

# Examining How Breakdowns in Pilot Monitoring of the Aircraft Flight Path Can Lead to Flight Path Deviations

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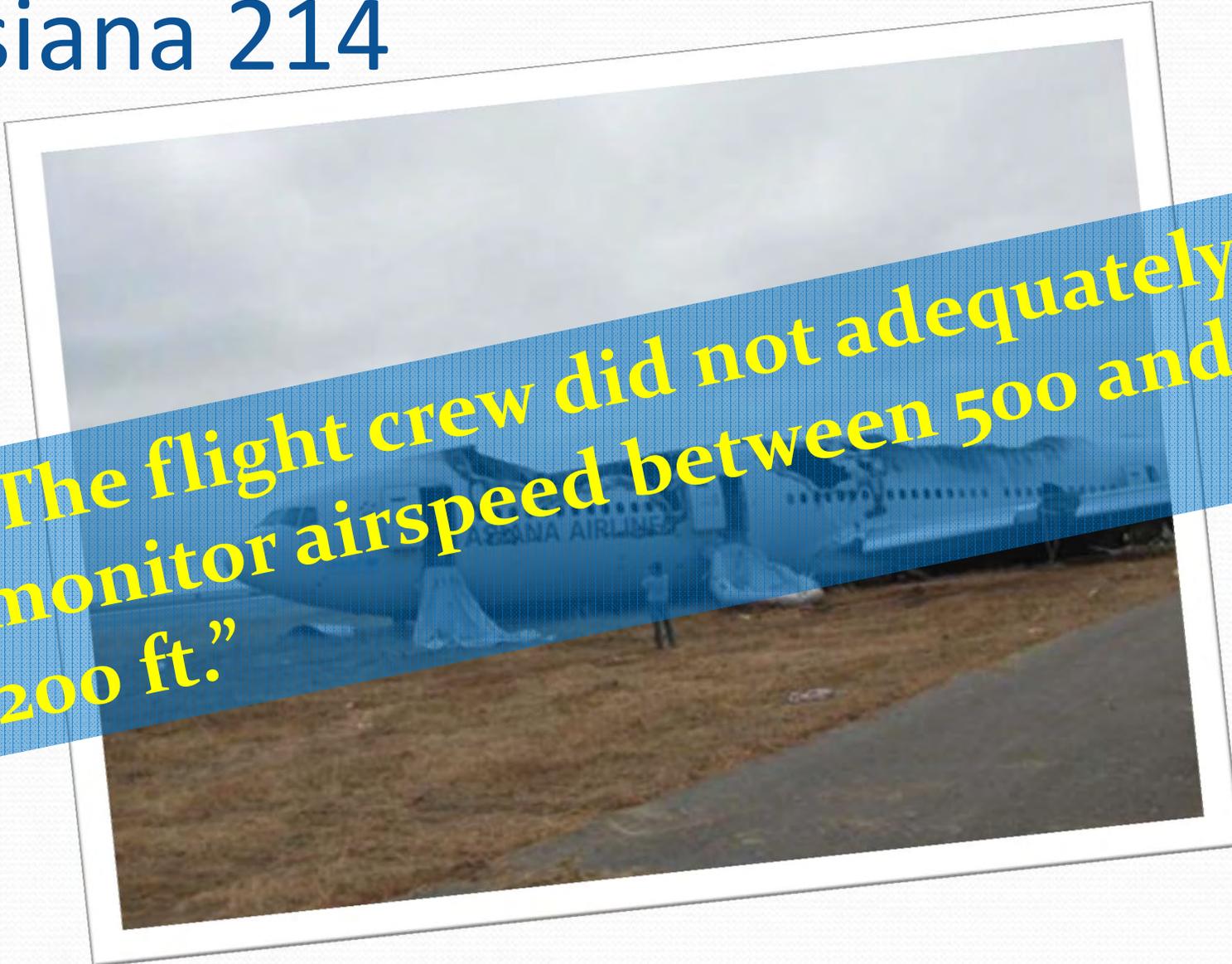
# Asiana 214





