Flight Test Safety Workshop

"Threat & Error Management" for Flight Test

Captain Don Gunther
Senior Director
Safety & Regulatory Compliance

History of Crew Resource Management (CRM)

- NASA workshop 1979
  - Cockpit Resource Management
  - Reduce “pilot error” through better use of resources
- Phase 1 - CLR/CCC - 1981
  - Derived from corporate management
  - Focus on management skills
  - Goal - fix the “Wrong Stuff” captains
- Phase 2 & 3 1986 - 1996
  - Change the name to Crew Resource Management
  - Focus on concepts
    - Decision Making
    - Teamwork and Leadership

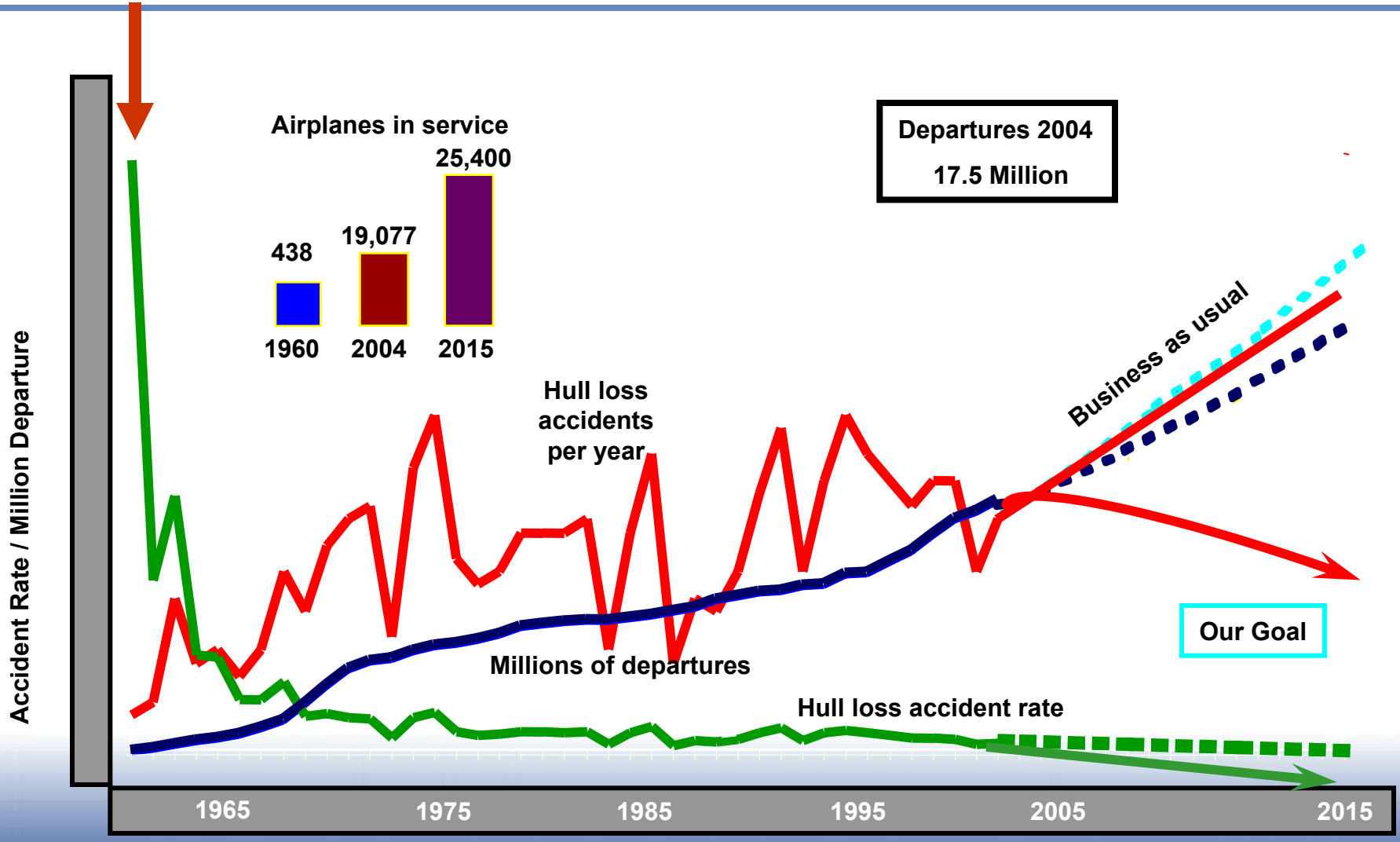
History of Crew Resource Management (CRM)

- Phase 4 - Error Management - 1997
  - Returned to original concept Error avoidance strategy
  - Focus on managing human error
  - Changed from PNF to PM
- Phase 5 - Threat and Error Management - 2001
  - Identify threats that can lead to errors
  - Develop strategies to manage threats and reduce errors

Why are we still doing TEM/CRM training?

