National Transportation Safety Board

Enhancing Crew Monitoring and Cross-checking

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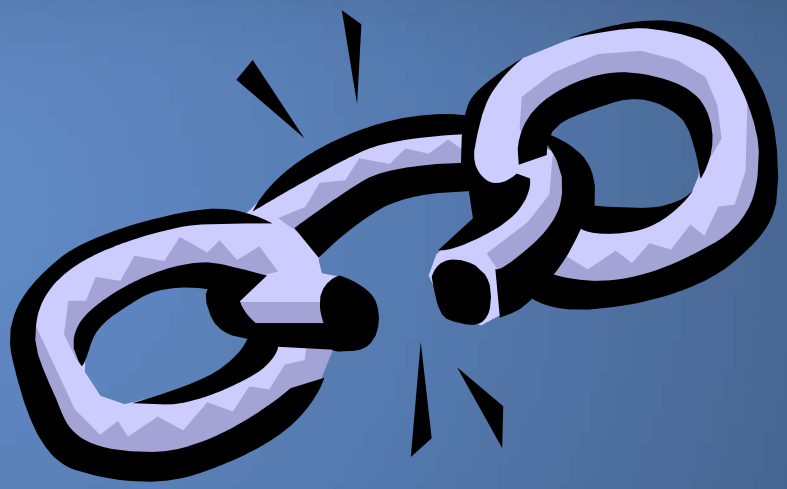
The last line of defense

- Each crewmember must carefully monitor the aircraft's flight path and systems, and actively cross-check the actions of each other.
- Effective monitoring and cross-checking can be the last line of defense
  - When this layer of defense is absent an error may go undetected, leading to adverse safety consequences

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.



Structure of Today's Discussion

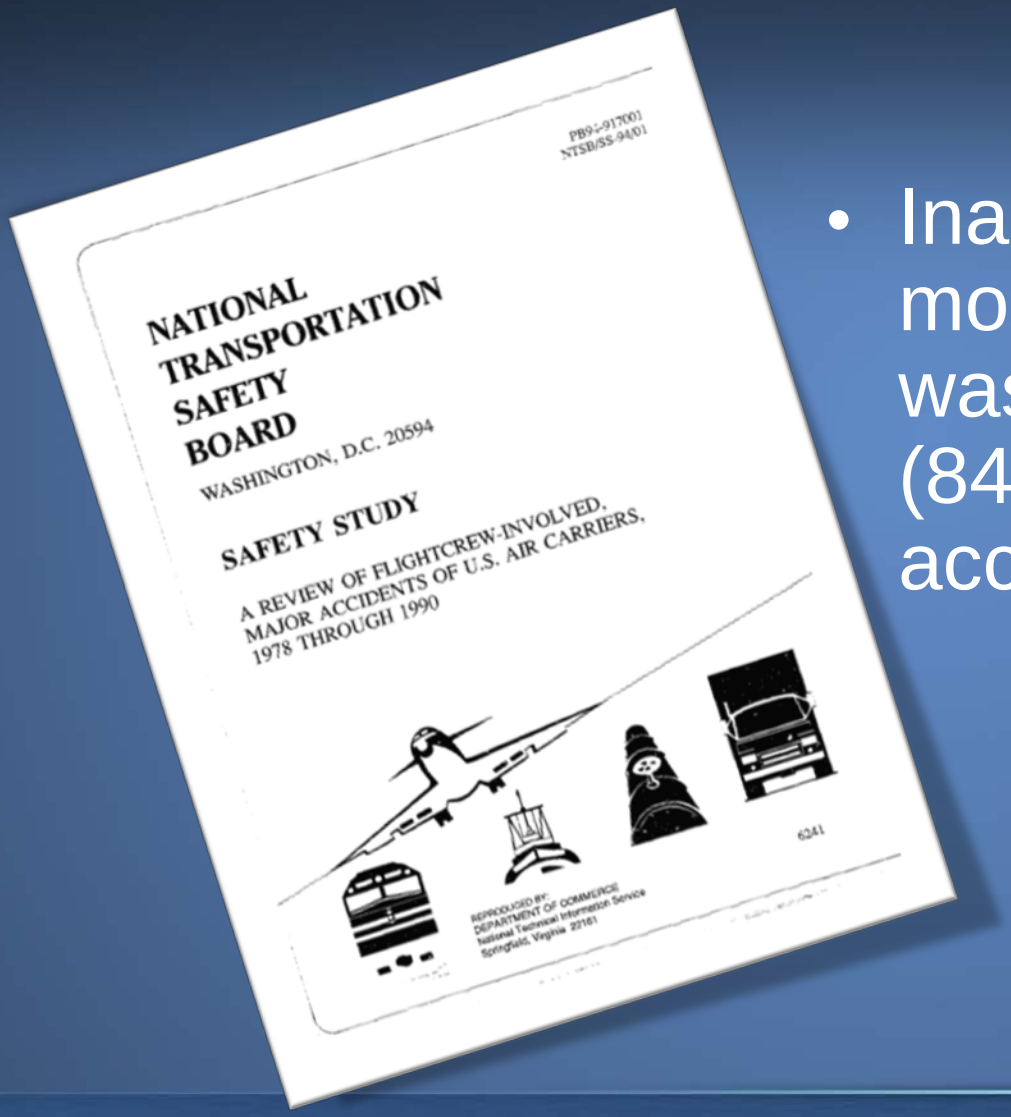
I. Why is monitoring important?

