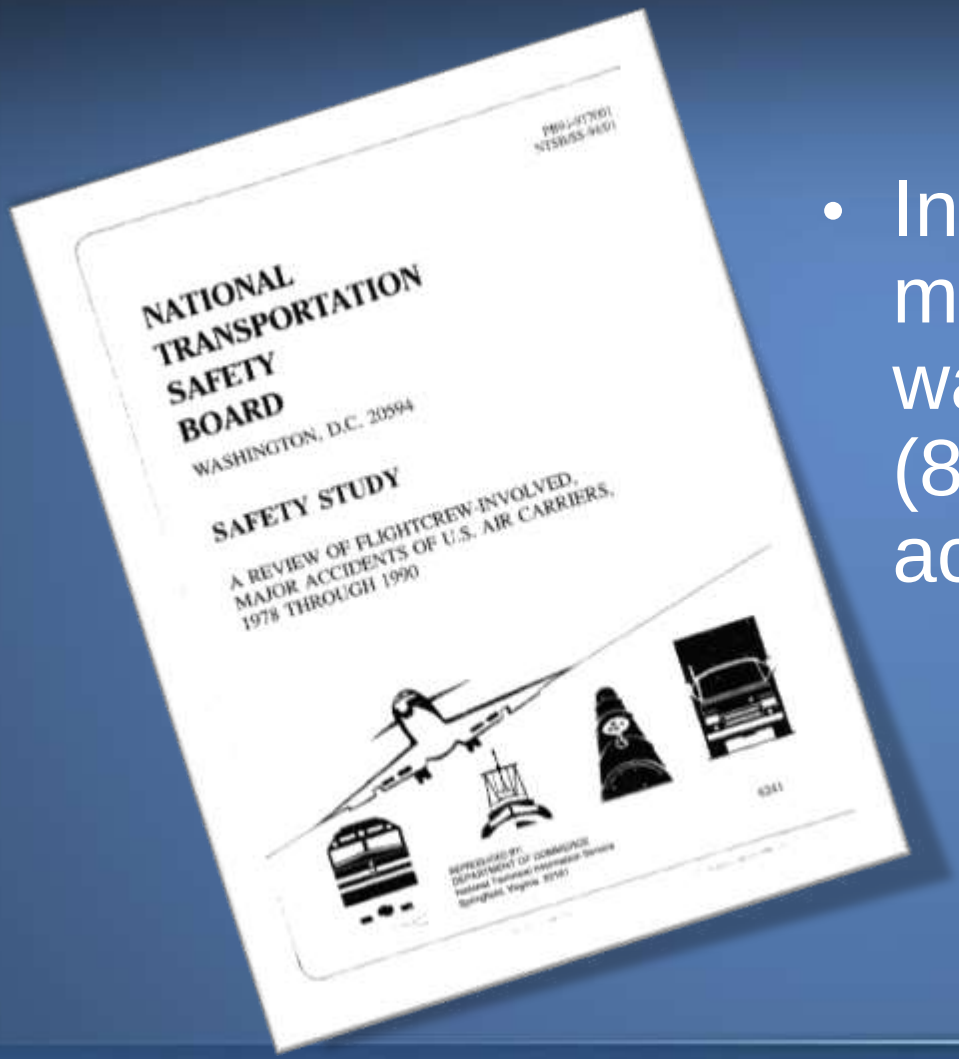
Effective Flight Path Monitoring: It's a Matter of Life or Death

Robert Sumwalt

Motivation for Interest



- Inadequate crew monitoring or challenging was a factor in 31 of 37 (84 percent) reviewed accidents.

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The Evolution

- ASRS Research (1996-97)
- US Airways focus (2001-2004)
- More Accidents (2006 – 2015) (A-07-13)
- Active Monitoring Working Group (2012 – 2014)
- ERAU Masters Capstone (2014)
  - 110 ASRS reports related to poor monitoring
  - 25 accidents

Scope of the problem

Inadequate monitoring of flight path has led to:

- 41 accidents in 43 years (1973-2015)
- These accidents claimed 830 lives

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Fact:

- Humans are not good at monitoring highly reliable, highly automated systems for extended periods of time.