# Asiana 214

**“The flight crew did not adequately monitor airspeed between 500 and 200 ft.”**

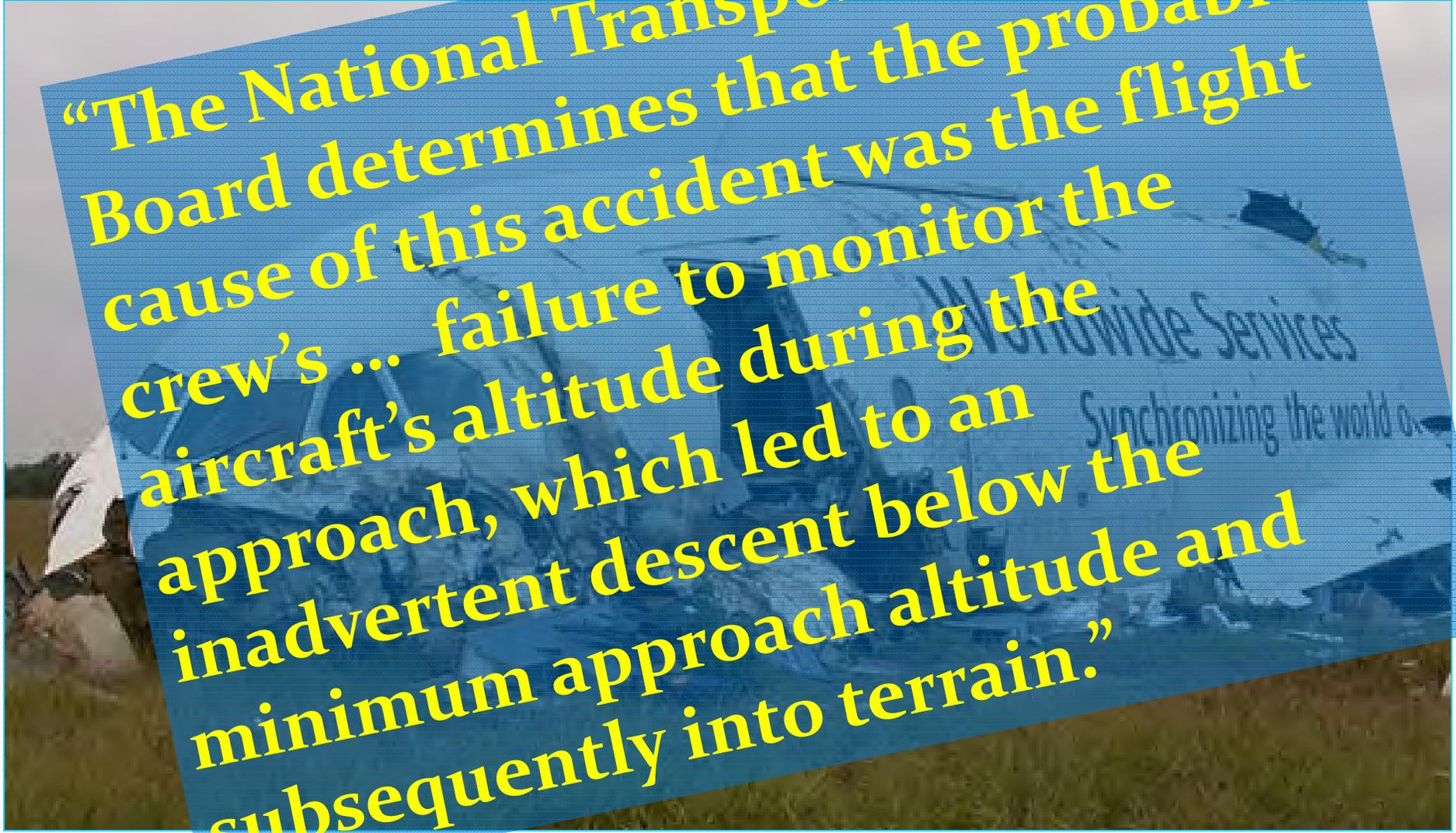


# UPS 1354



# 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.”





# Why this research is important

- In 1994 safety study, NTSB found that ineffective flight path monitoring was a factor in 31 of the 37 (84%) of the reviewed crew-involved air carrier accidents.
- Since that study, this researcher identified at least 11 additional high-profile accidents where ineffective flight path monitoring was cited by investigative authorities.
- 42 accidents in 35 years.
- This is an area that is ripe for improvements!