II. Barriers to effective monitoring

III. What you can do to improve monitoring

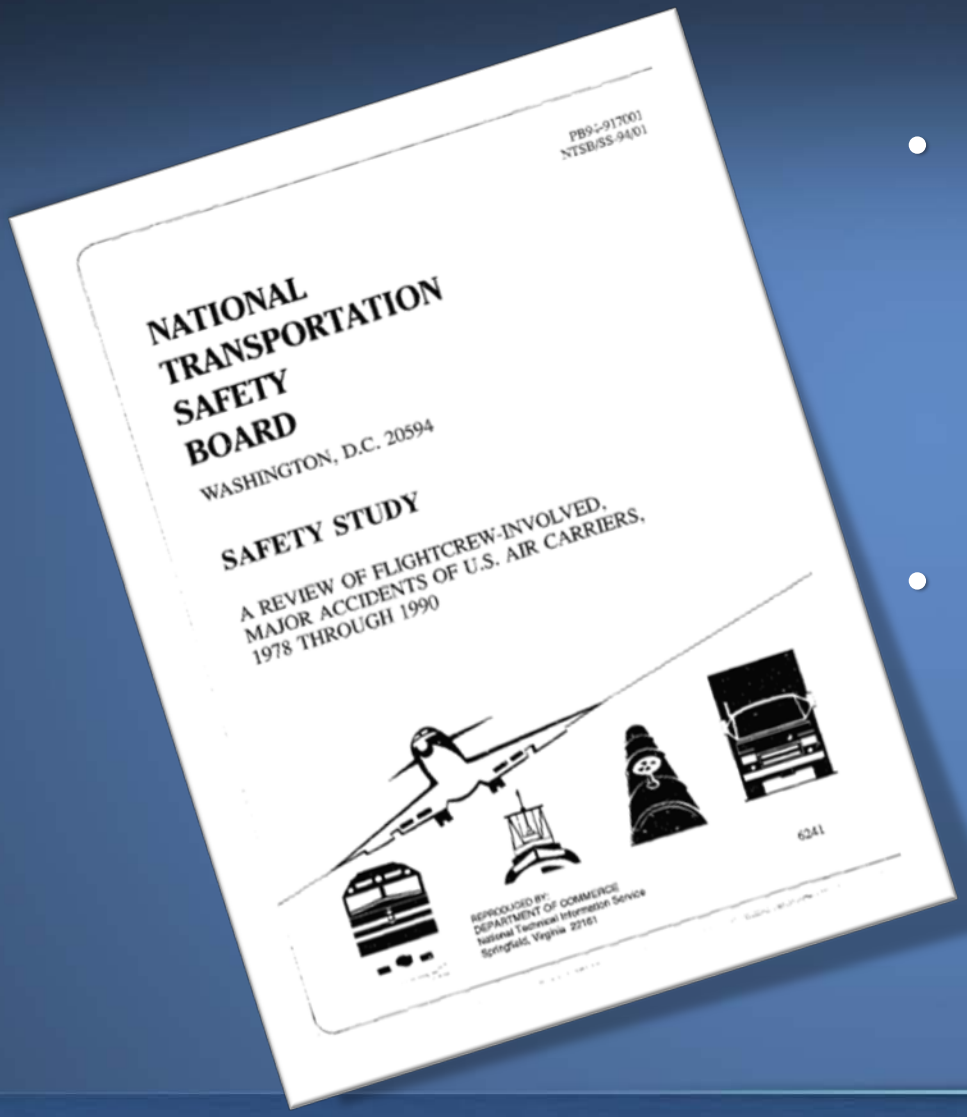
First discussion point:

WHY IS MONITORING IMPORTANT?



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

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

October 25, 2002 Eveleth, MN

According to NTSB

- "during the later stages of the approach, the flight crew failed to monitor the airplane's airspeed and allowed it to decrease to a dangerously low level (as low as about 50 knots below the company's recommended approach airspeed) and to remain below the recommended approach airspeed for about 50 seconds."