Who or what first detected the flight path deviation?

In 104 of 110 ASRS Reports

Deviation first detected by:	Number of ASRS Reports
ATC	49
Cockpit alerting system	22
Jumpseat rider	1
Crewmember	32

72

Someone or something other than the operating crew first detected the flight path deviation in 72 of 104 reports.

- $\chi 2 = 15.39$, $df = 1$, $p < 0.001$.

FAA rulemaking

- By March 2019, air carriers must include specific training pertaining to improving monitoring.

Two Clarifications

- Pilot Monitoring - What are we talking about?
- Which pilot is monitoring?

Pilot Monitoring: What Are We Talking About ?

ATC

Traffic Scan

Aircraft System Status

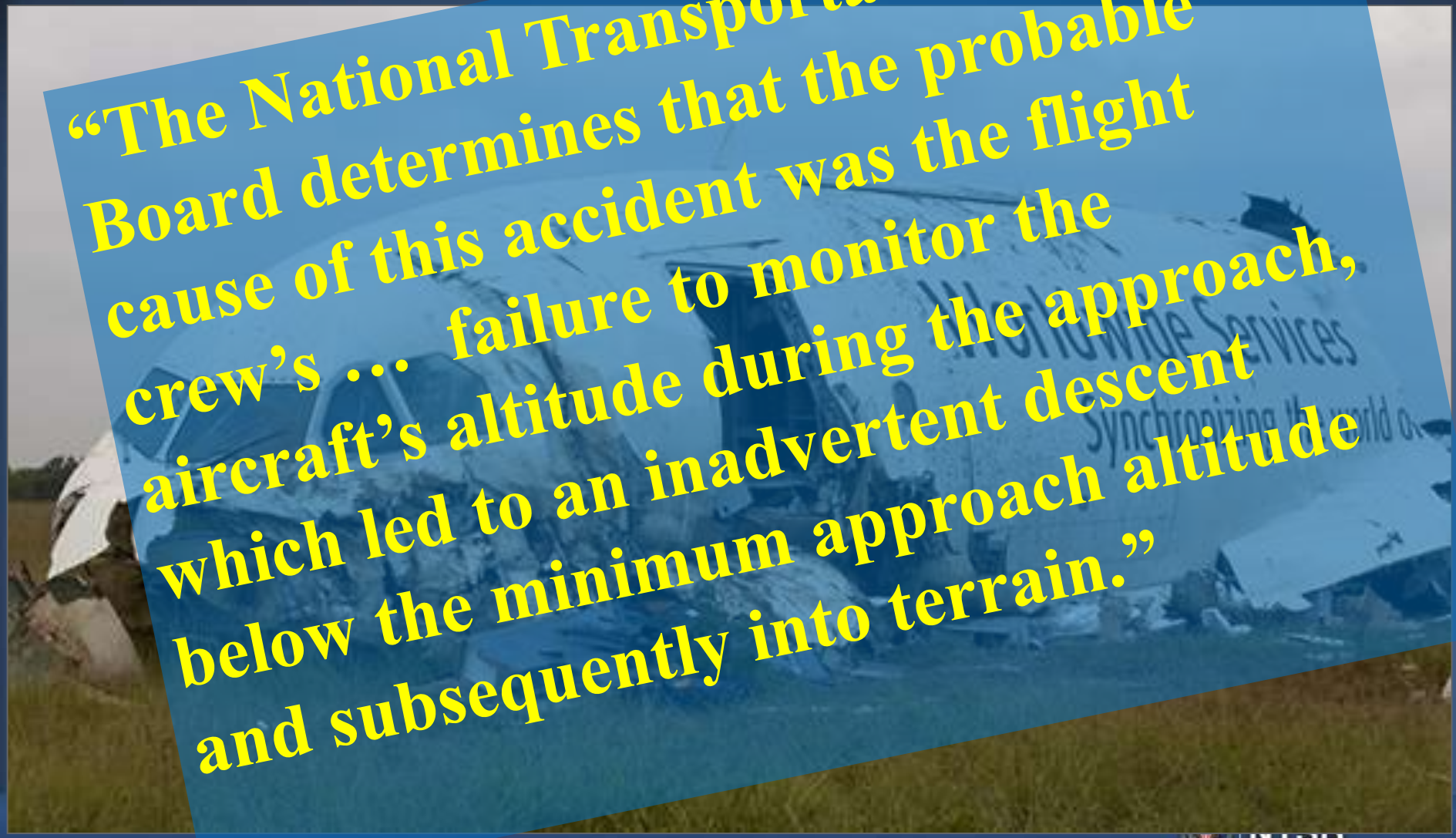
Fuel Quantity

Aircraft Flight Path

Asiana 214

NTSB

UPS 1354



"The National Transportation Safety Board determines that the probable cause of this accident was the flight crew's … failure to monitor the aircraft's altitude during the approach, which led to an inadvertent descent below the minimum approach altitude and subsequently into terrain."

Crash	Location	Failed to Monitor:
Eastern 401	Everglades	Altitude
Korean Air	Guam	Altitude
FedEx	Tallahassee	Altitude
Empire Airlines	Lubbock, TX	Airspeed
Colgan Air	Buffalo	Airspeed
Turkish Airlines	Amsterdam	Airspeed
Asiana	San Francisco	Airspeed
UPS	Birmingham	Altitude

- **<u>Altitude</u>** was the largest number of flight path parameters that were not monitored in **ASRS** reports.
  - 75 altitude deviations (68% of 110 ASRS reports)

- **<u>Airspeed</u>** was the leading category of flight path parameters not monitored in the **accidents**.
  - 10 speed deviations (40% of 25 accidents)

Pilot Monitoring: What Are We Talking About ?

ATC

Traffic Scan

Aircraft System Status

Fuel Quantity

Aircraft Flight Path

Pilot Monitoring:
What Are We Talking About ?

Aircraft Flight Path

Flight Path Monitoring

Which Pilot is Monitoring?

