awareness errors made by the flight crew. A description of factors that contributed to this accident, along with recommendations for modifying checklist procedures and cockpit warning indications are included.

Helios Airways Flight HCY522, a Boeing 737-300, with a crew of six and 115 passengers, took off from Larnaca, Cyprus at 0607UTC August 14, 2005. About seven minutes after takeoff, the aircraft was climbing through 16 thousand feet and the Cabin Altitude warning horn sounded.

The crew disengaged the Autopilot and Auto-throttle momentarily and then re-engaged them in modes to fly the programed flight route. As the aircraft continued climbing, the Captain contacted the airlines' operations base and reported a Takeoff Configuration Warning and a equipment cooling system problem. He requested the location of the circuit breakers for the equipment cooling system, and was informed that they were on a panel behind the captain's seat. As the aircraft climbed through 17 thousand feet, the Master Caution turned on, indicating that the passenger oxygen masks had deployed. The Master Caution was turned off, and the aircraft continued climbing. Communications with the operating base ceased as the aircraft climbed through 28 thousand feet, and the crew did not initiate or respond to any further communications for the rest of the flight. The aircraft continued to climb and leveled off at its programmed altitude of 34 thousand feet. The aircraft continued to fly the route programmed in the auto flight system for two hours and forty minutes, when the aircraft ran out of fuel and the aircraft crashed, killing all on board. Thirty minutes before the crash, Hellenic Air force F-16 fighters intercepted the aircraft, and observed the First officer slumped over the control wheel, and that the captain's seat was empty. They further observed that the passenger oxygen masks were deployed. The F-16 pilots tried to get the attention of the flight crew, but got no response. About fifteen minutes after the F-16s intercepted the aircraft the pilots observed a man who was not wearing an oxygen mask enter the cockpit and occupy the captain's seat. The man was believed to be the male flight attendant. The F-16 pilots tried without success to attract his attention. Five minutes before the aircraft crashed, the man started to respond to the F-16 pilots hand signals, but by then both of the aircraft's engines had flamed out, and 4 minutes later, the aircraft crashed.

This narrative has many examples of distractions that caused the flight crew to make an inaccurate assessment of the situation that resulted in this fatal accident. The Pilots reported for duty one hour before the flight's scheduled flight departure. This gave the crew only one hour to complete their preflight duties. These duties included flight- planning, a review of the aircraft maintenance logbook, preflight inspection of the aircraft, cockpit preparation for the flight and entry of the flight route into the aircraft flight management computer. The maintenance logbook contained an entry noting that the cabin pressurization system had been checked and tested for proper operation the evening preceding the flight. The accident investigation report (AAIASB, 2006, p. 116) concluded that the cabin pressurization Mode selector had been left in the MAN position by the maintenance crew. The accident investigation report (AAIASB, 2006, p. 117) also concluded that the flight crew failed to place the cabin pressurization Mode selector to the AUTO position during their prefight cockpit inspection. The report concluded that the cabin pressurization Mode selector remained in the MAN position until the aircraft crashed.

The flight crew's failure to detect the proper setting of the cabin pressurization system was the situation assessment error that distracted the crew from making accurate assessments of the critical events that led to their loss of control of the aircraft. The time for the crew's cockpit preflight inspection was limited, and they failed to notice that cabin pressurization mode selector was in the MAN position. They also failed to note the position of the mode selector when they performed the After Takeoff check list. After takeoff, at 12 thousand feet during the climb, the Cabin Pressurization warning horn sounded. The crew mistook the Cabin Pressurization warning horn for a Takeoff Configuration warning horn. While they were trying to deal with what they perceived as an aircraft configuration problem, they failed to respond to the indication that the cabin oxygen masks had deployed. They also failed to notice symptoms of hypoxia as the cabin altitude climbed to 28 thousand feet. The crew became incapacitated and remained so until the termination of the flight. The cabin crew did not establish communications with the flight crew immediately after the oxygen masks deployed. The confusion of the crew about the function of the Cabin Pressurization warning horn was instrumental in causing this accident. The accident report (AAIAS, 2006, pp. 104 – 110) provides several reports about crew confusion concerning the functions of the Cabin Pressurization warning horn and the Takeoff Configuration warning horn. The warning horn sounds intermittently for both conditions. While on the ground, the intermittent horn sounds only if the aircraft is not properly configured for takeoff. While airborne, the horn sounds only for a cabin pressurization failure.