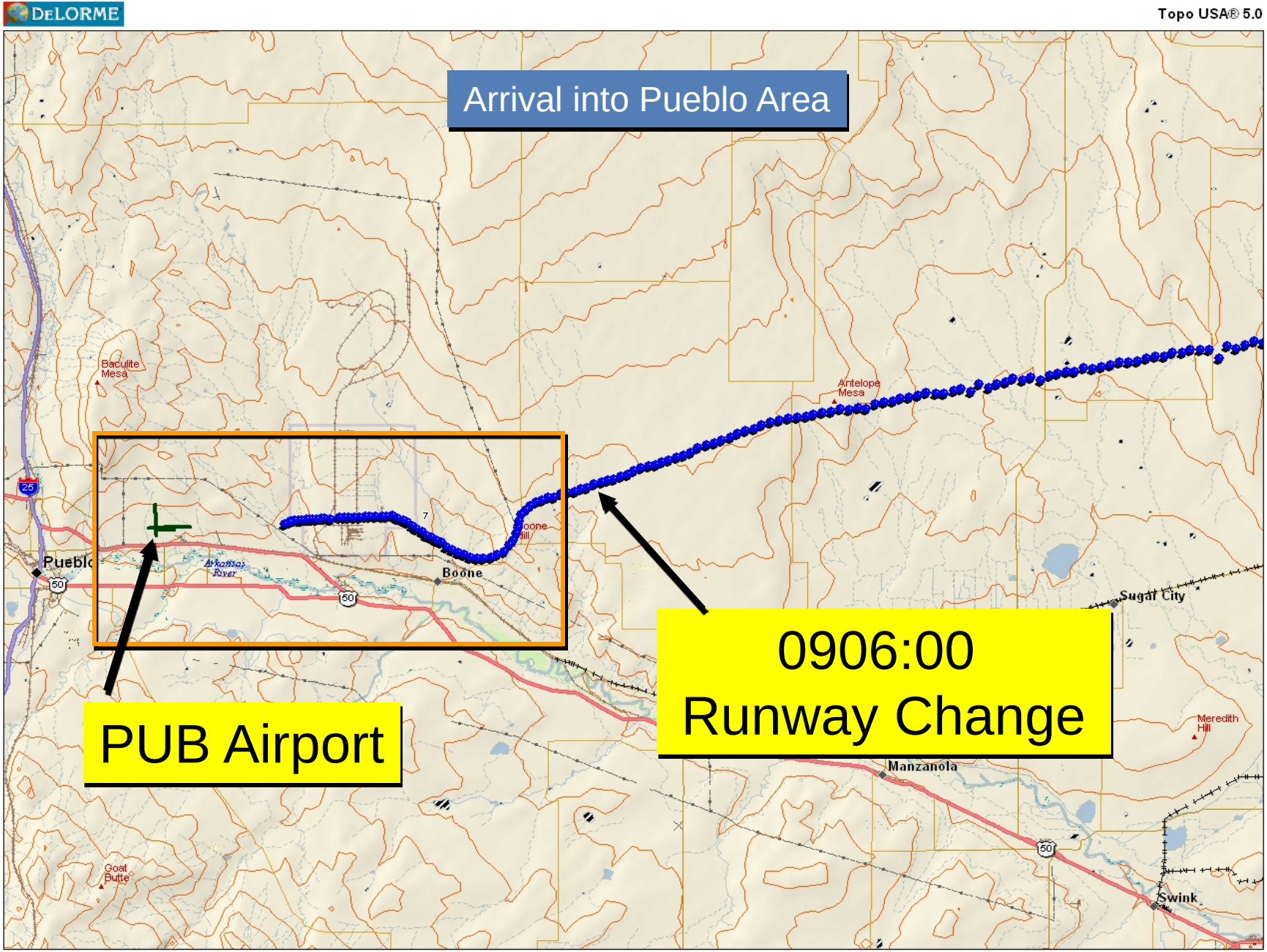
G-III, Nov. 22, 2004 Houston

Probable Cause

- “The flight crew's failure to adequately monitor and cross check the flight instruments during the approach…”

Accident Summary

- February 16, 2005
- Pueblo, CO
- Cessna Citation 560
  - Owned by Circuit City, Operated by Martinair
- Eight fatalities
- Part 91 flight


DeLORME
Topo USA® 5.0
Arrival into Pueblo Area
Baculite Mesa
Antelope Mesa
Pueblo
Boone
Arkansas River
Sugar City
Meredith Hill
Manzanola
Goat Butte
Swink
0906:00
Runway Change
PUB Airport
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www.delorme.com
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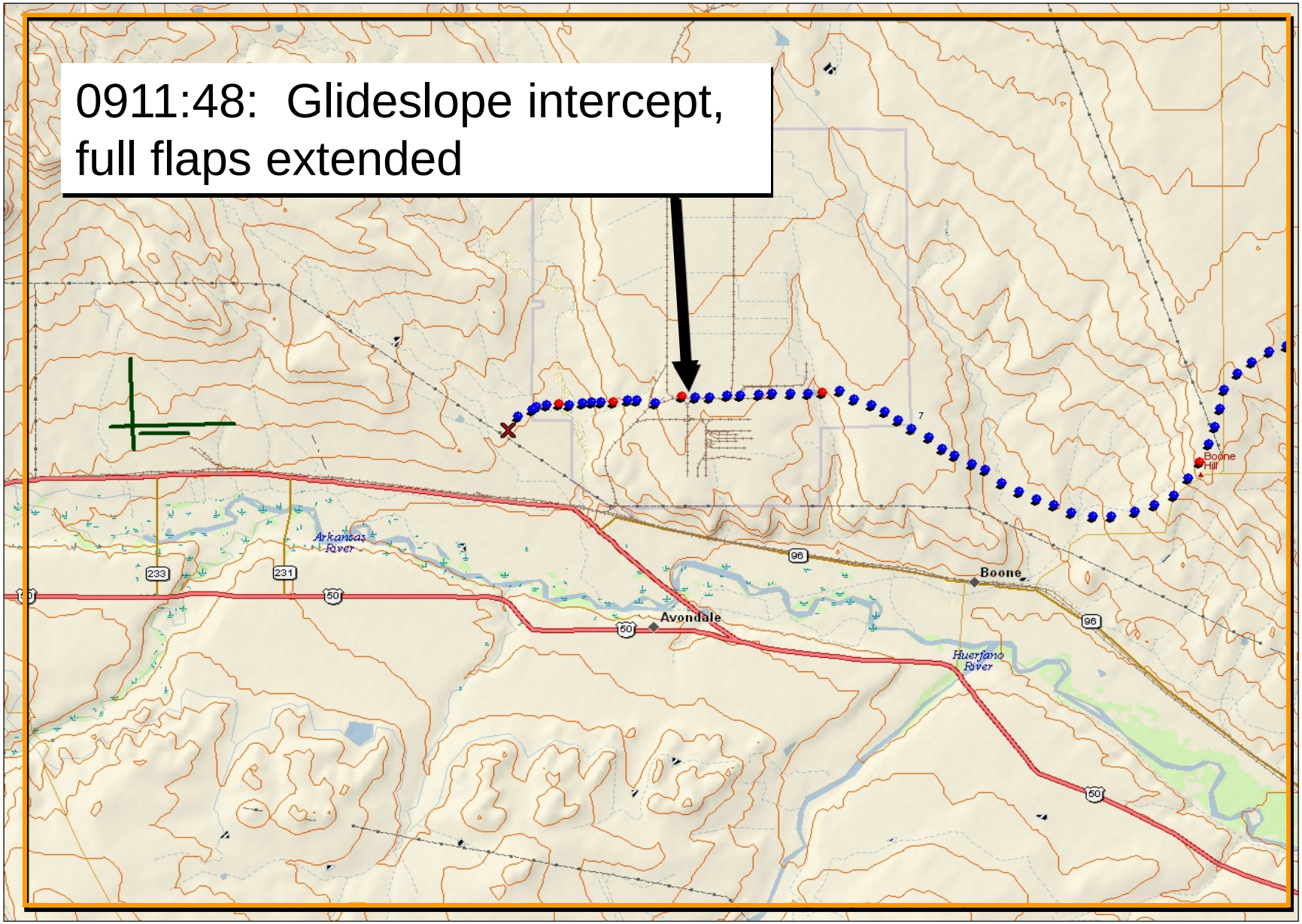
Data Zoom 9-0