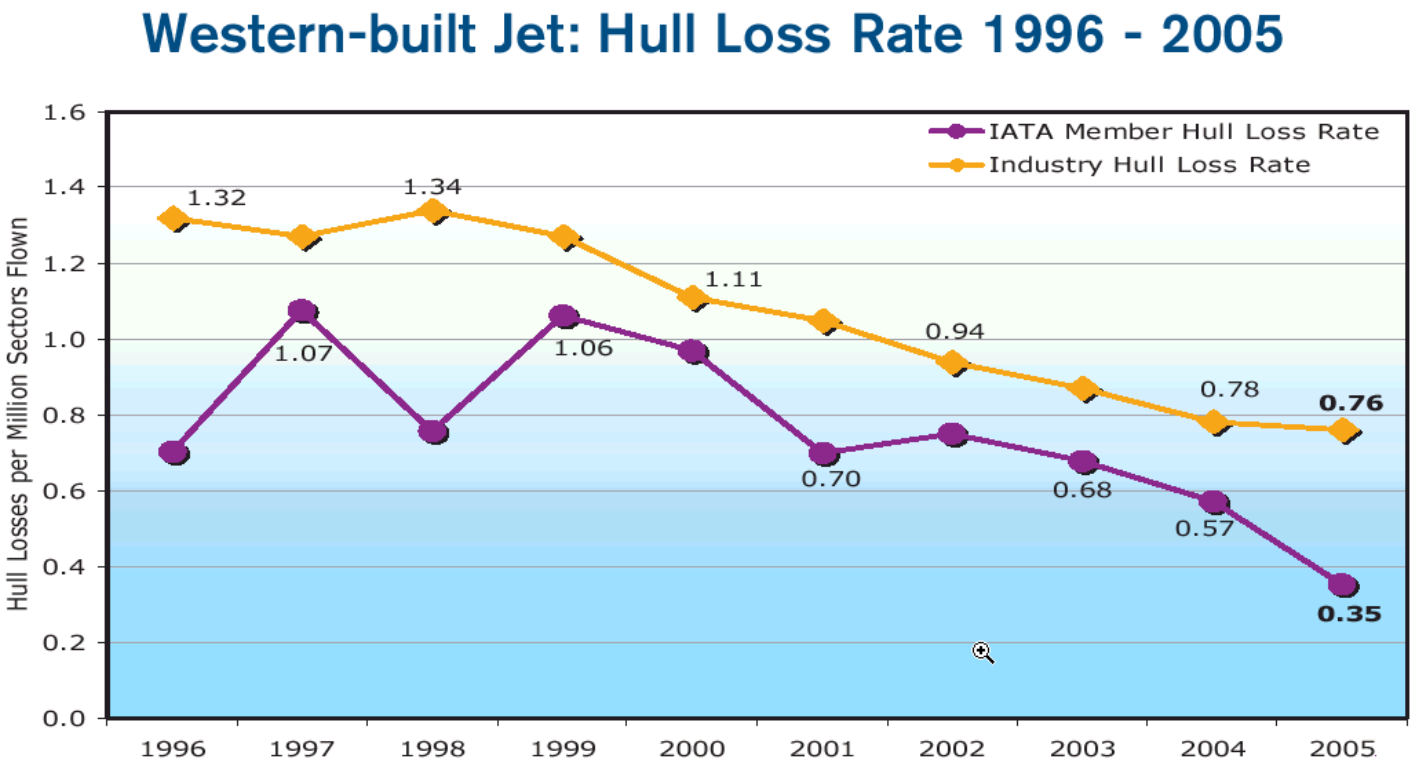
We Need to Continuously Improve Aviation Safety

