NTSB National Transportation Safety Board

Threat and Error Management

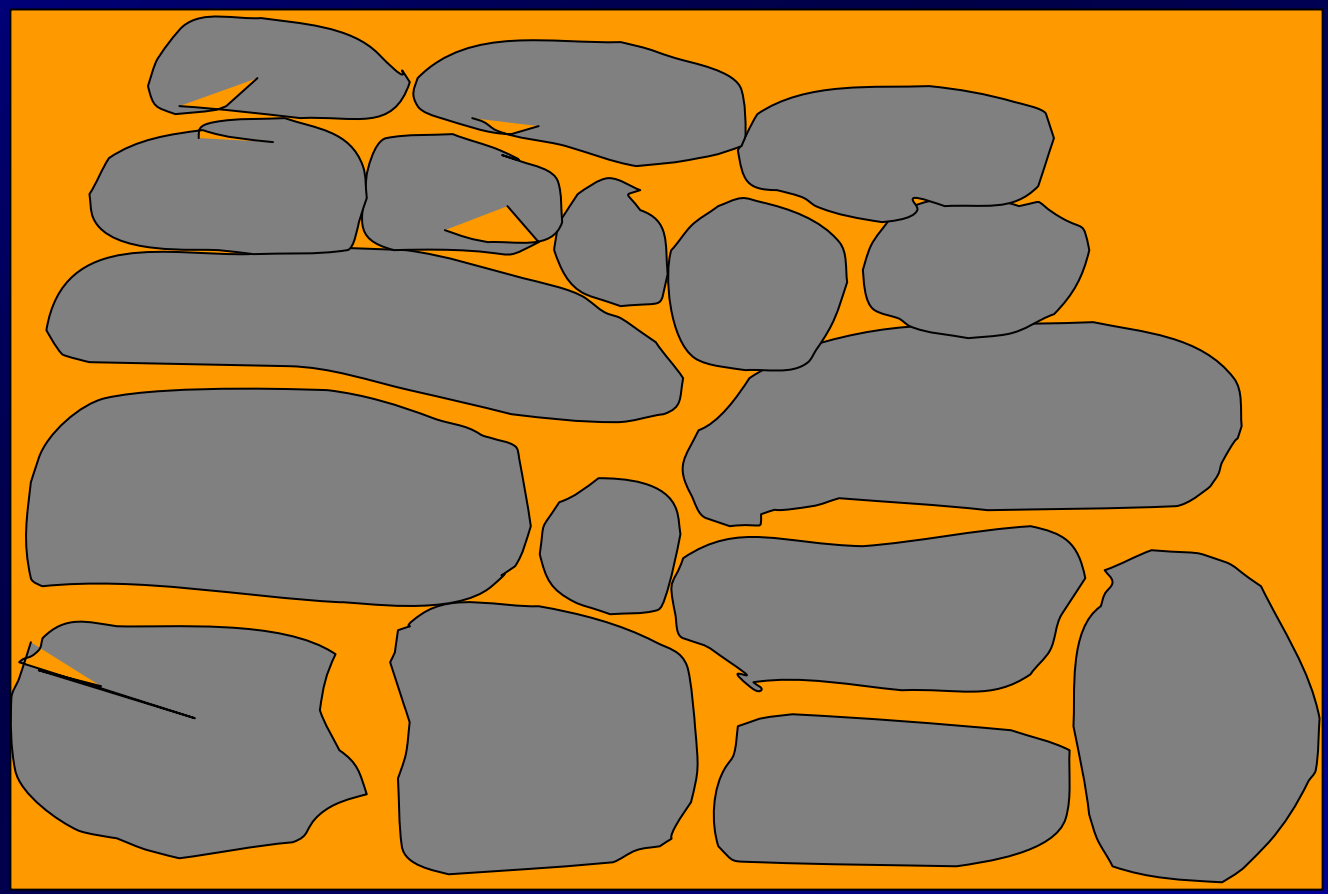
Society of Experimental Test Pilots
April 28, 2009

Robert Sumwalt, Board Member
NTSB

Threat and Error Management:

A Practical Perspective

Building a wall



How do we improve safety?

- Train crews/teams how to better manage Threats and Errors

Threat and Error Management is 6th Generation of CRM

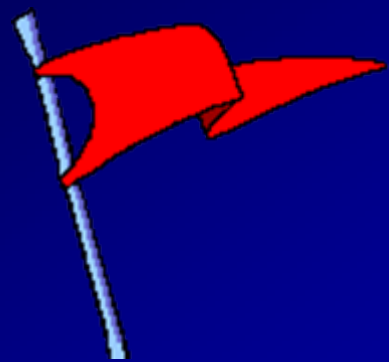
“Threats”

- Those things that can increase the operational complexity, and if not handled correctly, can decrease the safety margins

  - Weather
  - Delays
  - Mechanical Malfunctions
  - Stress
  - Time pressure
  - Distractions
  - ? ?
  - Maintenance shift carry-over

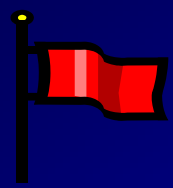
Threats

- Threats
  - Threats can increase error potential
  - Threats “put holes in” or weaken our barriers against error
- Threats = **Red Flags**



Be aware of threats!