Structure of Today's Discussion

I. Why is monitoring important?

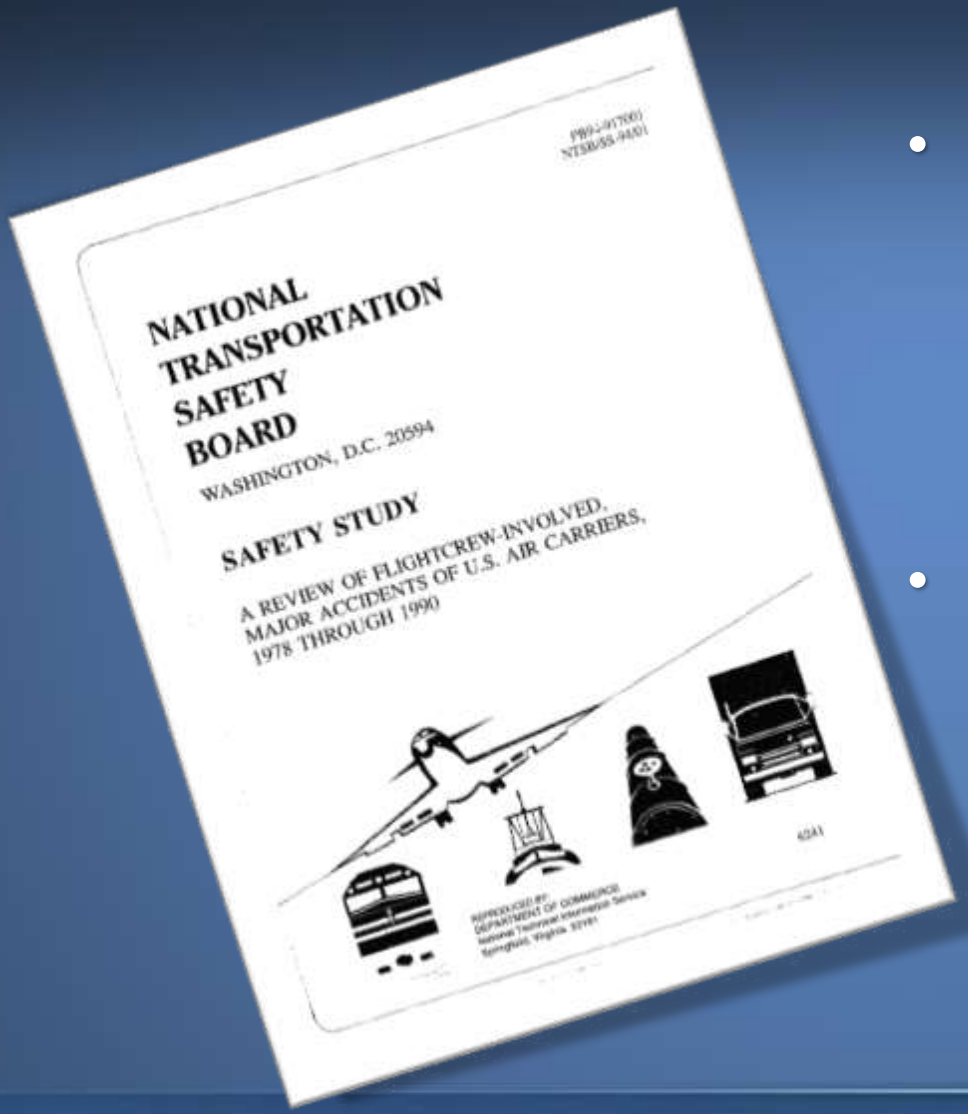
II. Barriers to effective monitoring

III. What you can do to improve monitoring

First discussion point:

WHY IS MONITORING IMPORTANT?

Monitoring errors are serious



- 76% of the monitoring/challenging errors involved failure to catch something that was causal to the accident
- 17% of the monitoring/challenging errors were failure to catch something that contributed to the accident's cause

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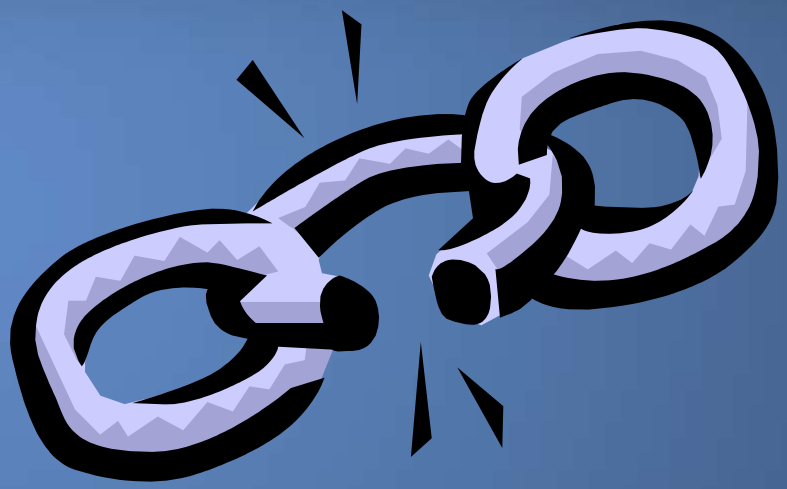
LOSA Findings

- 20% of flights had substandard monitoring/cross-checking in at least one flight phase.
  - These flights had 2-3 times more errors and undesired aircraft states (compared to flights with outstanding monitoring)

Good monitoring is important

- By better monitoring and cross-checking, a crewmember will be more likely to catch an error or unsafe act.
- This detection may break a chain of events leading to an accident scenario.



Second discussion point:

BARRIERS TO EFFECTIVE MONITORING?

Underlying factors associated with poor monitoring

Effective monitoring is not easy and intuitive.