DeLORME
Topo USA® 5.0
0911:48: Glideslope intercept, full flaps extended
Arkansas River
Boone
Avondale
Huerfano River
Boone Hill
233
231
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Data use subject to license.
© 2004 DeLorme. Topo USA® 5.0.
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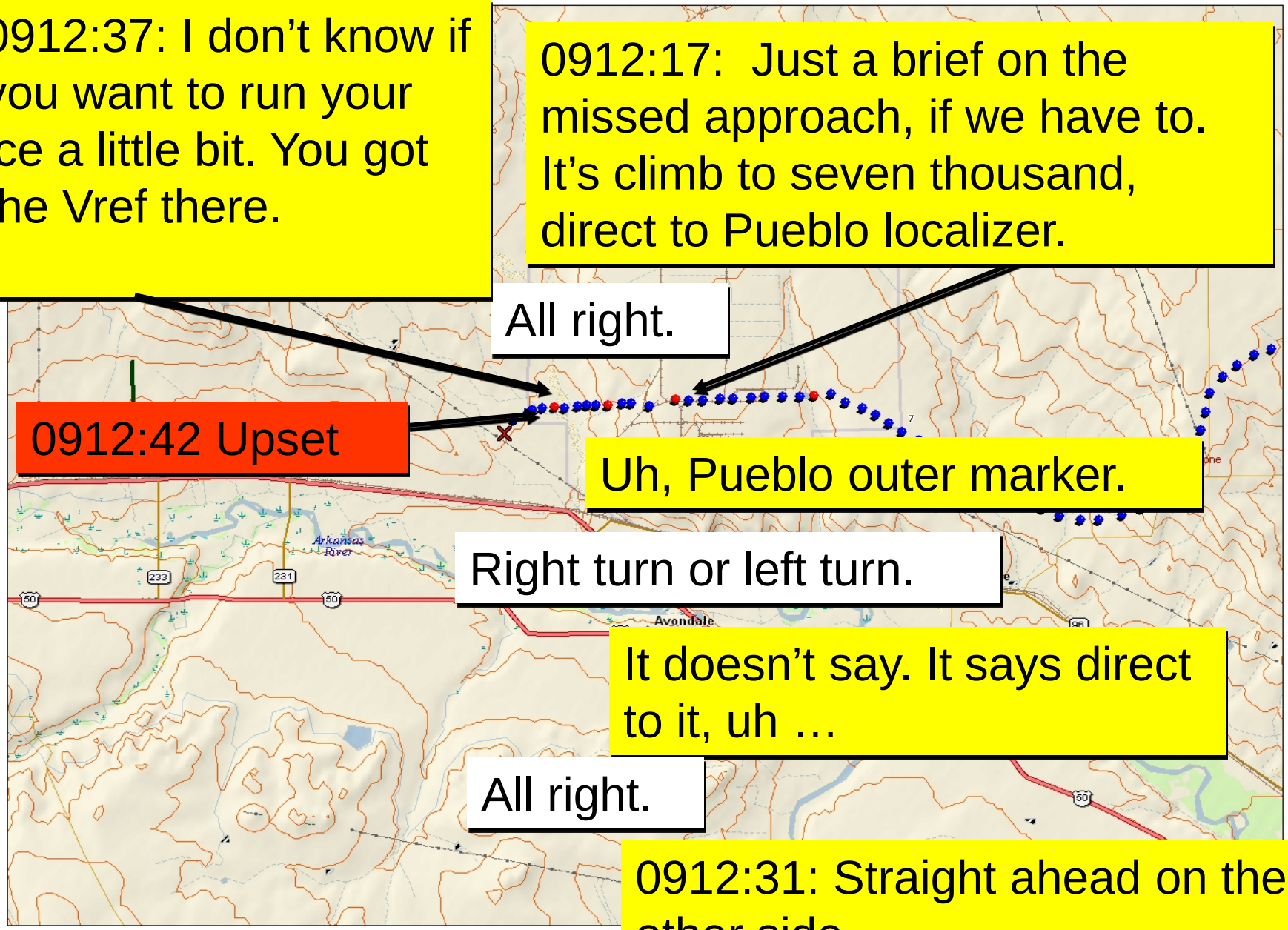
DeLORME
Topo USA® 5.0
0912:37: I don't know if you want to run your ice a little bit. You got the Vref there.
0912:17: Just a brief on the missed approach, if we have to. It's climb to seven thousand, direct to Pueblo localizer.
All right.
0912:42 Upset
Uh, Pueblo outer marker.
Right turn or left turn.
Arkansas River
233
231
50
Avondale
It doesn't say. It says direct to it, uh …
All right.
0912:31: Straight ahead on the other side.
Data use subject to license.
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Probable Cause