- "Snakes in the grass"
  - What are the things that can bite you on this flight?
- We want employees to identify, talk about and think about threats, and
- those things that are different about this operation or flight
  - Unfamiliar airport
  - Flying with new pilot
  - New procedures



- This puts the threats in the employees "mental RAM" and makes it readily available for retrieval
  - Example: mentally rehearse CFIT escape maneuver

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SHOWGIRLS, DRAG QUEENS

FIRST IN A 3-PART SERIES

WARNING: PILOT ERROR

How regional airlines failed to heed warning signals about pilots who didn't belong in the cockpit

“To err is human”

Marcus Tullius Cicero

106-43 B.C.

Why error management?

- Traditional thinking focused on eliminating human error in aviation
- Contemporary thinking acknowledges that error is a way of life
  - given the acceptance that human error may occur, the focus has become “How do you effectively manage error?”
  - proper error management greatly enhances safety

Errors will occur

"So we must create an error management system in which the crew recognizes and corrects errors before negative consequences occur."

- Captain Frank J. Tullo

"Aviation Week and Space Technology"

May 21, 2001

Threat and Error Management

Helps us avoid and trap errors.

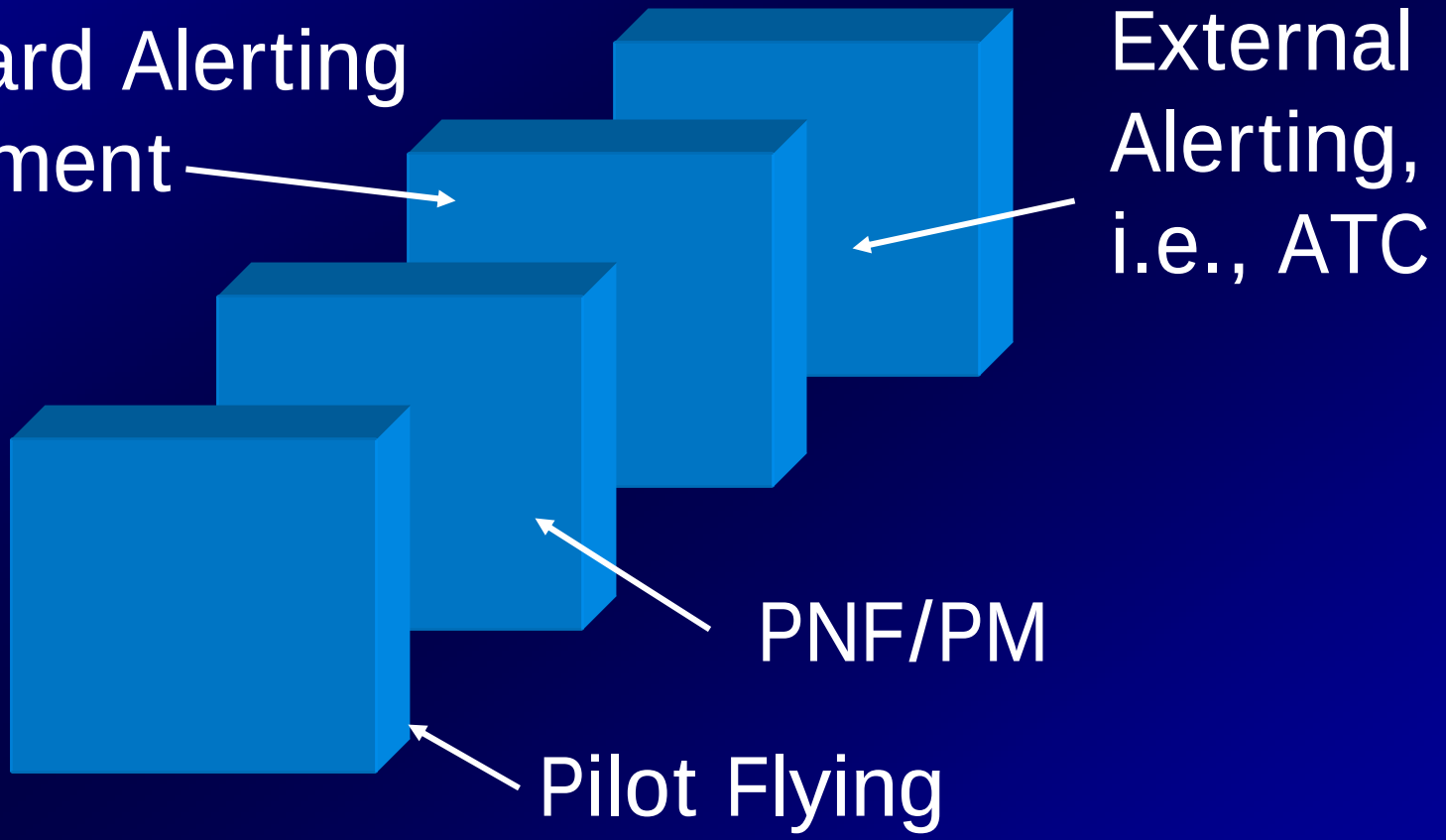
Avoiding Errors

- Good training
- High levels of proficiency
- Following SOPs
- Minimizing distractions
- Planning ahead
- Maintaining situational awareness
- CRM – the effective use of all available resources

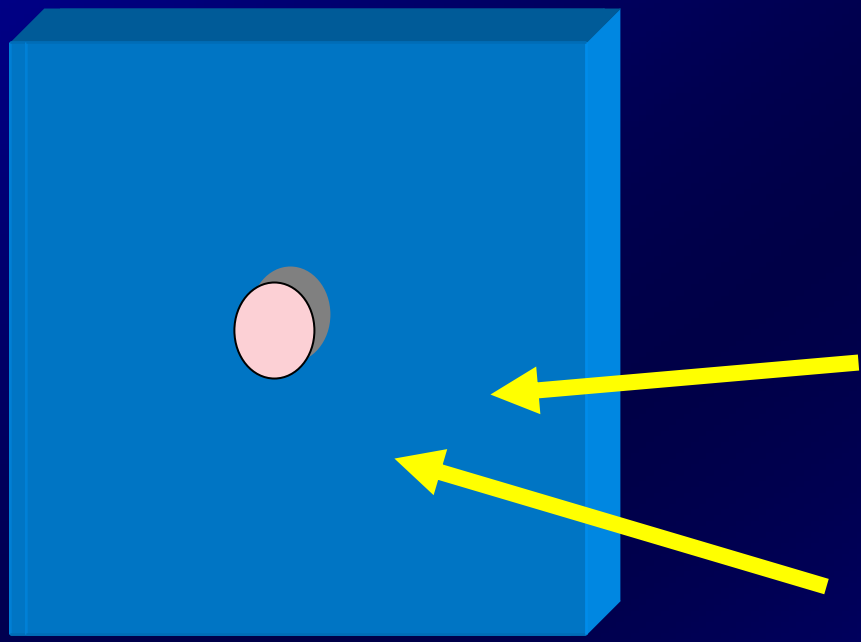
Trapping Errors

- Once an error is committed, it is difficult to catch (trap) your own error
- Other people are often more likely to catch your error
- Therefore, redundancy is one strong defense against error

Layers of Defense (barriers) to trap crew errors



Threats and errors put “holes” in our barriers



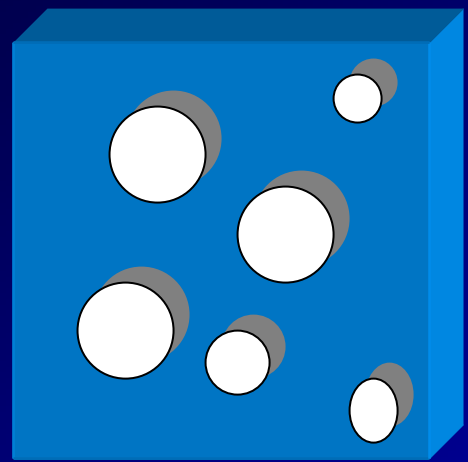
We can attempt to build barriers against error to trap errors