- It requires skill and discipline

Underlying factors associated with poor monitoring

There is somewhat of a monitoring paradox that works against effective monitoring.

- Serious errors do not occur frequently which can lead to boredom and complacency

"A low-probability, high-criticality error is exactly the one that must be caught and corrected."

Underlying factors associated with poor monitoring

Although traditional CRM courses have generally improved the ability of crewmembers to challenge others when a situation appears unsafe or unwise…

- **many of these courses provide little or no explicit guidance on how to improve monitoring.**

Barriers to Effective Monitoring

- Boredom
- Complacency
- Fatigue
- Time Pressure
- Mental workload
- Lack of vigilance
- Automation dependence/reliance
- Looking without seeing
  - Change blindness
  - Inattention blindness
- Poor workload management/ task allocation

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Automation Dependence

"If automation is highly but not perfectly reliable in executing decision choices, then the operator may not monitor the automation and its information sources and hence fail to detect the occasional times when the automation fails"

- Raja Parasuraman, 2002

Asiana 214 – San Francisco
July 2013

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U.S. NEWS
Pilots Cited in July Jet Crash
Pilots said to err in properly monitoring speed and trajectory.

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"Human factors research has demonstrated that system operators often become complacent about monitoring highly reliable automated systems when they develop a high degree of trust in those systems and when manual tasks compete with automated tasks for operator attention."

- NTSB report of Asiana crash

"The PF, PM, and observer believed the A/T system was controlling speed with thrust, they had a high degree of trust in the automated system, and they did not closely monitor these parameters during a period of elevated workload.

Thus, the flight crew's inadequate monitoring of airspeed and thrust indications appears to fit this pattern involving automation reliance."

- NTSB report of Asiana crash

Change Blindness

- “People are surprisingly poor at detecting even gross changes in a visual stimulus if they occur in objects that are not the focus of attention.”

  - S. Palmer, 1999, *Vision Science*.


MACH
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MACH
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Inattentional Blindness

Strategically Planning Workload

- In approximately one-third of the cases studied by researchers, pilots “failed to monitor errors, often because they had planned their own workload poorly and were doing something else at a critical time.”
  - Jentsch, Martin, Bowers (1997)
- Doing the right thing at the wrong time.
- Doing the wrong things at the wrong times.