# FAA rulemaking

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



# Scope of research

- Better understand factors that can lead to pilots' ineffectiveness at monitoring the aircraft flight path (FP).
- The research focused on, and was limited to, understanding those cases where the **aircraft flight path** was not sufficiently monitored which led to flight path deviations.
  - Cases involving taxi path deviations, and those involving inadequate monitoring of radio communications, intra-cockpit communications, traffic, and aircraft systems were not within the scope of the study.



# Approach

- Literature review
- Analysis of 110 ASRS reports where researcher determined inadequate monitoring was a factor in the flight path deviation
- Analysis of 25 accidents where inadequate monitoring was cited by investigative authority
- Findings and recommendations



# Literature review

- Cited 31 peer-reviewed, scholarly sources, articles, papers and publications to reveal human factors limitations and obstacles to effective monitoring.
  - Task management, workload, information processing.
  - Inattention blindness and change blindness
  - Attention
  - Vigilance
  - Flight deck automation
  - Training for monitoring



# Analysis of ASRS reports

- Researcher read and analyzed ASRS reports to determine if scope criteria was met.
  - Report must provide specific evidence that it involved a flight path deviation due to the crew's insufficient monitoring of flight path.
- First 110 reports that met scope criteria were analyzed.

# Data coding

Common Data Coding and Collection Form

Type of Report

ASRS Report/ ACN \_\_\_\_\_

Accident Report/ Accident Title: \_\_\_\_\_

A. Flight Phase

1. Takeoff  2. Climb  3. Level Flight

4. Descent  5. Approach  6. Landing

B. Role of Each Pilot

1. Captain was Pilot Flying

2. FO was Pilot Flying

C. Activities Pilots were Engaged in when Flight Path Deviation Occurred

Flight-Related Tasks

1. FMS Programming  2. Radio Communications  3. Chart Reading

4. Dealing with Abnormal/Emergency  5. Other \_\_\_\_\_

Non-Flight-Related Tasks

6. Eating  7. Conversation

8. Reading Non-Flight Related Material

9. Other Non-Flight Related Activities \_\_\_\_\_

D. Automation Status at Time of Flight Path Deviation

1. Autopilot Engaged  2. A/P Disengaged  3. Non-A/P Engaged

4. Auto-Throttle Engaged  5. A/T Disengaged  6. Non-A/T Engaged

E. Factors that Contributed to Flight Path Deviation

1. Poor Planning  2. Workload  3. Attention Management

4. Distraction  5. Fatigue  6. Boredom/Complacency

7. Looking W/o Seeing  8. Inappropriate Conduct  9. Runway/Arrival Change

10. Other \_\_\_\_\_

Data Coding and Collection Form

ion \_\_\_\_\_

1. TCAS  2. TAWS  3. ATC

is (Circle all that Apply: Vision, Hearing, Feet)  4. AT Crew

5. Other \_\_\_\_\_

tion \_\_\_\_\_

1. Stall  2. Control Deviation

3. Loss of Control  4. Loss of Separation

5. Other \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# Information collected

- Flight phase
- Role of each pilot (PF or PM)
- Activities pilots were engaged with when flight path deviation occurred
- Automation status
- Contributing factors
- Detection of flight path deviation
- Consequences of deviation

# SPSS

\*Combined database.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Add-ons Window Help