Even good barriers have weaknesses

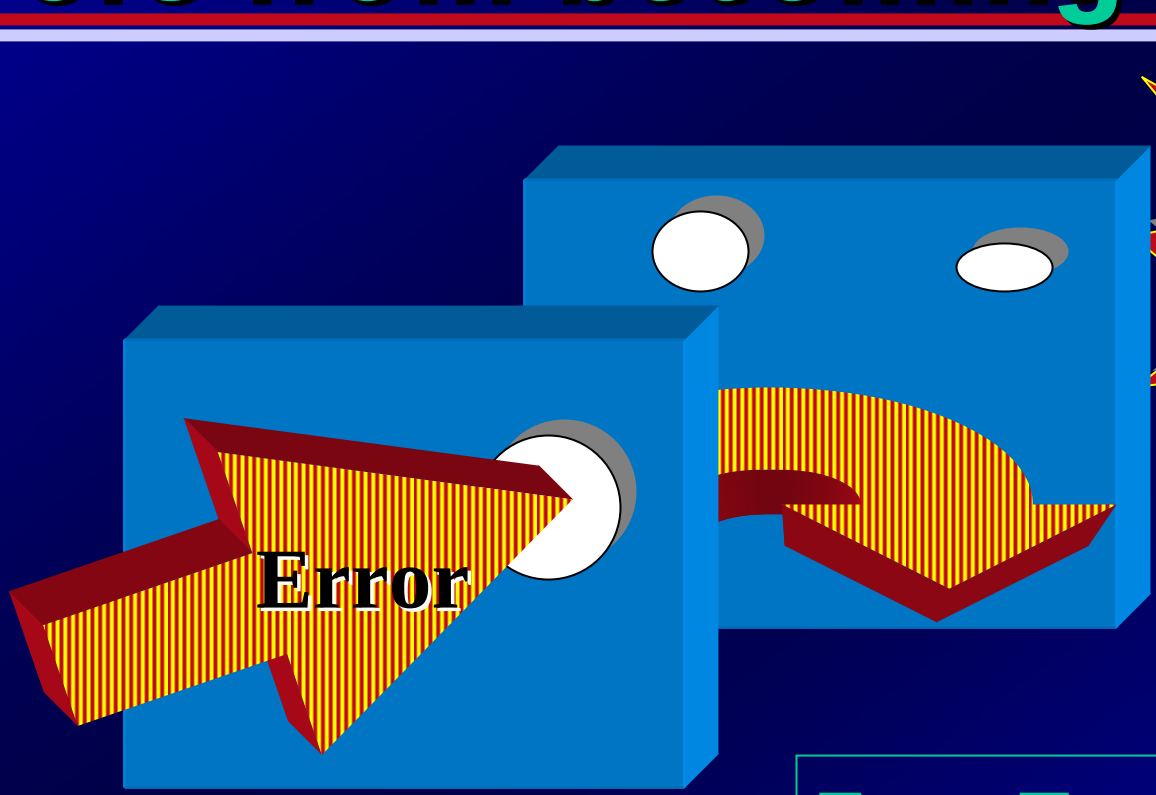
Threat and Error Management helps reduce the size of these holes

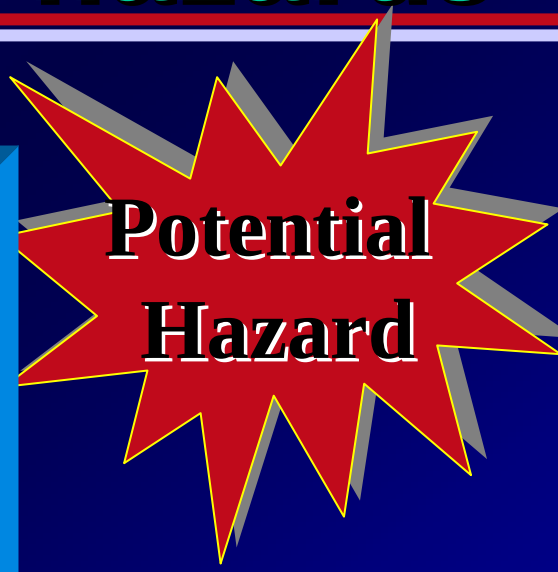
Examples of how “holes in defenses” can be formed

- Increasing workload
- Undue time pressure
- Fatigue
- Procedural non-compliance
- Poor crew coordination
- Interruptions / Distractions



