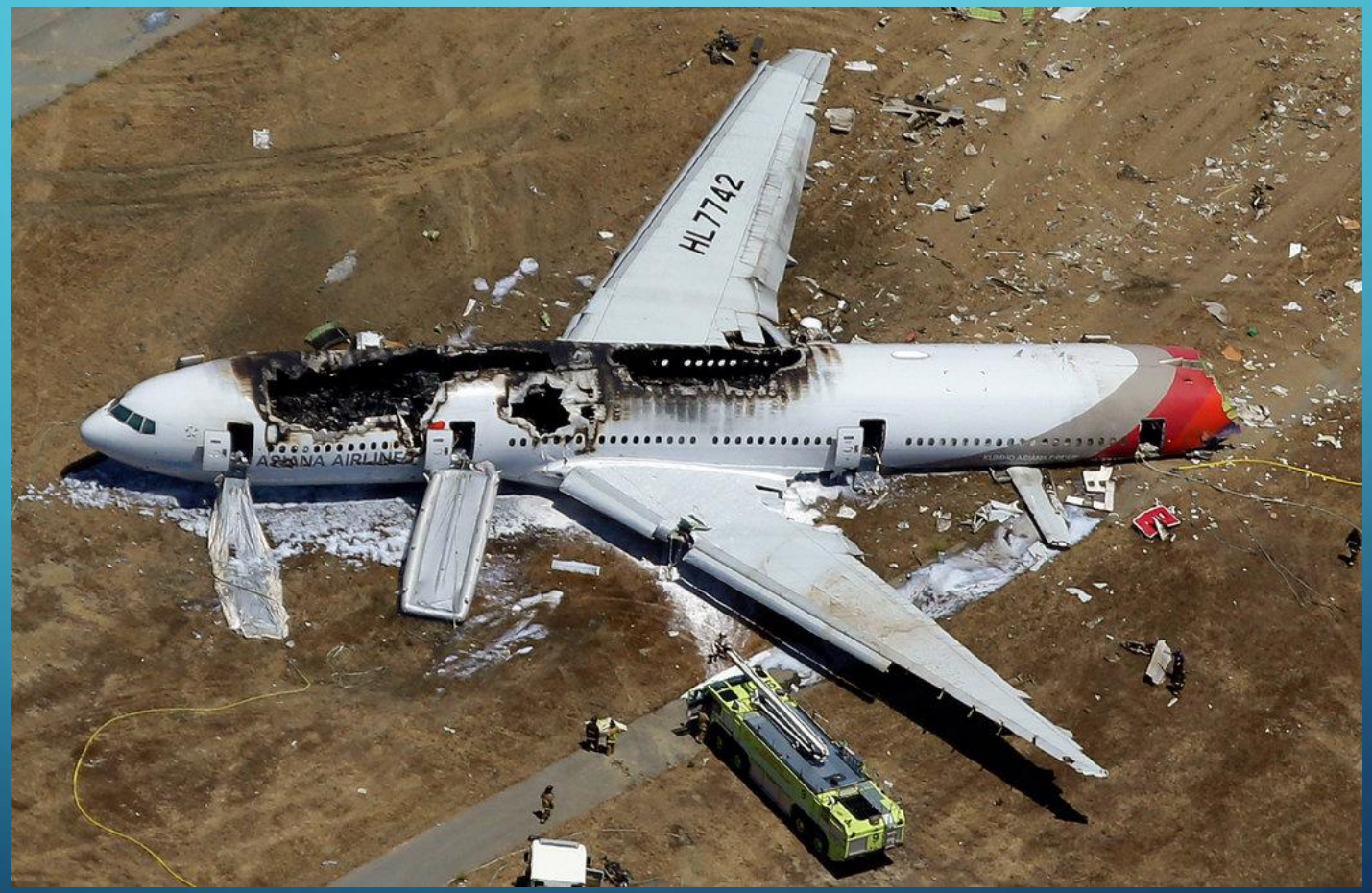
AUTOMATION MANAGEMENT



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