"Flight crew's failure to effectively monitor and maintain airspeed and comply with procedures for deice boot activation on the approach, which caused an aerodynamic stall from which they did not recover."

NTSB Finding

- "All operators would benefit from an increased focus on providing monitoring skills in their training programs…"

NTSB Recommendation A-07-13 to FAA:

Require pilot training programs be modified to contain modules that teach and emphasize monitoring skills and workload management and include opportunities to practice and demonstrate proficiency in these areas.

Colgan Air flight 3407

HOT-2: gear's down.

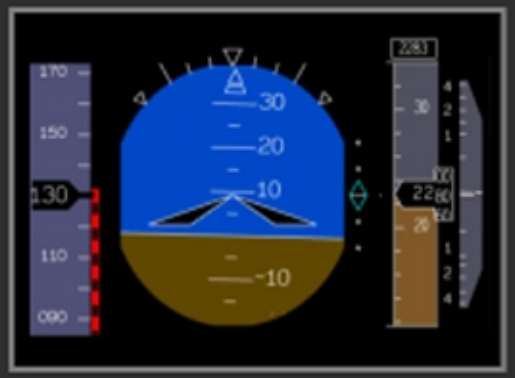
HOT-1: flaps fifteen before landing checklist.

HOT-2: uhhh.

National Transportation Safety Board *Board Meeting*

22:16:27

130 knots **2280** feet Shaker **ON** Pusher **OFF** Power Condition Flap



Heading **247** °

Pedal L R

Auto Pilot **OFF** Gear **DOWN**

Probable Cause

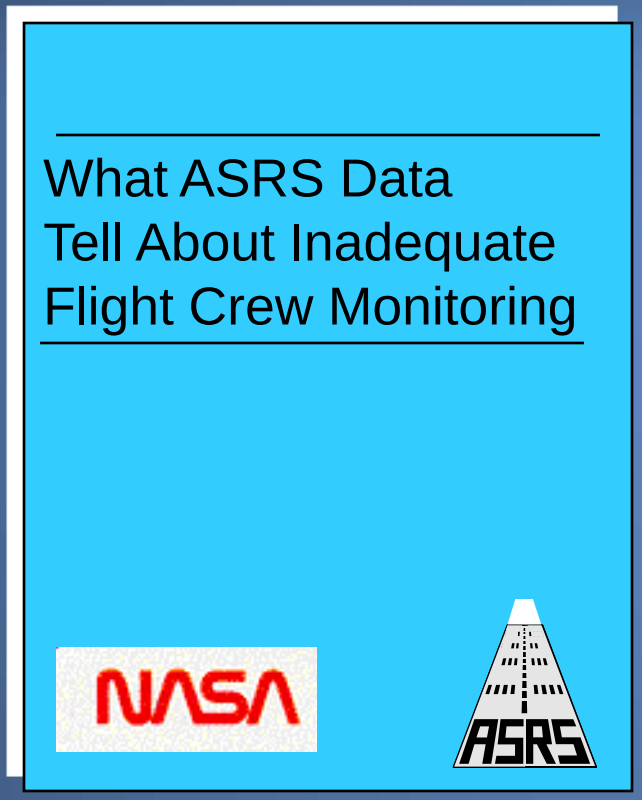
- "… the captain's inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall from which the airplane did not recover.