Layers of defense help deflect errors from becoming hazards

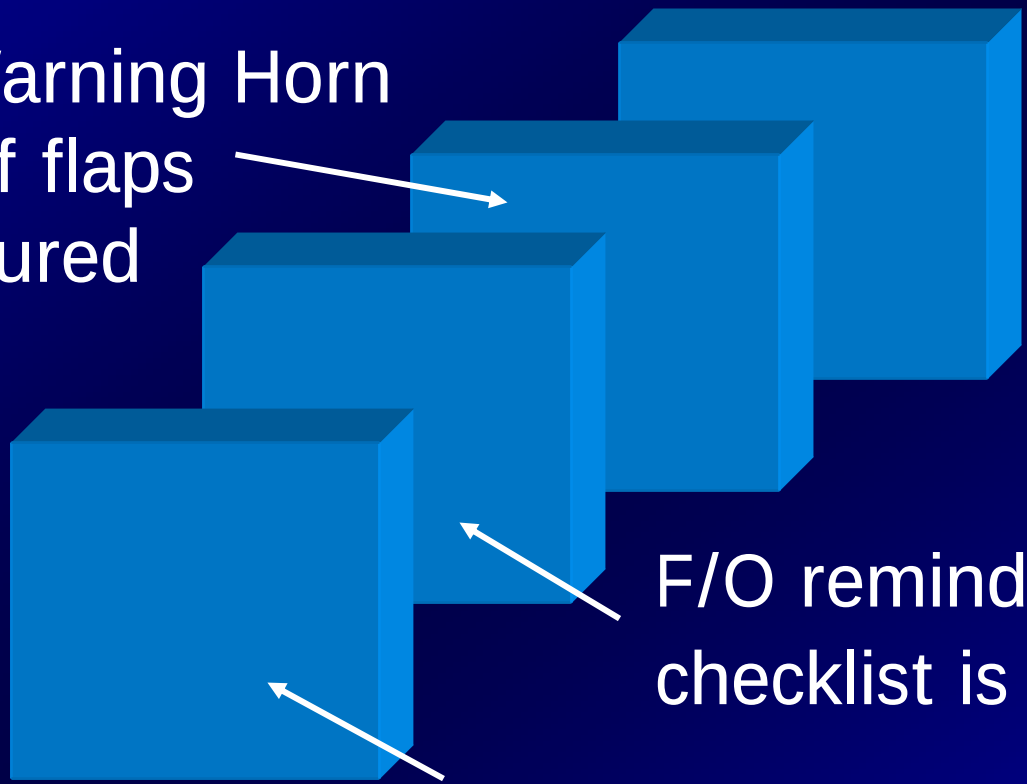




Error Trapped.
Hazard Averted

Designed system redundancies

Takeoff Warning Horn activates if flaps not configured



External Alerting - does not exist

F/O reminds Captain if checklist is not done

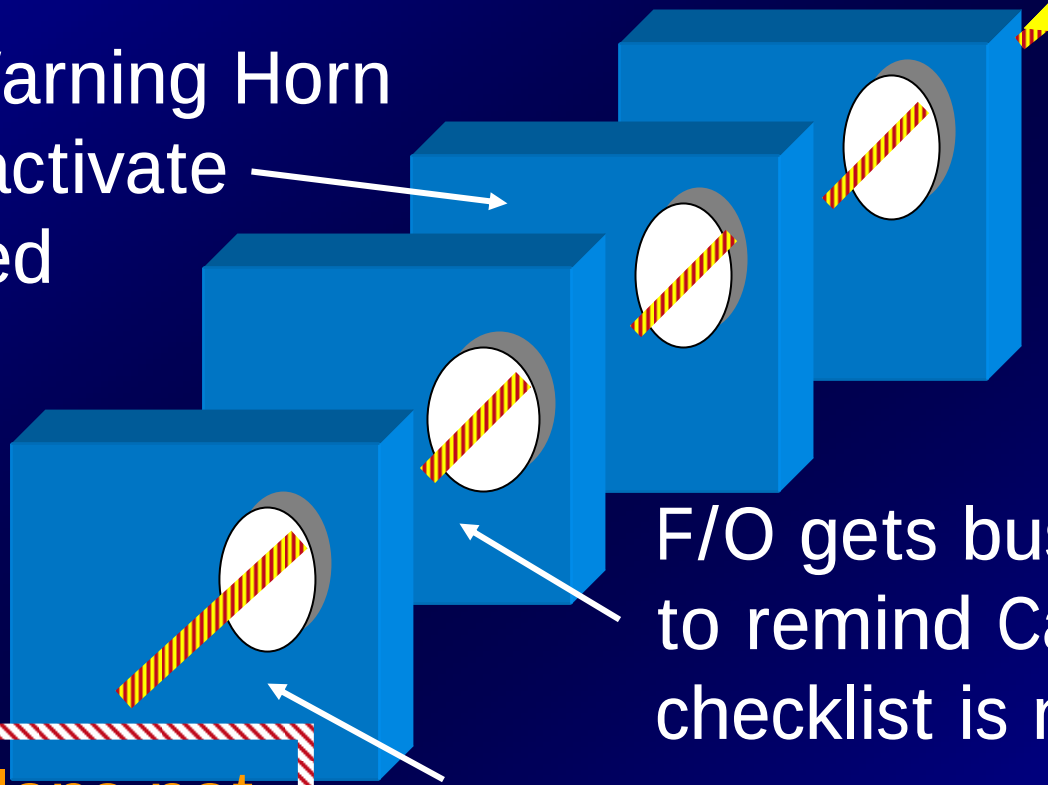
Captain calls for checklist

Holes in defenses

Accident

Takeoff Warning Horn does not activate as designed

External Alerting - does not exist

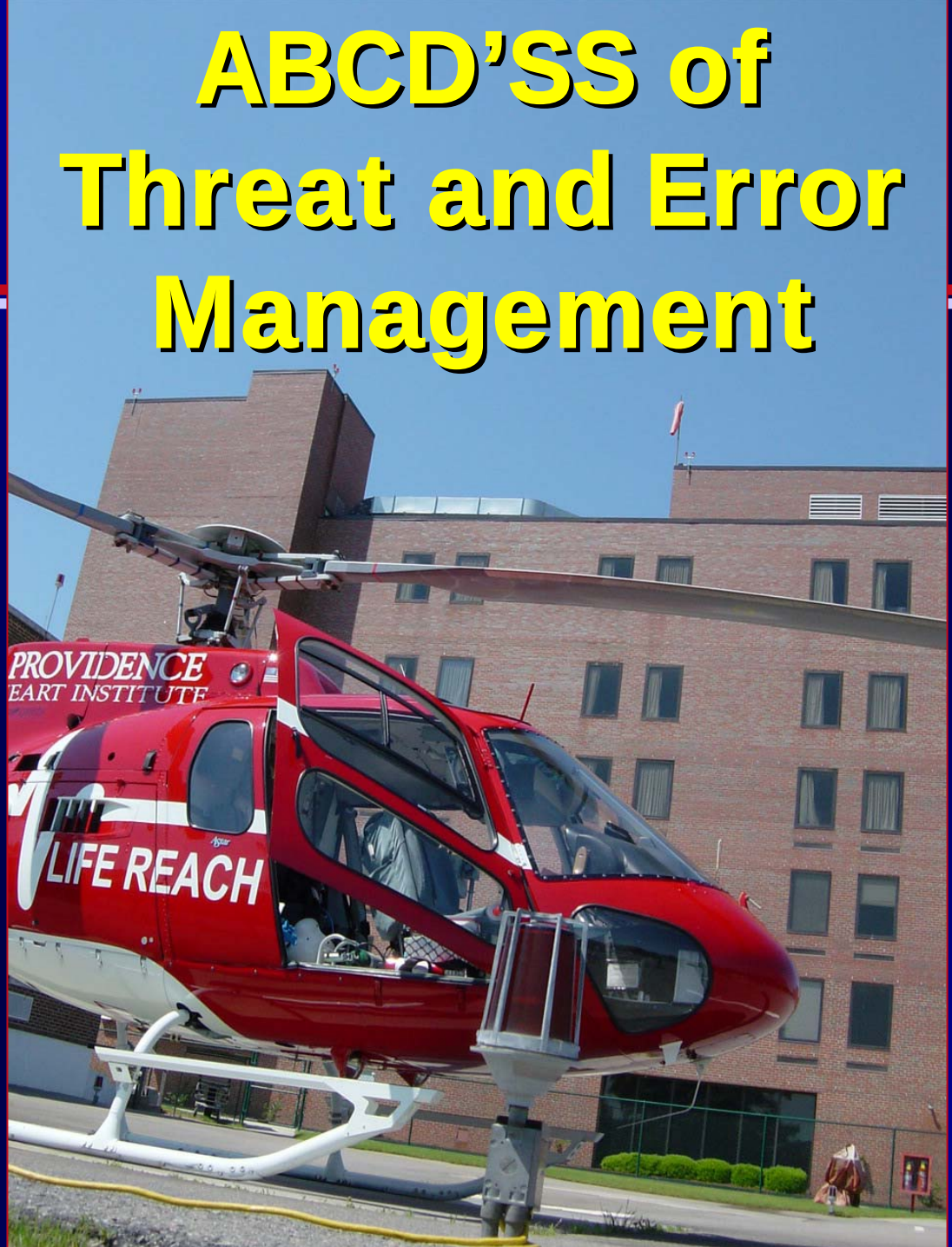


F/O gets busy and forgets to remind Captain that checklist is not done

Error – flaps not set from flow

Captain has developed personal style of allowing FO to initiate checklist

ABCD'SS of Threat and Error Management



Threat and Error Management ABCD'SS