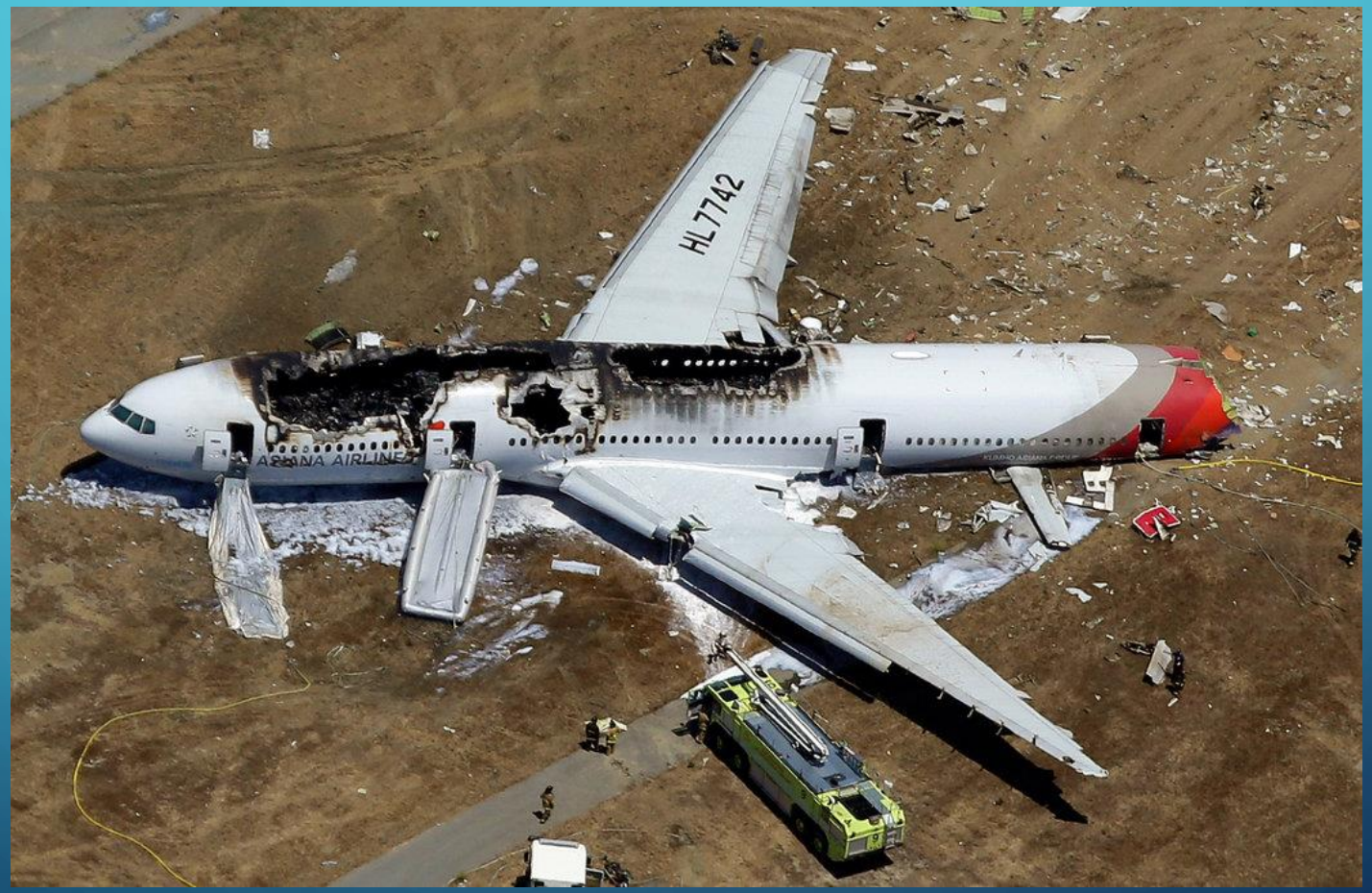
ASIANA FLIGHT 214 (2013)



