Human factors in aviation accident investigation
Aeronautics Conference and Annual General Meeting

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Outline

- Who we are, what we do?
- Evolution of accident investigation
- Review of Air Canada pitch excursion
  - What really happened and why?
- Organizational drift
- Safety Management Systems
- Investigating for organizational factors
- Lessons learned
Who we are

• The Transportation Safety Board of Canada (TSB) is an independent agency that investigates air, marine, pipeline, and rail occurrences.

• Approximately 230 employees. Board consists of up to 5 members, including the Chair.

• We establish what happened and why, but we are neither the regulator nor a court. We don’t assign fault or determine civil or criminal liability.
What we do

• conduct independent investigations
• identify safety deficiencies
• identify causes and contributing factors
• make recommendations
• make our reports public
TSB offices

- Head Office is in Gatineau, Quebec
- The Engineering Laboratory is in Ottawa, Ontario.
- Regional offices are located across the country to allow investigators to quickly reach the scene of an accident:
  - Vancouver, British Columbia
  - Calgary, Alberta
  - Edmonton, Alberta
  - Winnipeg, Manitoba
  - Toronto, Ontario
  - Montréal, Quebec
  - Québec, Quebec
  - Halifax, Nova Scotia
Communicating what we know

Safety critical information is communicated to stakeholders immediately via:

- Occurrence Bulletins
- Meetings or phone calls
- Safety Information Letters
- Safety Advisory Letters
- Board Safety Concerns
- **Recommendations** are used to address systemic issues posing the highest risk
- **The Watchlist!**
Watchlist 2012

Loss of Life on Fishing Vessels
Marine Safety Management Systems
Landing Accidents and Runway Overruns
Air Safety Management Systems
Risk of Collisions on Runways
Collisions with Land and Water
Passenger Trains Colliding with Vehicles
On-Board Video and Voice Recorders Following Signal Indications
Background

• “What” happened vs. “why” it happened
• Evolution of accident investigation:
  • aircraft design
  • cockpit design
  • physiological factors
  • psychological influences on decision-making and risk-taking
  • performance of the flight crew, not just the pilot (CRM, TEM)
  • organizational factors
TSB Investigation Report A11F0012

Credit: The Canadian Press/HO-Air Canada
The media response ...

- Pilot mistook Venus for aircraft, plunged plane toward Atlantic  
  (Fox News, April 17, 2012)

- Sleepy Air Canada pilot thought Venus was a plane  
  (Reuters, April 17, 2012)

- Pilot sends plane into dive after mistaking Venus for oncoming plane  
  (CNN, April 17, 2012)
More headlines ...

• Pilot fatigue to blame for dipping incident that left 16 injured (National Post, April 17, 2012)

• Passengers sue Air Canada for $20-million after groggy pilot sent plane into terrifying nosedive (National Post, May 8, 2012)

• Venus, one of the brightest objects in the night sky, hoodwinked the fatigued pilot (ICTMN, April 17, 2012)
What really happened?

- 2138 – Flight departed CYYZ, climbed to 35000 ft.
- 0040 – First Officer (FO) expressed need for a rest and commenced approved controlled rest in position falling deeply asleep
- 0118 – Captain turned on seatbelt sign
- 0155 – Captain made mandatory position report which roused the FO who reported not feeling altogether well
- Coincidentally, a USAF C-17 at 34000 ft. appeared on TCAS; Captain apprised FO of this traffic
What really happened? (cont’d)

• FO initially mistook planet Venus for aircraft, but Captain advised that target was ahead and 1000 ft. below

• FO continued to scan visually

• When FO saw oncoming aircraft, interpreted position as being above and descending towards them; FO reacted to prevent perceived imminent collision by pushing forward on control column to descend

• Captain intervened by pulling back on control column to regain altitude

• During pitch excursion (from +2 to -6 to + 2 degrees), vertical acceleration went from -.5g to +2g in 5 seconds resulting in some unsecured passengers and crew being injured
Why did this happen?

• FO had interrupted sleep night before flight which increased likelihood FO would feel fatigued and need rest during overnight eastbound flight

• FO experienced circadian low due to time of day and fatigue due to interrupted sleep increasing propensity for sleep and worsened sleep inertia

• FO slept for approx. 75 minutes which likely placed FO into slow-wave sleep and induced longer, more severe sleep inertia

• By identifying the oncoming aircraft, the captain engaged the FO before the effects of sleep inertia had worn off.

• Under the effects of sleep inertia, the FO perceived the oncoming aircraft to be on a collision course and pushed forward on the control column.
Factors to consider

• North American pilots flying eastward at night across the Atlantic experience circadian lows that magnify performance decrements and increase desire to sleep

• Fatigue Risk Management
  • Education and awareness programs and strategies
  • Controlled rest policies and procedures
  • Use of relief pilot

• Sleep Inertia
**Controlled rest**

- Strategic napping to improve crew alertness during critical phases of flight.
- Rest periods are 40 minutes (max) and must be completed 30 minutes before top of descent.
- In–charge flight attendant must be advised ... and instructed to call the flight deck at a specific time.
- Unless required due to an abnormal or emergency situation, the awakened pilot should be provided at least 15 minutes without any flight duties to become fully awake before resuming normal duties.
Factors to consider (cont’d)

- Crew training on rationale for controlled rest procedures
  - Notifying Service Director
  - Not engaging resting pilot immediately after waking up

- Multiple safety occurrence reporting systems

- Passenger safety
Balancing competing priorities
Limits of acceptable performance

Organizational drift

“Drift is generated by normal processes of reconciling differential pressures on an organization (efficiency, capacity utilization, safety) against a background of uncertain technology and imperfect knowledge.”

Safety Management Systems (SMS)

SMS integrates safety into all daily activities.

“It is a systematic, explicit, and comprehensive process for managing safety risks ... it becomes part of that organization’s culture, and [part] of the way people go about their work.”

SMS requires the following:

- Hazard Identification
- Incident Reporting and Analysis
- Strong Safety Culture
Investigating for organizational factors

- Goal conflicts
- Inadequate risk analysis
- Employee adaptations
- Missed “weak signals”

**COMPLEX INTERACTION = NO SINGLE FACTOR AS SOLE CAUSE**
Employee adaptations

• Faced with time pressures or multiple goals, workers and management may be tempted to create “locally efficient practices.”

• Why? *To get the job done!*

• Past successes are taken as a guarantee of future safety.
Pilot error or management error?

- Drift, goal conflicts and adaptations are natural.

- No one sets out to have an accident; they just want to **get the work done**.

- The decision to value production over safety is implicit.
Conclusions

• Strive to recognize and address goal conflicts

• Importance of thinking through “What can go wrong”?

• Look for “employee adaptations” and understand why they occur

• Amplify “weak signals”

• Complex relationship between “mindful processes” and safety culture
QUESTIONS?