Acknowledge that we are error prone

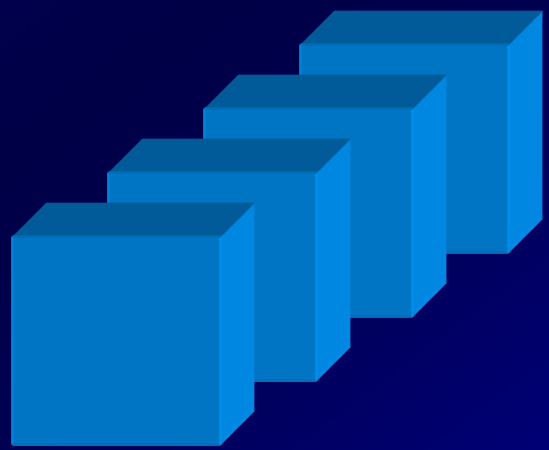
Threat and Error Management ABCD'SS

- This does not mean that errors are okay
  - Naturally we would prefer not to make them
  - However, the reality is that we will make mistakes, so acceptance and awareness are vital
- Acknowledge that threats can affect performance

Acknowledge errors

Threat and Error Management ABCD'SS

Maximize Barriers



Realize the importance of redundancies

- Keep as much redundancy in the operation, for as long as possible
- Plan best time for being “out of the loop” (split cockpit)
  - lowest workload
  - least risk
- Both pilots “cross-verify” critical checklist items (“killer items”) and ATC clearances
- Maintenance: RII – back up each other
  - Continental Express at Eagle Lake