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NTSB REPORT

- EXECUTIVE SUMMARY
- On July 6, 2013, about 1128 Pacific daylight time, a Boeing 777-200ER, Korean registration HL7742, operating as Asiana Airlines flight 214, was on approach to runway 28L when it struck a seawall at San Francisco International Airport (SFO), San Francisco, California. Three of the 291 passengers were fatally injured; 40 passengers, 8 of the 12 flight attendants, and 1 of the 4 flight crewmembers received serious injuries. The other 248 passengers, 4 flight attendants, and 3 flight crewmembers received minor injuries or were not injured. The airplane was destroyed by impact forces and a postcrash fire. Flight 214 was a regularly scheduled international passenger flight from Incheon International Airport, Seoul, Korea, operating under the provisions of 14 *Code of Federal Regulations* Part 129. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed.
- The flight was vectored for a visual approach to runway 28L and intercepted the final approach course about 14 nautical miles (nm) from the threshold at an altitude slightly above the desired 3Â° glidepath. This set the flight crew up for a straight-in visual approach; however, after the flight crew accepted an air traffic control instruction to maintain 180 knots to 5 nm from the runway, the flight crew mismanaged the airplane's descent, which resulted in the airplane being well above the desired 3° glidepath when it reached the 5 nm point. The flight crew's difficulty in managing the airplane's descent continued as the approach continued. In an attempt to increase the airplane's descent rate and capture the desired glidepath, the pilot flying (PF) selected an autopilot (A/P) mode (flight level change speed [FLCH SPD]) that instead resulted in the autoflight system initiating a climb because the airplane was below the selected altitude. The PF disconnected the A/P and moved the thrust levers to idle, which caused the autothrottle (A/T) to change to the HOLD mode, a mode in which the A/T does not control airspeed. The PF then pitched the airplane down and increased the descent rate. Neither the PF, the pilot monitoring (PM), nor the observer noted the change in A/T mode to HOLD.

- As the airplane reached 500 ft above airport elevation, the point at which Asiana's procedures dictated that the approach must be stabilized, the precision approach path indicator (PAPI) would have shown the flight crew that the airplane was slightly above the desired glidepath. Also, the airspeed, which had been decreasing rapidly, had just reached the proper approach speed of 137 knots. However, the thrust levers were still at idle, and the descent rate was about 1,200 ft per minute, well above the descent rate of about 700 fpm needed to maintain the desired glidepath; these were two indications that the approach was not stabilized. Based on these two indications, the flight crew should have determined that the approach was unstabilized and initiated a go-around, but they did not do so. As the approach continued, it became increasingly unstabilized as the airplane descended below the desired glidepath; the PAPI displayed three and then four red lights, indicating the continuing descent below the glidepath. The decreasing trend in airspeed continued, and about 200 ft, the flight crew became aware of the low airspeed and low path conditions but did not initiate a go-around until the airplane was below 100 ft, at which point the airplane did not have the performance capability to accomplish a go-around. The flight crew's insufficient monitoring of airspeed indications during the approach resulted from expectancy, increased workload, fatigue, and automation reliance.
- When the main landing gear and the aft fuselage struck the seawall, the tail of the airplane broke off at the aft pressure bulkhead. The airplane slid along the runway, lifted partially into the air, spun about 330 degrees, and impacted the ground a final time. The impact forces, which exceeded certification limits, resulted in the inflation of two slide/rafts within the cabin, injuring and temporarily trapping two flight attendants. Six occupants were ejected from the airplane during the impact sequence: two of the three fatally injured passengers and four of the seriously injured flight attendants. The four flight attendants were wearing their restraints but were ejected due to the destruction of the aft galley where they were seated. The two ejected passengers (one of whom was later rolled over by two firefighting vehicles) were not wearing their seatbelts and would likely have remained in the cabin and survived if they had been wearing them.
- After the airplane came to a stop, a fire initiated within the separated right engine, which came to rest adjacent to the right side of the fuselage. When one of the flight attendants became aware of the fire, he initiated an evacuation, and 98% of the passengers successfully self-evacuated. As the fire spread into the fuselage, firefighters entered the airplane and extricated five passengers (one of whom later died) who were injured and unable to evacuate. Overall, 99% of the airplane's occupants survived.