Bad News / Good News

Bad News

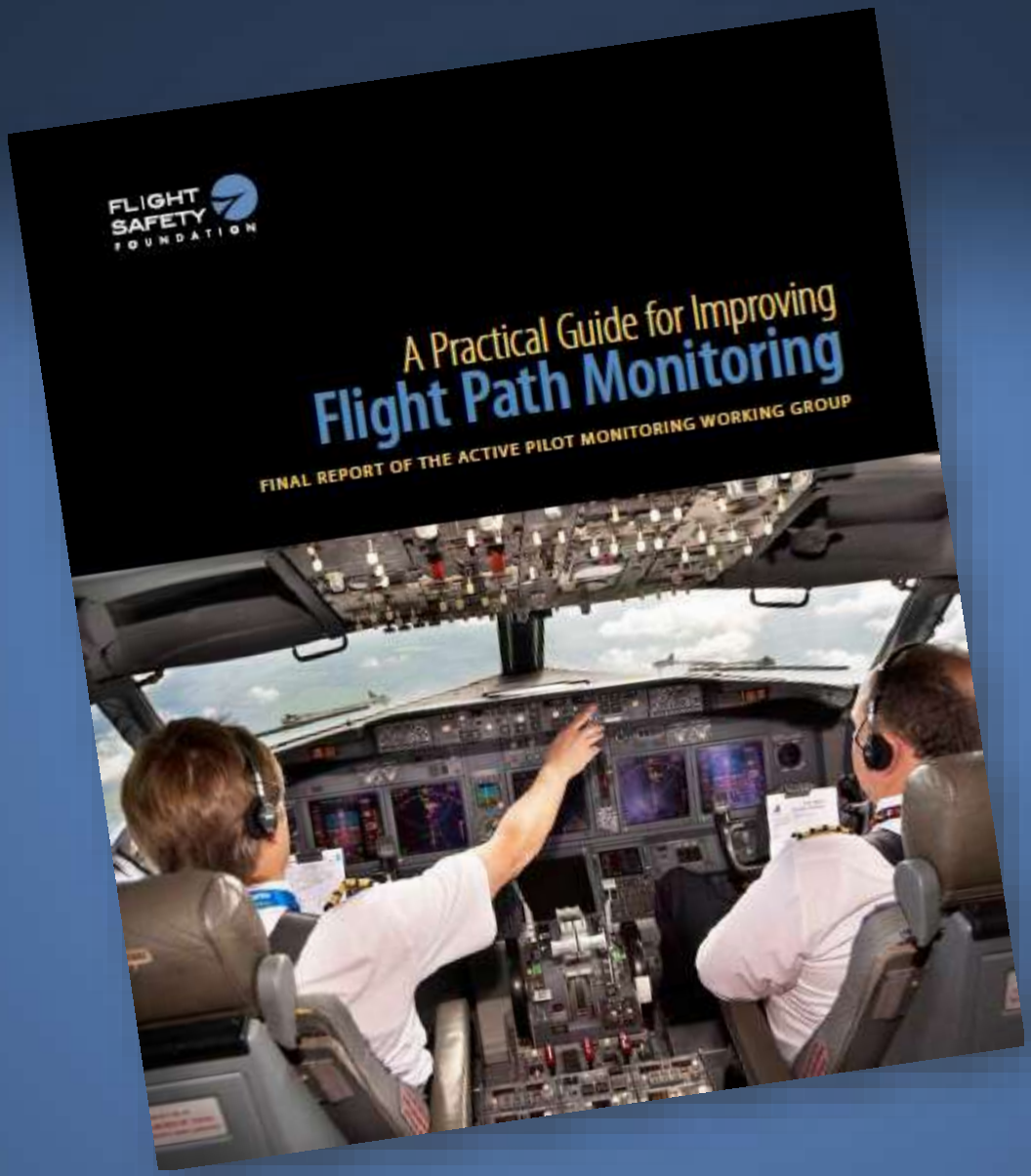
- Humans are not naturally good at monitoring highly reliable / highly automated systems over periods of time.

Good News

- Monitoring performance can be improved significantly by using the following procedures.

Third discussion point:

WHAT YOU CAN DO TO IMPROVE MONITORING


FLIGHT SAFETY FOUNDATION
A Practical Guide for Improving
Flight Path Monitoring
FINAL REPORT OF THE ACTIVE PILOT MONITORING WORKING GROUP