Maximize **Barriers**

Flight Crew Example:

- Climbing out of 10,000 feet, with clearance to 12,000
  - Timing of "10,000 foot announcement"

Maximize **Barriers**

Planing and awareness are the keys

- We’re not saying don’t do these things - obviously you must do them
- The point is to PLAN them (when able) to conduct them during lowest workload, least risk periods
- We realize that not everything can be planned, so when one pilot is out of loop, be very aware of reduced redundancy

Maximize **Barriers**

Threat and Error Management ABCD'SS

Communicate

Threats and Intentions Effectively

Communicate

Anything that can:

- Reduce your ability to detect errors
- Anything that can increase your chance of making errors

Communicate

Communicate threats

- "Snakes in the grass"
  - What are the things that can bite you on this flight or operation?
  - Identify, discuss and think about these things (threats) and those that are different about this operation

Communicate

Effective communications

- Effective communication
  - Makes sure that everyone is “on the same page”
  - Raises crew’s situational awareness
  - Helps avoid and trap the consequences of errors

Communicate

Ways communications can be improved

- Research shows that the way a crew communicates can be a predictor of the way that the crew performs.
  - In short, crews who communicated better were those crews who made fewer errors

Communicate

Improving communications

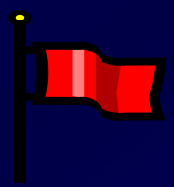
- Improved performance (i.e., fewer errors) was associated with crews who showed increased number of :
  - commands
  - inquiries
  - acknowledgements
  - verbal observations about flight status

- Foushee & Manos (1981)
- Foushe, Lauber, et al (1986)

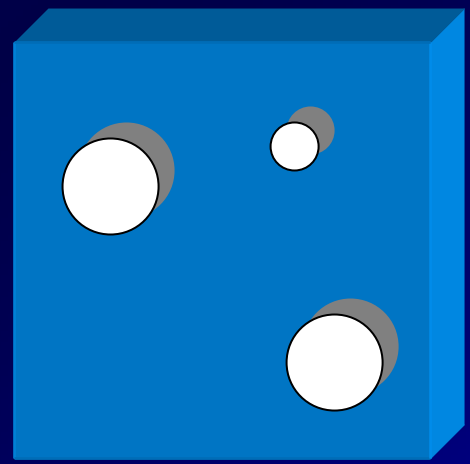
Communicate

Threat and Error Management ABCD'SS

Distractions and Interruptions



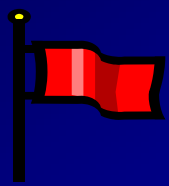
Distractions & Interruptions can form “holes in defenses”



Manage Distractions

Distractions & Interruptions are Red Flags

- Treat Distractions and Interruptions as Red Flags



Manage Distractions

Distractions & Interruptions

http://asrs.arc.nasa.gov/

NASA Ames is researching distractions and interruptions in air carrier operations

Manage Distractions

"Interruptions Always Distract"

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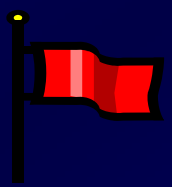
Identify – the interruption

Ask – what was I doing before being interrupted?