Visible: 36 of 36 Variables

	Ref_Number	Event_type	Flight_Phase_Combined	Flight_Phase_2	Flight_Phase_3	Flight_Phase_4	Flight_Phase_5	Pilot_Role_Combined	Pilot_Role_1	Pilot_Role_2	Activities_1	Activities_2	Activities_3	Activities_4	Activities_5	Ac
1	1153010	ASRS	Approach	0	0	0	Approach	First Officer	0	First Officer	0	Radio Comm	.	.	.	
2	824757	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	0	Radio Comm	.	.	.	
3	810325	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	FMS programming	.	.	.	.	
4	722352	ASRS	Descent	0	0	Descent	0	First Officer	0	First Officer	FMS programming	.	.	.	.	
5	808249	ASRS	Level Flight	0	Level Flight	0	0	First Officer	0	First Officer	0	.	.	.	.	
6	510322	ASRS	Climb	Climb	0	0	0	Captain	Captain	0	0	.	.	Abnormal/Emerg	.	
7	509440	ASRS	Descent	0	0	Descent	0	Captain	Captain	0	0	.	.	.	.	
8	509270	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	0	.	.	.	Other flight related	
9	509220	ASRS	Climb	Climb	0	0	0	First Officer	0	First Officer	0	.	.	.	Other flight related	
10	507749	ASRS	Climb	Climb	0	0	0	Captain	Captain	0	FMS programming	.	.	.	.	
11	1118622	ASRS	Approach	0	0	0	Approach	First Officer	0	First Officer	0	Radio Comm	.	.	Other flight related	
12	1121700	ASRS	Descent	0	0	Descent	0	Captain	Captain	0	0	.	.	Abnormal/Emerg	.	
13	1114284	ASRS	Descent	0	0	Descent	0	Captain	Captain	0	FMS programming	.	.	.	.	
14	1113770	ASRS	Descent	0	0	Descent	0	First Officer	0	First Officer	FMS programming	.	.	.	.	
15	466290	ASRS	Climb	Climb	0	0	0	Captain	Captain	0	FMS programming	.	.	.	.	
16	461159	ASRS	Descent	0	0	Descent	0	Captain	Captain	0	0	.	.	.	Other flight related	
17	460030	ASRS	Climb	Climb	0	0	0	Captain	Captain	0	FMS programming	Radio Comm	.	.	.	
18	467430	ASRS	Climb	Climb	0	0	0	Captain	Captain	0	0	Radio Comm	.	.	.	
19	468330	ASRS	Descent	0	0	Descent	0	First Officer	0	First Officer	0	.	.	.	.	Cor
20	1110487	ASRS	Approach	0	0	0	Approach	First Officer	0	First Officer	0	.	.	.	Other flight related	
21	1149809	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	0	.	.	.	.	
22	1133957	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	0	.	.	.	.	
23	1130600	ASRS	Approach	0	0	0	Approach	Captain	Captain	0	0	.	.	.	.	
24	1125852	ASRS	Descent	0	0	Descent	0	Captain	Captain	0	0	.	.	.	.	
25	1124461	ASRS	Descent	0	0	Descent	0	First Officer	0	First Officer	0	.	.	.	.	
26	924521	ASRS	Climb	Climb	0	0	0	First Officer	0	First Officer	0	.	.	.	Other flight related	
27	914396	ASRS	Climb	Climb	0	0	0	First Officer	0	First Officer	FMS programming	.	.	.	Other flight related	
28	910412	ASRS	Descent	0	0	Descent	0	First Officer	0	First Officer	0	.	.	Abnormal/Emerg	.	
29	910386	ASRS	Climb	Climb	0	0	0	First Officer	0	First Officer	0	.	.	.	Other flight related	

Data View Variable View

IBM SPSS Statistics Processor is ready Processor area code: ON

# Accident analysis

Collision with Trees and Crash Short of the Runway, Corporate Airlines Flight 5966  
BAE Systems BAE-J3201, N875JX  
Kirksville, Missouri  
October 19, 2004



Crashed during approach, Boeing 737-800,  
near Amsterdam Schiphol Airport,  
25 February 2009

Loss of Control on Approach  
Colgan Air, Inc.  
Operating as Continental Connection Flight 3407  
Bombardier DHC-8-400, N200WQ  
Clarence Center, New York  
February 12, 2009

Descent Below Visual Glidepath and Impact With Seawall  
Asiana Airlines Flight 214  
Boeing 777-200ER, HL7742  
San Francisco, California  
July 6, 2013

Accident Report  
SBI/AAR-10/01  
B2010-910401



Aviation  
Accident Report



# Accident analysis

- 25 aircraft accidents
  - 22 investigated by NTSB
  - 3 investigated by foreign accident investigation authorities
- Accidents occurred between December 1972 and July 2013
- These accidents collectively claimed **894** lives and resulted in **180** serious injuries
- Involved scheduled domestic and air carriers, foreign air carriers, charter operators, and part 91 operators.