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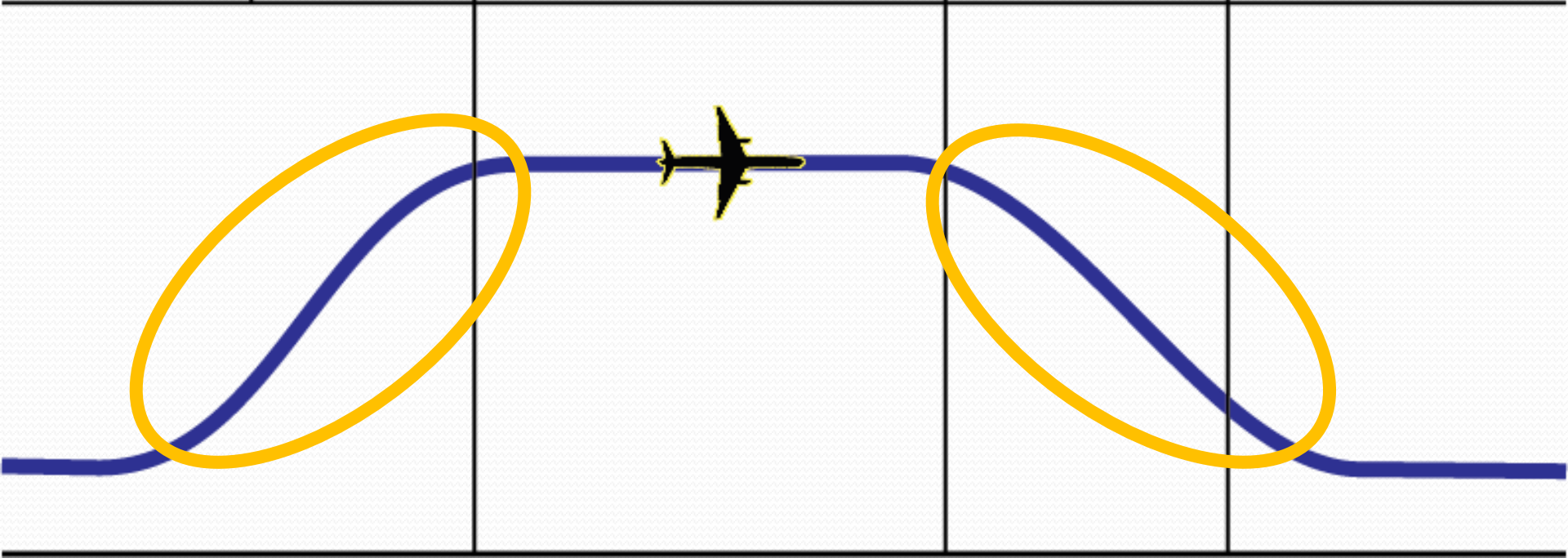
What you can do to improve monitoring

- Strategically plan workload
- Actively monitor

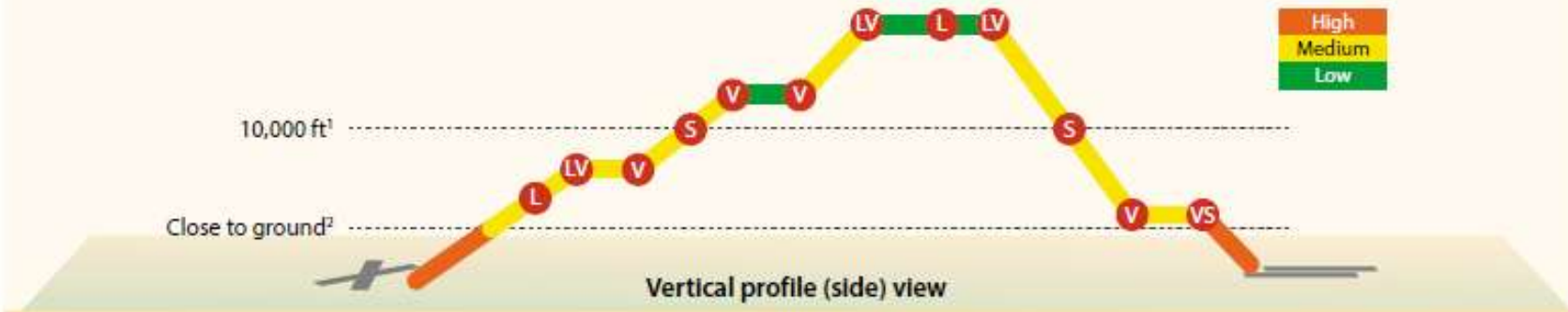
Flight phase where Flight Path Deviation occurred

	Climb	Level	Descent	Approach
ASRS	26%	8%	46%	20%
Accidents	16%	12%	4%	68%



Areas of Vulnerability (AOV)

Areas of Vulnerability (AOV) to Flight Path Deviation, In-Flight Profile Examples



L Lateral trajectory change V Vertical trajectory change S Speed change

Notes:

1. 10,000 ft is used in the United States as the boundary altitude for sterile cockpit rules and for the 250 KIAS speed restriction (both required below 10,000 ft). For the purpose of the AOV model, an altitude of other than 10,000 ft may be chosen, but it is suggested that this boundary match the use of sterile cockpit rules for your operator (or nation/state) for ease of operational applicability by flight crews
2. "Close to ground" may be defined by the operator, but it is suggested that this be an altitude no less than (a) 1,500 ft AGL or (b) the altitude of the surrounding terrain (if terrain threats exist within 5 nm [9 km] of the flight path), whichever is higher.

