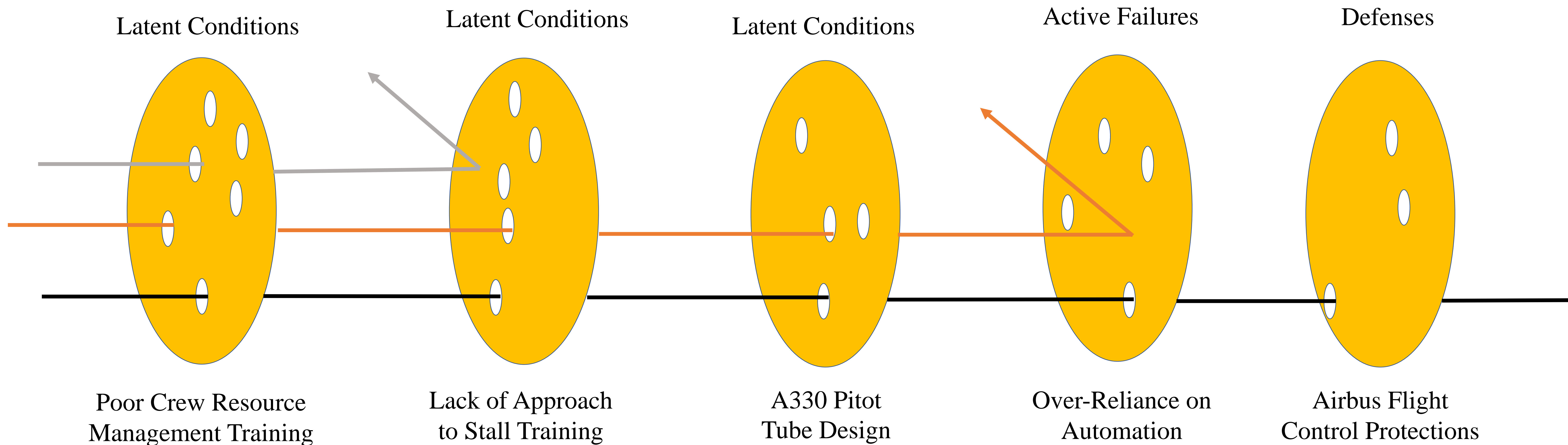


Organizational Accidents & the Swiss Cheese Model: Learning from Air France 447

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Air France flight 447 was an Airbus A330 operating from Rio de Janeiro to Paris in the dark of morning on June 1st 2009. The flight crew consisted of an 11,000-hour captain, a 3,000-hour first officer, and an “expert” relief first officer. Shortly after the captain left the flight deck to take a rest break, an area of thunderstorms caused icing in the pitot tubes and inconsistent airspeed indications. The aircraft responded by disconnecting the autopilot and switched it’s flight control mode to “alternate law.” The pilot flying aggressively handled the aircraft and the crew failed to resolve the airspeed issue, leading to a high-altitude stall that was never recovered from.



James Reason’s Swiss Cheese Model

- ❑ Originally presented in 1991
- ❑ Illustrates the interaction of latent conditions, active failures, and defenses in an aviation safety system to prevent hazardous situations
- ❑ Latent Condition: Actions or decisions made far before the accident by people far removed from the situation, whose effects remain dormant until combined with other factors. Examples include:
 - ❑ Training Programs
 - ❑ Standard Operating Procedures (SOPs)
 - ❑ Aircraft design
 - ❑ Safety Culture
- ❑ Active Failures: Operational personnel failures whose effects directly tie to a negative outcome. Examples include:
 - ❑ Deviation from SOPs
 - ❑ Unsafe acts
 - ❑ Violation of Regulations
 - ❑ Poor interpersonal communication (CRM)
- ❑ Defenses: Barriers that, if all else fails, is designed to prevent a hazardous situation from occurring or limit the extent of a hazard’s damage. Examples include:
 - ❑ Automation
 - ❑ Stick pusher

Swiss Cheese Model for Air France 447

- Latent Conditions**
 - ❑ Ineffective Crew Resource Management (CRM) Training
 - ❑ Captain lacked leadership skills as evident during the flight
 - ❑ Crew was unable to identify the problem and execute recovery procedures
 - ❑ Crewmembers input opposing controls movements during the abnormal
 - ❑ Lack of Approach to Stall Training
 - ❑ Company review revealed little stall identification and recovery training
 - ❑ Both FOs trained on stalls doing a couple of simulator sessions for their initial Airbus type training
 - ❑ A330 Pitot Tube Design
 - ❑ A faulty pitot heating element design resulted in erroneous readings when ice crystals were present in the pitot tubes during flight
- Active Failures**
 - ❑ Captains’ Selection of Pilot Flying
 - ❑ Captain selected the least-experience pilot to fly the aircraft while he went on his rest break. This happened as the A330 approached the ITCZ, an oceanic area known for thunderstorms
 - ❑ Captain did not explain duties of each crewmember in the case of an emergency/abnormal
 - ❑ Over Reliance on Automation
 - ❑ Once the autopilot disconnected, the PF overcontrolled the aircraft and began a steep climb. This destabilized the flight path as the aircraft approached stall
 - ❑ PF seemed unprepared to hand-fly the aircraft at high altitudes
- Defenses**
 - ❑ Airbus Flight Control Protections
 - ❑ Airbus’ “normal” flight control law keeps the aircraft within a safe range of attitudes and speeds
 - ❑ With inconsistent airspeed indications, Airbus changes to “alternate law,” which removes many of those protections

Safety Recommendations

- ❑ Mandate Flying the Aircraft Without Autopilot
 - ❑ Include hand-flying scenarios in recurrent simulator training sessions
 - ❑ Incorporate a hand-flying currency in which pilots, within a given time period, must fly the aircraft with no autopilot up to 10,000 feet MSL
- ❑ Establish Roles During Rest Break Before the Flight Begins
 - ❑ Mandate by SOP, emphasize in captain upgrade training, and include in the captain’s preflight crew briefing the establishment of duties while the captain takes a rest break
 - ❑ Briefing should include who is PF/PM, briefly review what each of those duties consists of, and criteria to recall the captain back to the flight deck
- ❑ Improve Stall Recognition at High Altitudes
 - ❑ Using the simulator, retrain all pilots on approach to stall scenarios both with all instruments operating and with some instruments inoperative
 - ❑ Install an angle of attack indicator in the flight deck and reference it during training
- ❑ Continually Train Pilots on CRM Principles
 - ❑ Ensure captains can lead the flight crew during emergencies & abnormals
 - ❑ Use LOFT scenarios to practice, improve, and give feedback on crew communication and CRM
 - ❑ Design a training program to improve the CRM of all employees