SAFETY ISSUES

- **Adherence of Asiana pilots to standard operating procedures (SOP) regarding callouts.** The flight crew did not consistently adhere to Asiana's SOPs involving selections and callouts pertaining to the autoflight system's mode control panel. This lack of adherence is likely the reason that the PF did not call out "flight level change" when he selected FLCH SPD. As a result, and because the PM's attention was likely on changing the flap setting at that time, the PM did not notice that FLCH SPD was engaged.
- **Reduced design complexity and enhanced training on the airplane's autoflight system.** The PF had an inaccurate understanding of how the Boeing 777 A/P and A/T systems interact to control airspeed in FLCH SPD mode, what happens when the A/T is overridden and the throttles transition to HOLD in a FLCH SPD descent, and how the A/T automatic engagement feature operates. The PF's faulty mental model of the airplane's automation logic led to his inadvertent deactivation of automatic airspeed control. Both reduced design complexity and improved systems training can help reduce the type of error made by the PF.
- **Opportunity at Asiana for new instructors to supervise trainee pilots in operational service during instructor training.** The PM was an experienced 777 captain who was on his first flight as an instructor pilot supervising a trainee captain gaining operating experience. The PM did not have the opportunity during his instructor training to supervise and instruct a trainee during line operations while being observed by an experienced instructor. Such an opportunity would have improved the PM's awareness of the dynamic and often unpredictable challenges that an instructor must deal with when supervising a trainee during line operations.

- **Guidance for Asiana pilots on use of flight directors during a visual approach.** During the accident flight, after the A/P was disconnected, the PM loosely followed Asiana's informal practice, which was to turn both flight directors (F/Ds) off and then turn the PM's F/D back on when conducting a visual approach. However, the two F/D switches were not both in the off position at the same time. If they had been, the A/T mode would have changed to speed mode and maintained the approach speed of 137 knots. In addition, during a visual approach, F/D pitch and roll guidance is not needed and can be a distraction.
- **More manual flight for Asiana pilots.** Asiana's automation policy emphasized the full use of all automation and did not encourage manual flight during line operations. If the PF had been provided with more opportunity to manually fly the 777 during training, he would most likely have better used pitch trim, recognized that the airspeed was decaying, and taken the appropriate corrective action of adding power. FAA guidance and a recent US regulatory change support the need for pilots to regularly perform manual flight so that their airplane handling skills do not degrade.

1. The following were not factors in the accident: flight crew certification and qualification; flight crew behavioral or medical conditions or the use of alcohol or drugs; airplane certification and maintenance; preimpact structural, engine, or system failures; or the air traffic controllers' handling of the flight.
2. Although the instrument landing system glideslope was out of service, the lack of a glideslope should not have precluded the pilots' successful completion of a visual approach.
3. The flight crew mismanaged the airplane's vertical profile during the initial approach, which resulted in the airplane being well above the desired glidepath when it reached the 5 nautical mile point, and this increased the difficulty of achieving a stabilized approach.
4. The flight crew's mismanagement of the airplane's vertical profile during the initial approach led to a period of increased workload that reduced the pilot monitoring's awareness of the pilot flying's actions around the time of the unintended deactivation of automatic airspeed control.