# Which pilot was PF?

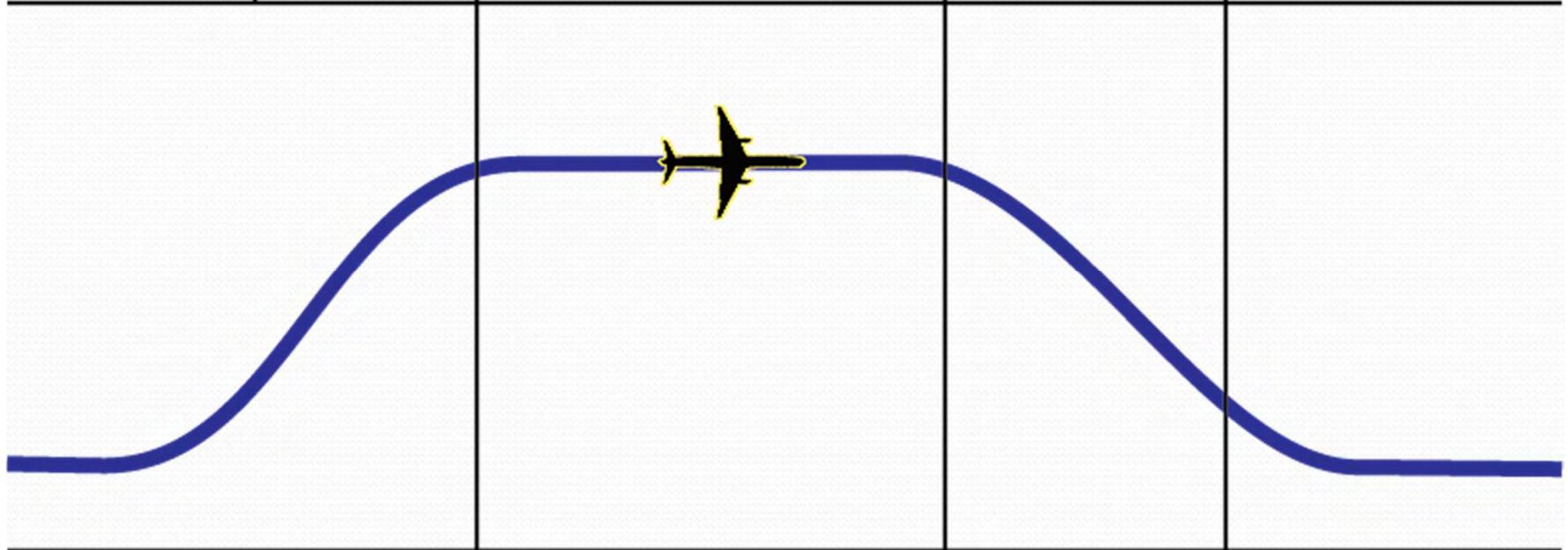


	Captain	First Officer
ASRS data	56%	44%
Accident data	65%	35%

No statistically significant difference, but potentially noteworthy.

# Flight phase where Flight Path Deviation occurred

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



# Crew activities when flight path deviation occurred

## ASRS Reports

- Programming FMS, radio communications, traffic search, dealing with aircraft malfunction, normal checklists, chart reading/approach briefing.

## Accidents

- 6 of the 25 accidents involved dealing with aircraft abnormality or malfunction.

# Contributing factors

- Distractions
- Automation reliance
- Fatigue
- High workload
- Complacency
- Runway/arrival change
- Rushing/time pressure



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# Who or what first detected the flight path deviation?