1965 - 2004



Boeing 2004 Statistical Data – May 2005

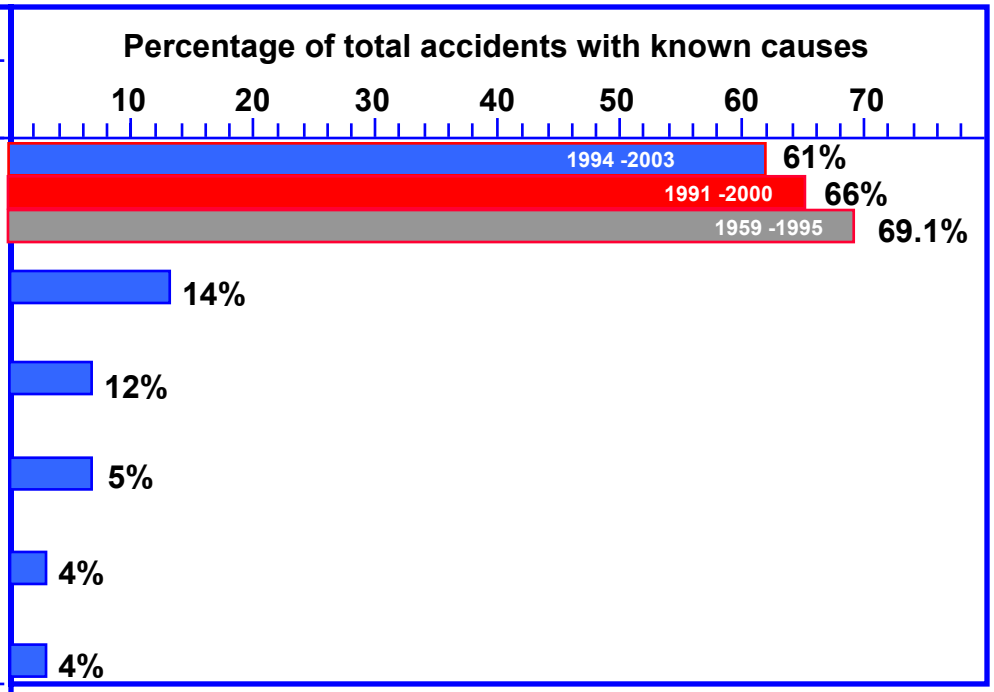
Accident Rate



Accidents by Primary Cause

1994 - 2003

Primary Factor	*Number of accidents* Total
Flight crew	84
Airplane	19
Weather	16
Miscellaneous/other	7
Maintenance	5
Airport/ATC	5
Total with known causes	136
Unknown or awaiting reports	50
Total	186



Excludes:
- Sabotage
- Military action

Boeing 2003 Statistical Data – May 2004

TEM Workshop Agenda

- Developing a TEM Program
  - Line Observation Safety Audit (LOSA)
- TEM Program
  - Case Studies
  - Decision-making & Leadership
- Automation Policy

Developing a TEM Program

Error

“If I commit an error I do it without bad intention.”