I recommend that crews who fly versions of the Boeing 737-300 without an Engine Indicating and Crew Alerting System (EICAS) under take a thorough systems review of the 737-300 warning horn functions. I also recommend that a check for the proper position of the cabin pressurization mode selector be added to the Boeing 737-300 After Takeoff Checklist. I further recommend that crews be exposed to various subtle pressurization problems (e.g. gradual loss of cabin pressure) during training in flight simulators as well as the sudden loss of cabin pressure scenario. Annual training for all aircrews should include a review of hypoxia symptoms. In addition, flight attendants should be briefed to inform the pilots as soon as possible of a passenger oxygen mask deployment.

Air France Flight AF 447 June 1, 2009

This narrative is based on information from the final accident report (BEA, July 3, 2012) concerning the fatal crash of Air France flight AF 447. AF flight AF 447, an Airbus A330-203, with a crew of a Captain , two first officers (FO), nine flight attendants , and 216 passengers, departed Rio de Janeiro on May 31, 2009, bound for Paris, France. The aircraft climbed to 35 thousand feet and proceeded without incident for two hours and ten minutes. The Pitot probes then became obstructed by ice, causing inaccurate airspeed indications and disconnection of the Auto Flight System. The two FOs were flying the aircraft. They lost control of the aircraft and it crashed into the Atlantic Ocean four minutes and 23 seconds later, killing all on board.
The accident report (BEA pp. 22-24) provides a detailed narrative of the events that occurred from the time the Auto Flight system disconnected until the time the aircraft crashed. The following synopsis is a summary of this narrative.

After the Auto Flight system disconnected, the inaccurate airspeed indications continued, and the pilot flying (PF) for reasons unknown, put the aircraft into a steep climb to 38 thousand feet. During the climb, the PF trimmed the movable horizontal stabilizer to its maximum nose up position of 13 degrees, where it remained until the flight crashed. The stall warning sounded intermittently, and the aircraft entered a high angle of attack attitude and a low airspeed condition outside of the aircraft flight envelope This silenced the stall warning. At 38 thousand feet, the aircraft started to descend at about 10 thousand feet per minute and a forward speed of 110kts. The PF lowered the aircraft nose momentarily to an angle of attack within the aircraft flight envelope. The stall warning sounded briefly and ceased when the PF raised the nose back to the high angle of attack attitude. The aircraft remained in this attitude until impact with ocean.

The pilots were faced with numerous distractions (BEA pp.173-182) that caused them to inaccurately assess the situation they encountered. When the Auto Flight warnings and cautions sounded, the aircraft was in a stable pitch, roll and airspeed condition. Very little manual control input would have been required to keep the aircraft on a stable flight path. In my opinion, the pilots were distracted by the sudden necessity to manually control the aircraft, the numerous warnings and cautions presented along with unreliable airspeed indications. In the face of all these distractions, the pilots failed to immediately assess the implications of various airspeed indication failures or recognize the requirement to perform the Unreliable Airspeed Indication checklist. In the face of all this confusion, the PF put the aircraft into a steep climb which caused more distractions, leading to the fatal outcome of the flight. The Airbus 320s and 340s have histories of problems with Pitot probes (BEA p.124,p-.p.144). More attention should be addressed to improving these probes and the crew warnings associated these probes. These unreliable airspeed indication problems should be explicitly identified on the ECAM, as well the as the procedures required to deal with them. Above all pilots should be continually trained and reminded to make flight path control their first priority in any emergency situation

CONCLUSIONS

The incident and accidents discussed in these papers illustrate how difficult accurate situation assessment can be during emergencies, and how difficult it is to focus on basic flight path control when faced with multiple distractions. Research and training to promote accurate situation assessment in all phases of flight operation should be expanded and continued.

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