Decide – what action to take to get back on track



Manage Distractions

Threat and Error Management ABCD'SS

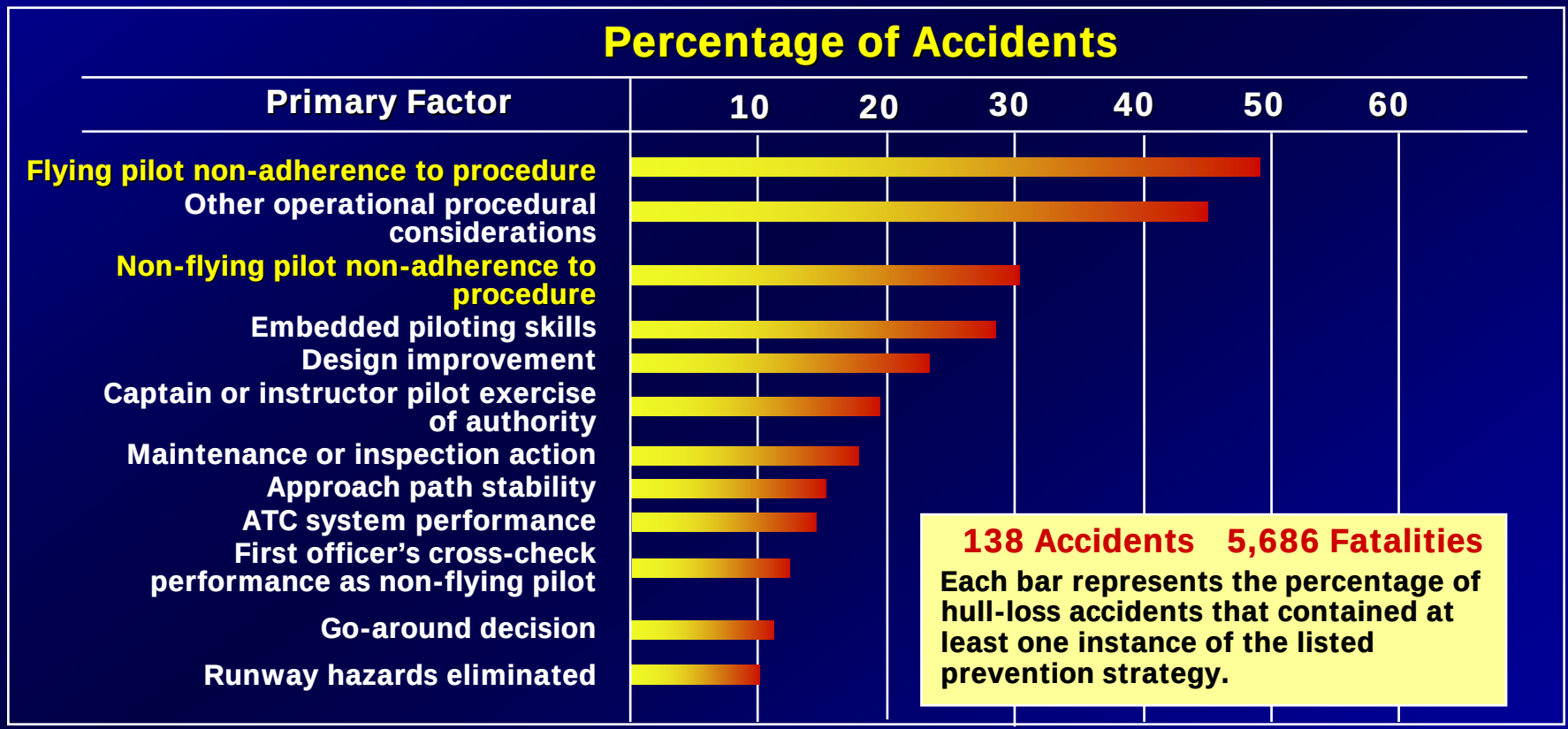
Follow SOPs

Standard Operating Procedures

Importance of SOPs

Source: Boeing

Accident Cause Factors (1982-1991)



Follow **SOPs**

How SOPs relate to error

- University of Texas LOSA data show that crews who intentionally erred by not following SOPs were 3 times more likely to commit another error with consequential results

- “Normalization of Deviance”

Follow **SOPs**

Standard Operating Procedures

- SOPs establish a consistent baseline for performance
- Because the baseline is established, deviations from it can be identified easier
  - "Hmm, I don't usually miss things like that."
- Allows crewmembers to concentrate on issues not covered by SOPs

Follow **SOPs**

Threat and Error Management ABCD'SS

Sensible?

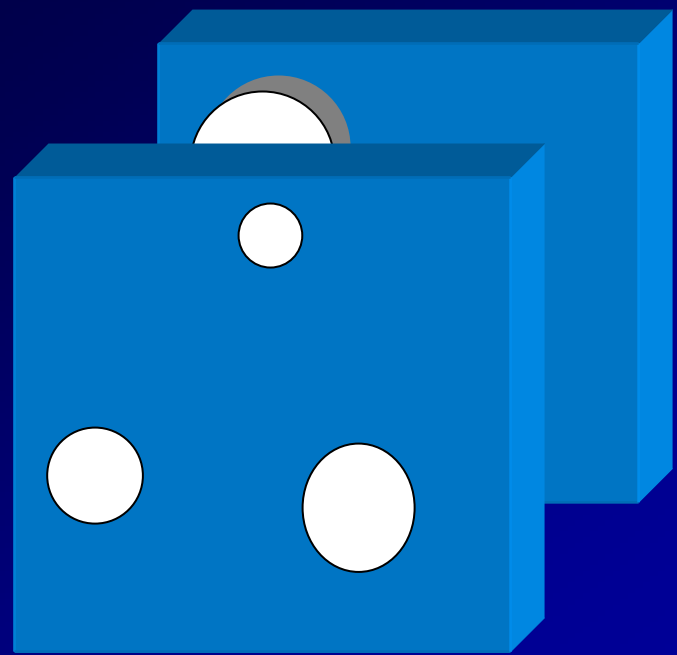
Sensible?

- Ask yourself and make sure that what you are doing (and are about to do) is sensible

Sensible?

Threat and Error Management ABCD'SS

- **A** Acknowledge
- **B** Barriers
- **C** Communicate
- **D** Distractions
- **S** SOPs
- **S** Sensible



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