Source: Active Pilot Monitoring Working Group

What Skilled Monitors Do

- “In general, skilled monitors understand the importance of areas of vulnerability (AOV).
- “They avoid (defer) doing non-monitoring–related tasks while operating in areas where they are most vulnerable to flight path errors.
- “They also plan to conduct activities such as briefing the approach in a less vulnerable AOV.”

  - *A Practical Guide For Improving Flight Path Monitoring*

Strategically Planning Tasks

- Strategically plan workload / tasks to maximize monitoring during those Areas of Vulnerability (AOV)
  - Examples of non-monitoring tasks that should be conducted during lower AOV include stowing charts, programming the FMS, getting ATIS, accomplishing approach briefing, PA announcements, non-essential conversation, etc.

Actively Monitor

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Actively Monitor

Actively Monitor

- Pilots must “actively monitor” the aircraft.
- This means you must mentally fly the aircraft, even when the autopilot or other pilot is flying.
  - Monitor the flight instruments just as you would when hand flying.

Enhancing Monitoring: Taxi

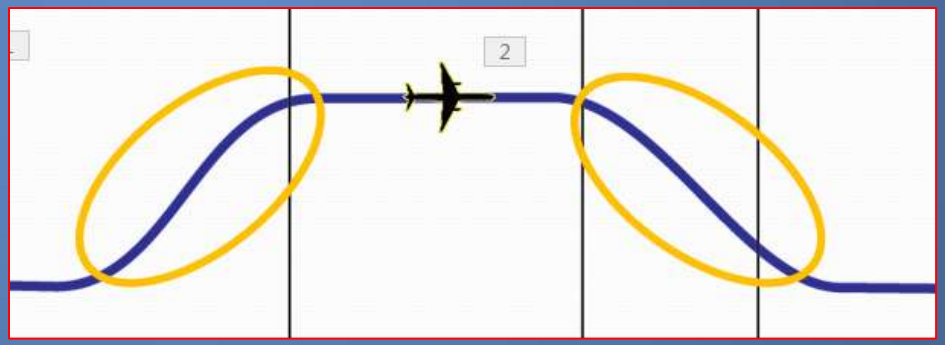
- When approaching an active runway, **both pilots** will suspend non-monitoring tasks to ensure the hold short instructions are complied with.

- Non-monitoring tasks:
  - FMS programming
  - Calling Ops
  - Checklists
  - etc.

Enhancing Monitoring: In-Flight

- Perform non-essential duties/activities during lowest workload periods (e.g., cruise altitude or level flight)

- During the last 1000 feet of altitude change, both pilots will focus on making sure the aircraft levels at the assigned altitude



Approach Briefing: Before TOD

- By briefing prior to TOD, greater attention can be devoted to monitoring during descent.
- LOSA Data: Crews who briefed after TOD averaged making 1.6 times more errors in descent/ approach/ landing phase.

Enhancing Monitoring: Automation

- During high workload, FMS inputs will be made by PM, upon the request of PF.

  High workload examples

  - below 10,000 feet
  - within 1000 feet of level off or Transition Altitude.

How is your monitoring?

- One way of assessing your current monitoring ability is to ask: “How often do I miss making the 1,000’ to level-off altitude callout?”
  - When this callout is missed, you probably aren’t actively monitoring the aircraft.

Paradigm shift

It must become accepted that monitoring is a “core skill,” just as it is currently accepted that a good pilot must posses good “stick and rudder” and effective communicational skills.

Summary

- Inadequate flight crew monitoring has been cited by a number of sources as a problem for aviation safety.

- While it is true that humans are not naturally good monitors, crew monitoring performance can be significantly improved.

“If I had been watching the instruments, I could have prevented the accident."

- First Officer in fatal CFIT accident

National Transportation Safety Board