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

A red bracket on the right side of the table groups the first three rows (ATC, Cockpit alerting system, and Jumpseat rider) with the number 72, indicating that these three categories together account for 72 reports.

- Someone or something other than the operating crew first detected the flight path deviation in 72 of 104 reports.
- $\chi^2 = 15.39$ ,  $df = 1$ ,  $p < 0.001$ .

# Consequences – ASRS reports

Consequence	Number of ASRS reports
Altitude deviation	75
Course deviation	20
Speed deviation	14
Loss of separation	2
Well below glideslope	2
Collision course with ground or obstacle	2
Other	4

Consequences were not mutually exclusive. Therefore, the number of consequence citations exceed the number of reviewed ASRS reports.

# Consequences by flight phase - ASRS

<b>Flt. Phase</b>	<b>Altitude dev.</b>	<b>Course dev.</b>	<b>Speed dev.</b>	<b>Other</b>	<b>Totals</b>
Climb	19	7	5	4	35
Level	8	0	1	0	9
Descent	41	7	3	0	51
Approach	7	6	5	6	24
<b>Totals</b>	<b>75</b>	<b>20</b>	<b>14</b>	<b>10</b>	<b>119</b>

# Consequences – Accidents



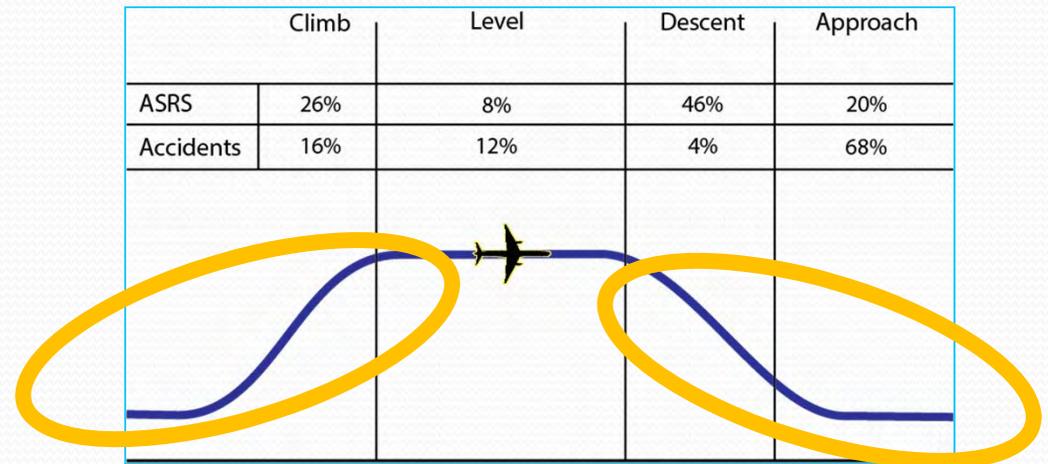
- CFIT – 14
- Stall – 11

- **Altitude** was the largest number of flight path parameters that were not monitored in **ASRS** reports.
  - 75 altitude deviations (68% of 110 ASRS reports)
- **Airspeed** was the leading category of flight path parameters not monitored in the **accidents**.
  - 10 speed deviations (40% of 25 accidents)



# Findings and recommendations

- The study underscores the importance of the need for pilots to plan ahead, get ahead, and stay ahead.
  - » Workload management strategies should be developed and incorporated so pilots can monitor at critical junctures in flight.





# Findings and recommendations

- Data show that pilots are, in some cases, treating automation as “setting it and forgetting it.”
  - » Pilots should “mentally fly” the aircraft when automation (or the other pilot) is flying.
  - » This can be accomplished calling anticipated FMA changes before they occur, instead of waiting for them to occur.



“Once you put pilots on automation, their manual abilities degrade and their flight path awareness is dulled: flying becomes a monitoring task, an abstraction on a screen, a mindnumbing wait for the next hotel.”

- William Langewiesche, *Vanity Fair*, October 2014