1. About 200 ft, one or more flight crewmembers became aware of the low airspeed and low path conditions, but the flight crew did not initiate a go-around until the airplane was below 100 ft, at which point the airplane did not have the performance capability to accomplish a go-around.
2. The flight crew was experiencing fatigue, which likely degraded their performance during the approach.
3. Nonstandard communication and coordination between the pilot flying and the pilot monitoring when making selections on the mode control panel to control the autopilot flight director system (AFDS) and autothrottle (A/T) likely resulted, at least in part, from role confusion and subsequently degraded their awareness of AFDS and A/T modes.
4. Insufficient flight crew monitoring of airspeed indications during the approach likely resulted from expectancy, increased workload, fatigue, and automation reliance.
5. The delayed initiation of a go-around by the pilot flying and the pilot monitoring after they became aware of the airplane's low path and airspeed likely resulted from a combination of surprise, nonstandard communication, and role confusion.

1. By encouraging flight crews to manually fly the airplane before the last 1,000 ft of the approach, Asiana Airlines would improve its pilots' abilities to cope with maneuvering changes commonly experienced at major airports and would allow them to be more proficient in establishing stabilized approaches under demanding conditions; in this accident, the pilot flying may have better used pitch trim, recognized that the airspeed was decaying, and taken the appropriate corrective action of adding power.

AUTOMATION MANAGEMENT

- Over- Reliance on automation
- Lack of systems knowledge or understanding
- Design complexity challenges

- How could these have been addressed?

RISK MANAGEMENT

- Instructor and training pilot in the cockpit
- Air traffic control issued a non-standard approach instruction
- Decision to make go-around was very delayed
- Airport had challeges in the rescue efforts (including a fire truck rolling over an injured passenger on the runway)

- How could these have been mitigated?

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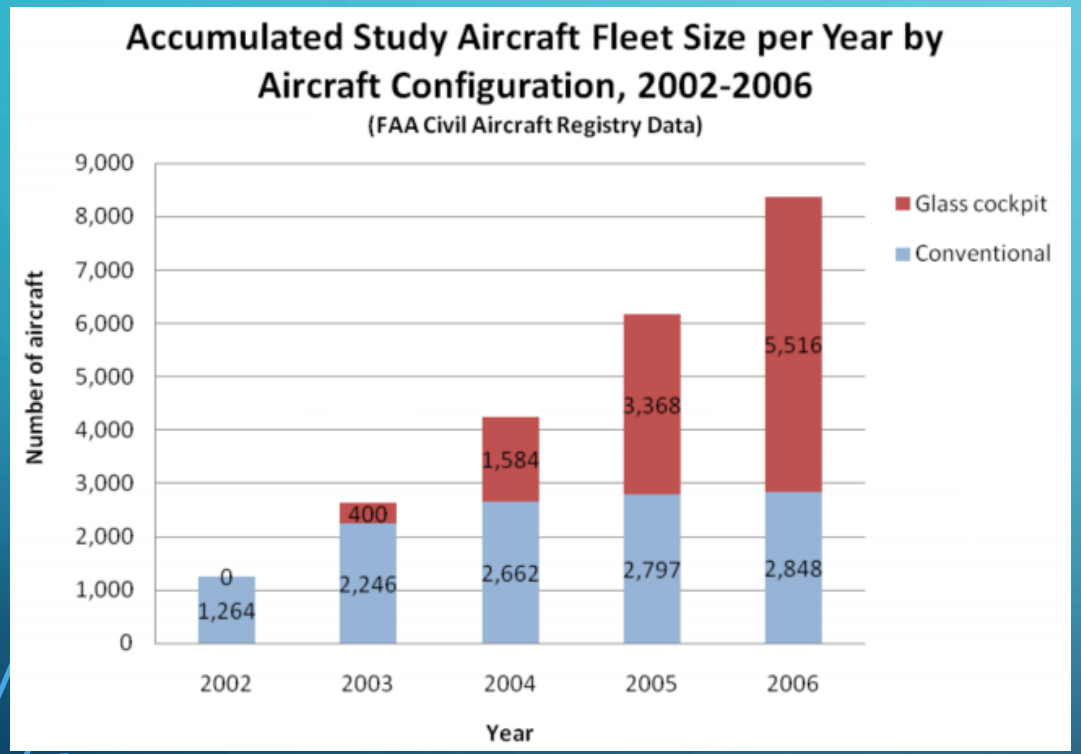