  Contributing to the accident: (1) the flight crew's failure to monitor airspeed in relation to the rising position of the low speed Cue…"

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)

ASRS Study



- ASRS study found evidence that inadequate monitoring can lead to adverse safety consequences
  - Altitude deviations
  - CFTT
  - Stall
  - Loss of aircraft control
  - Course/heading/track deviations

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
- Looking without seeing
  - Inattention blindness
  - Change blindness
- Poor workload management/ task allocation

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
ALT CRZ
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AP1
1FD2
A/THR
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280
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.80
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MACH
ALT CRZ
NAV
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Inattentional Blindness

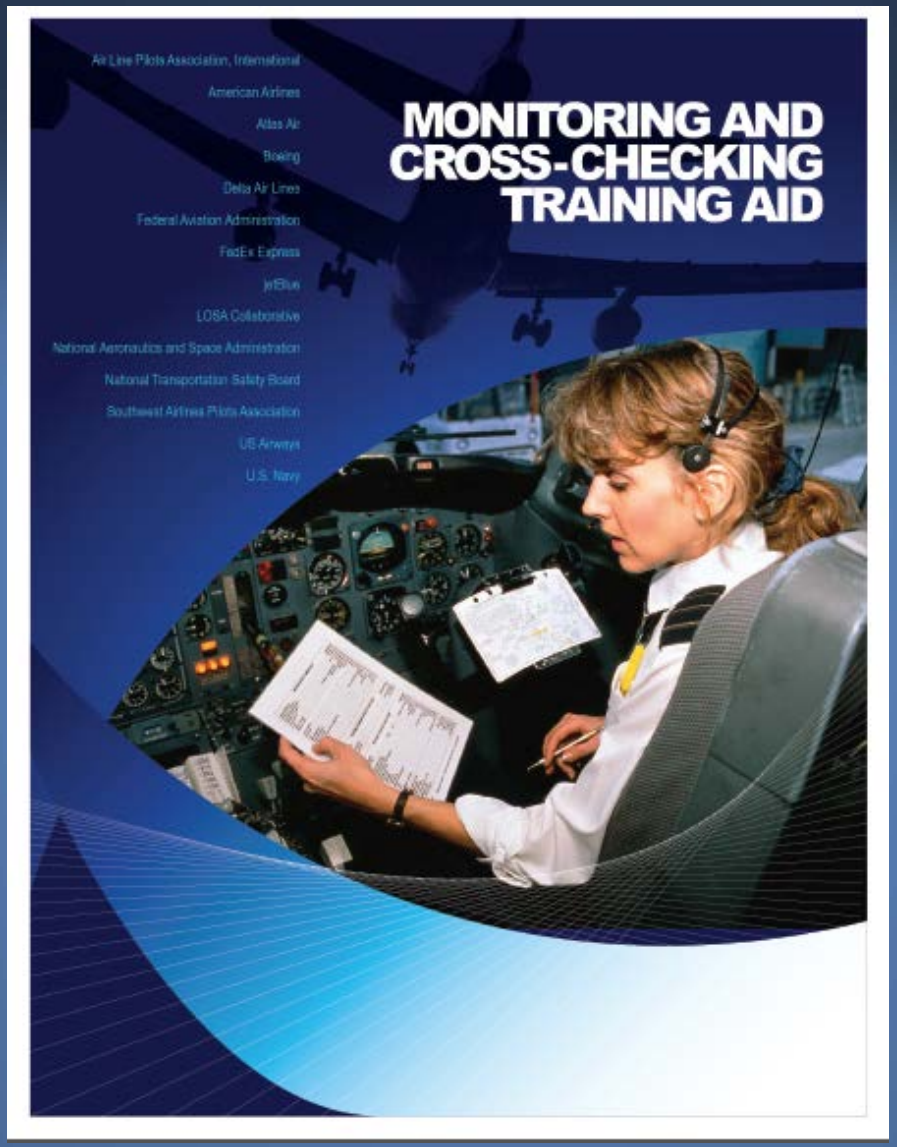
Bad News / Good News

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.


Air Line Pilots Association, International
American Airlines
Atlas Air
Boeing
Delta Air Lines
Federal Aviation Administration
FedEx Express
JetBlue
LOSA Collaborative
National Aeronautics and Space Administration
National Transportation Safety Board
Southwest Airlines Pilots Association
US Airways
U.S. Navy
MONITORING AND CROSS-CHECKING TRAINING AID

Third discussion point:

WHAT YOU CAN DO TO IMPROVE MONITORING

NTSB

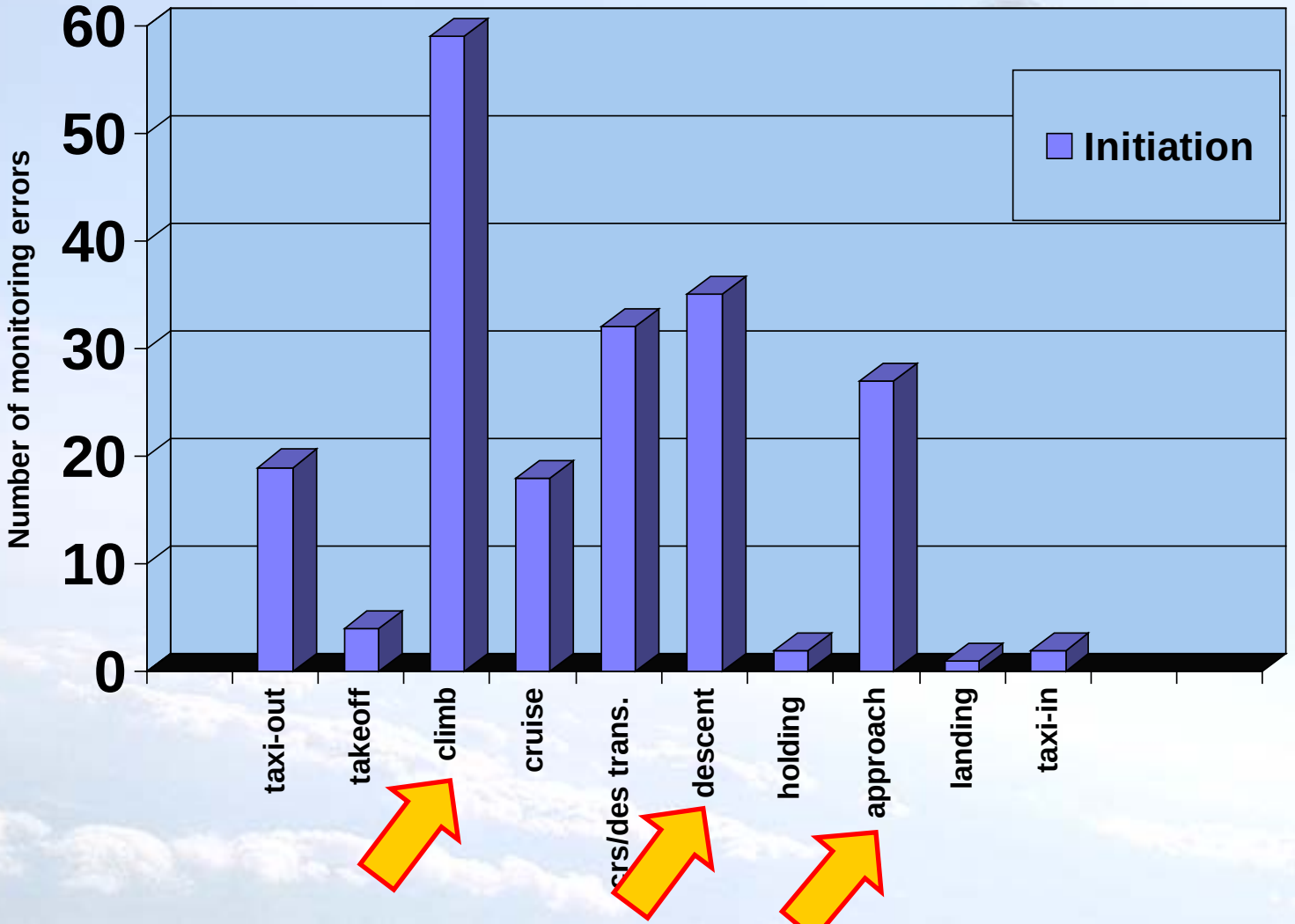
Actively Monitor

- 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.

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.