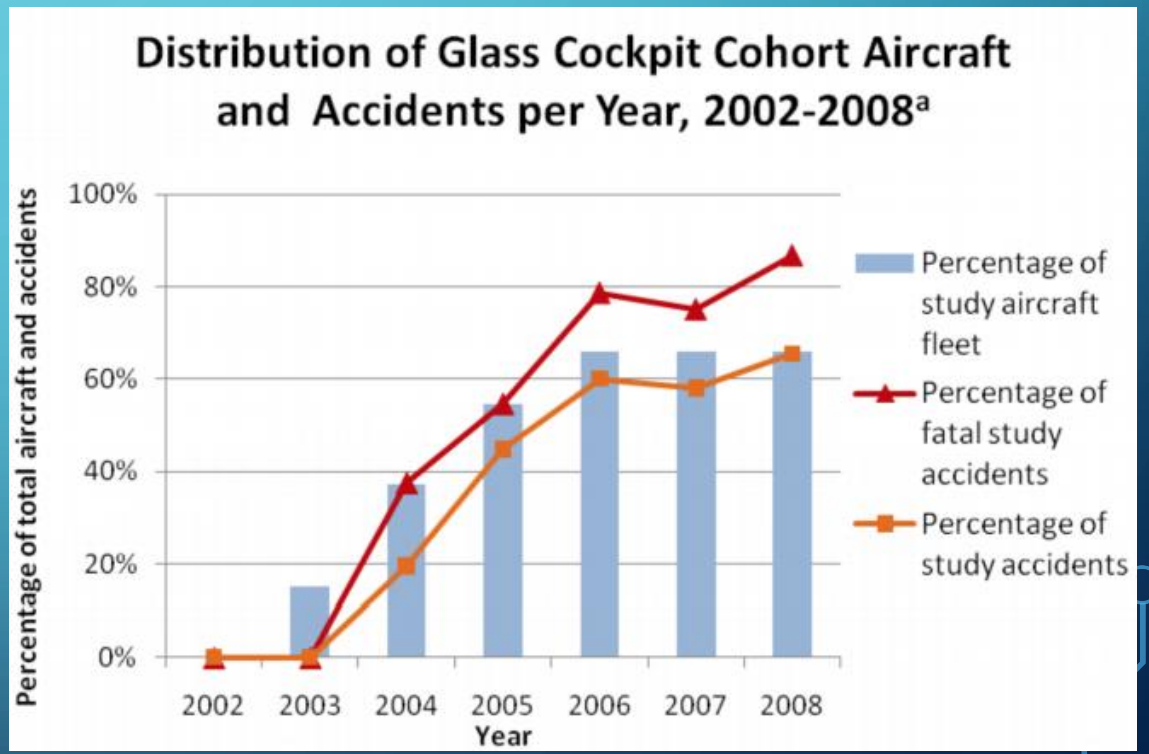

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CONCLUSIONS FROM STUDIES

- Glass cockpit aircraft account for more than equal share of fatal accidents
- Glass cockpit aircraft fatal accident twice as likely
- (not helicopter specific)

WHY?

- More likely to lose Situational Awareness while engrossed in systems or due to over-reliance
- May cause pilots' hand flying skills to degrade
- Pilots tend to not verify modes of operation and data that are programmed
- Automation Dependency
- Automation Avoidance: more complexity + inadequate training = less confidence

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SOLUTIONS

- Prioritize: Aviate, Navigate, Communicate, Program, Plan for future
- Practice:
  - use simuators and know it inside and out.
  - Practice and be ready for failures
- Use Checklists and procedures to minimize errors and maximize efficiency
- Use external resources when tech workload is high. (ATC, co-pilot, passengers)