ASRS Monitoring Study: Flight Phase where Monitoring Errors Occurred



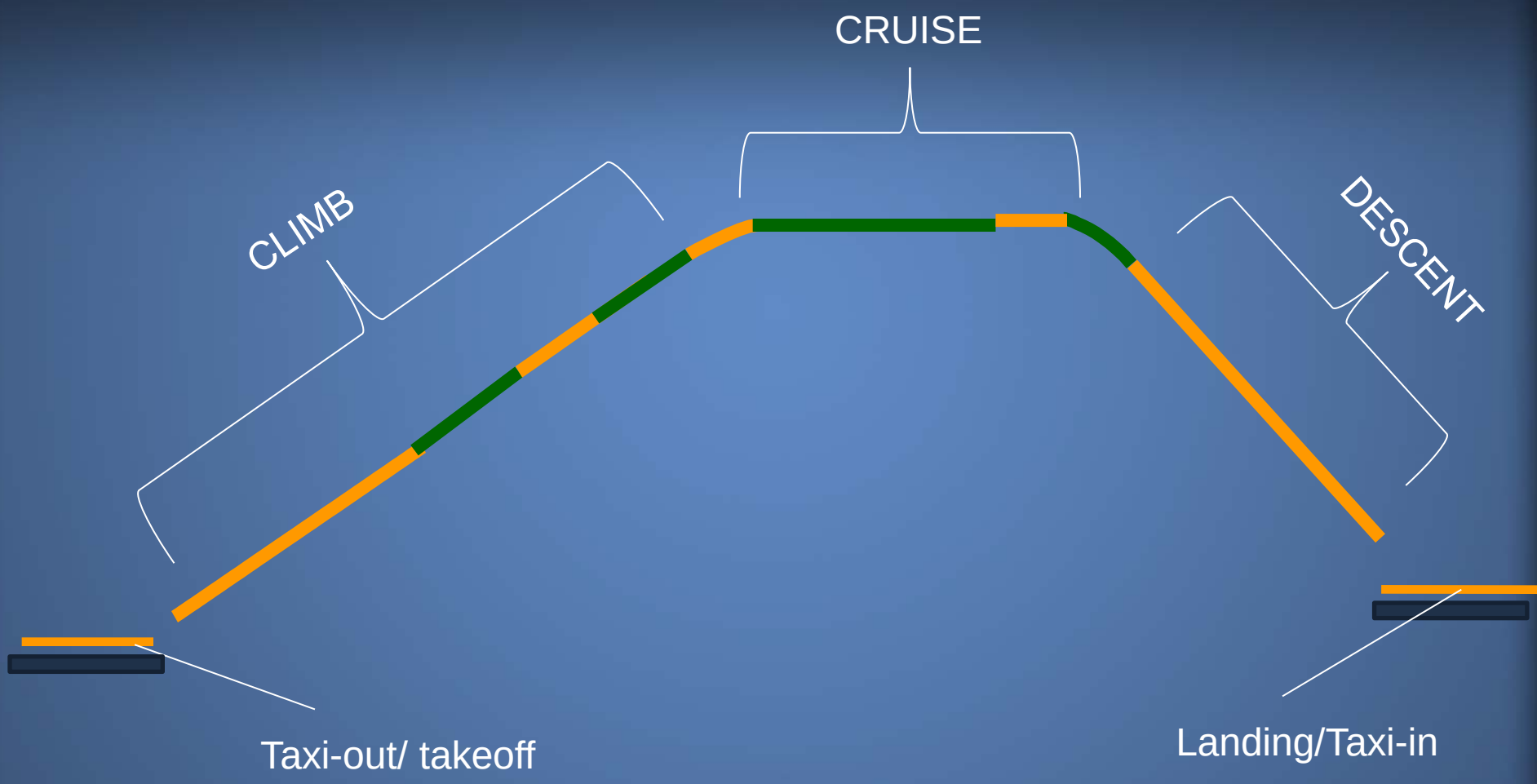
ASRS Study Significant Findings

- 76 percent of monitoring errors occurred when aircraft was climbing, descending or on approach (“vertical flight phase”)
- 30 percent of the reports indicated that pilots were programming the FMS shortly before or during the monitoring error

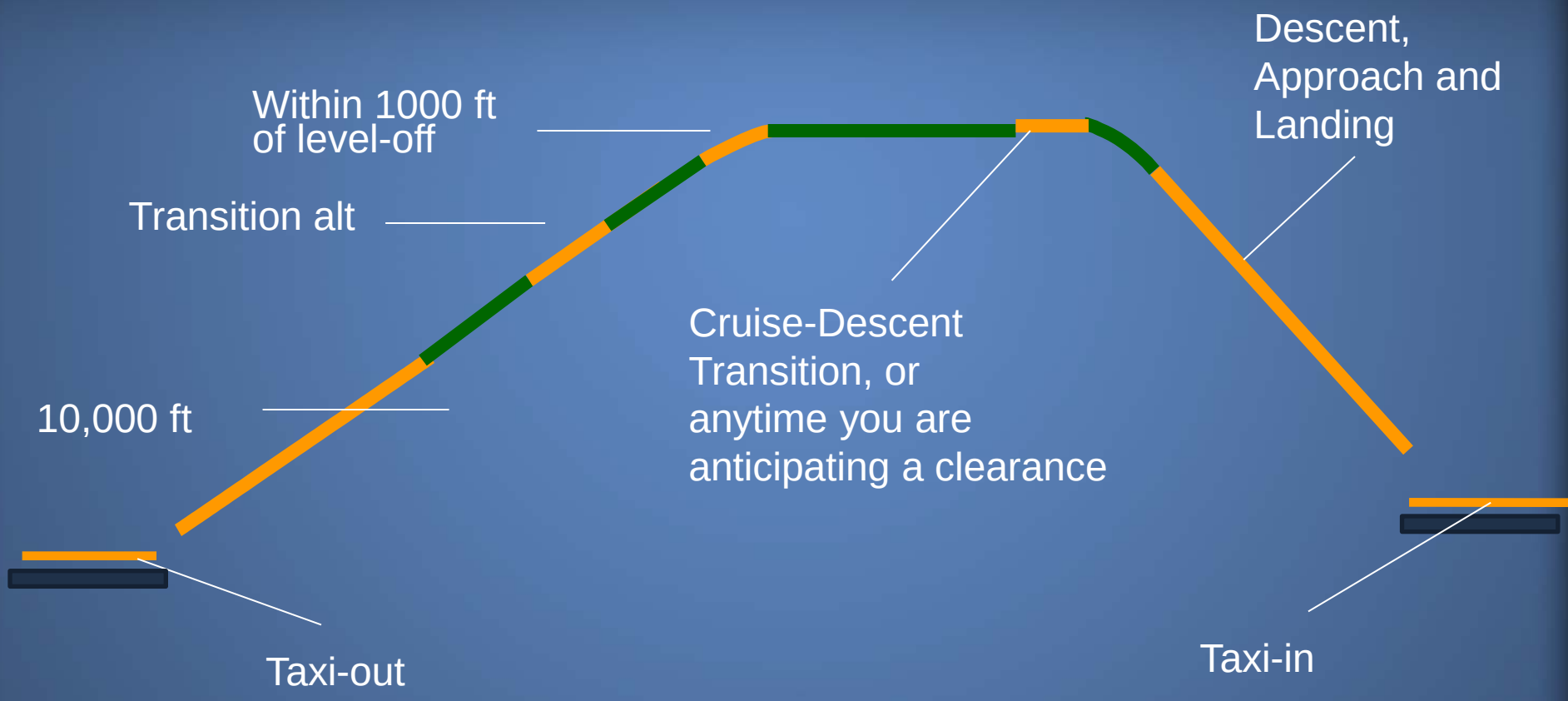
Strategically Planning Tasks

- Pilots should recognize those flight phases where poor monitoring can be most problematic.
- 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.

Areas of Vulnerability



Areas of Vulnerability



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 FBO
  - 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.

  <u>High workload examples</u>

  - 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

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