Stand Watie – Brigadier General Civil War

Safety Culture

Aviation Week Article on Healthy Organizations

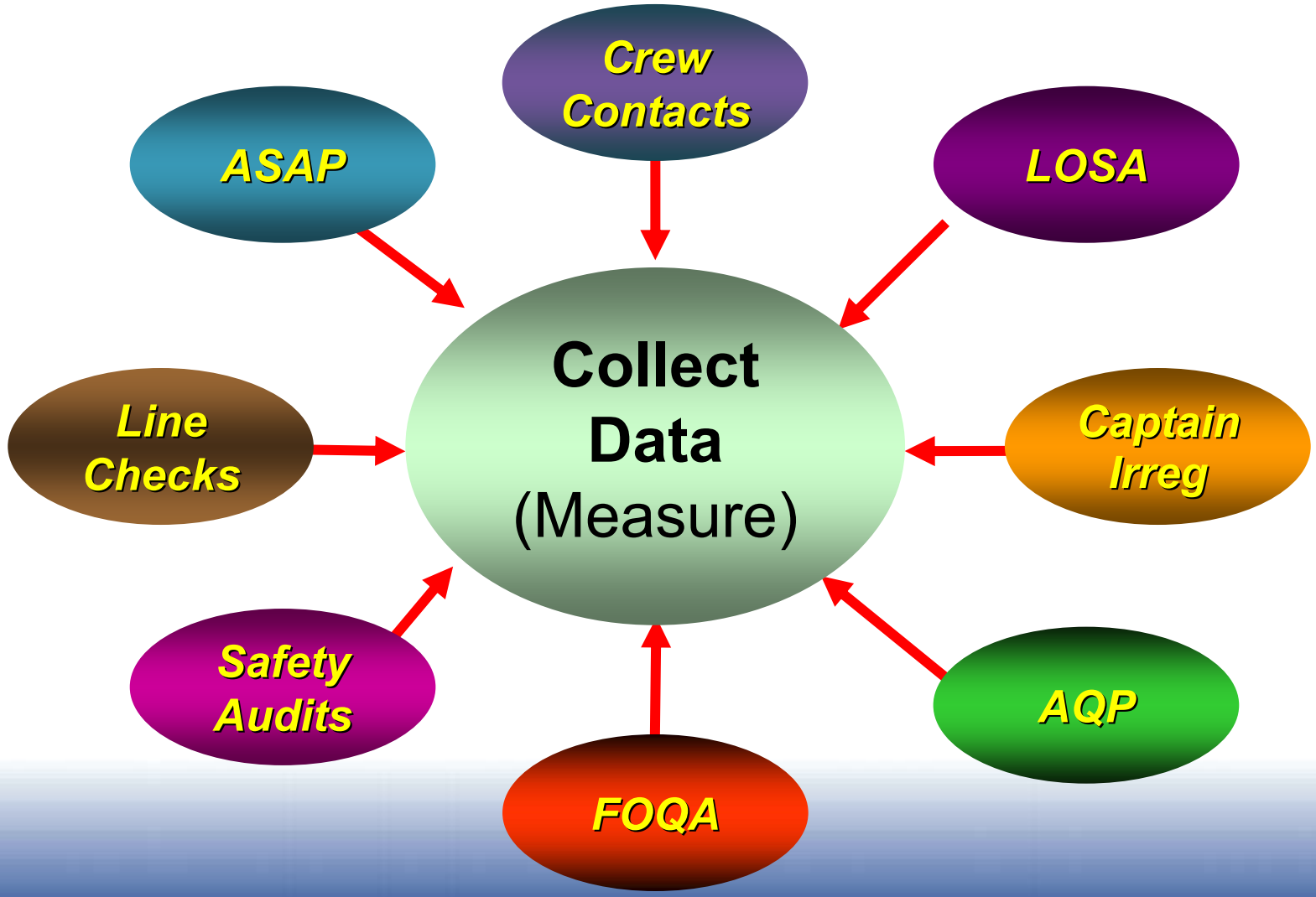
"Investing the time and money needed to get at the root cause of a problem takes total commitment at the most senior levels of a company or organization. In most organizational settings, communicators learn early in life how bad news can impact their leaders. If the news is valued and the communicator is protected, there is a real chance information can and will routinely flow upward in time for proper action to be taken."

The Safety Change Program
"Tailored to Continental"

- To properly target change we need current operational data, specifically for Continental, which is unique due to its…
  - History & Culture
  - Areas of operation (CMI, polar routes, etc.)
  - Training Programs
  - Philosophy

The Safety Change Program

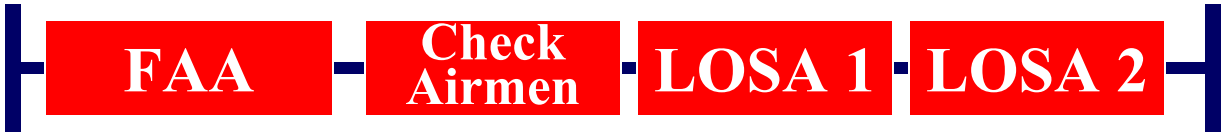
"Tailored to Continental"



By not having data to discover the precursors "specific" to your operations, this is the bottom-line…

LOSA Information for TEM

“Normal” Performance



Perfect **Normal**

- **Distance between “Perfect” and “Normal” performance varies as a function of culture, training, etc.**
- **LOSA enables us to get as close to normal performance than was previously possible.**

The Continental LOSA Process

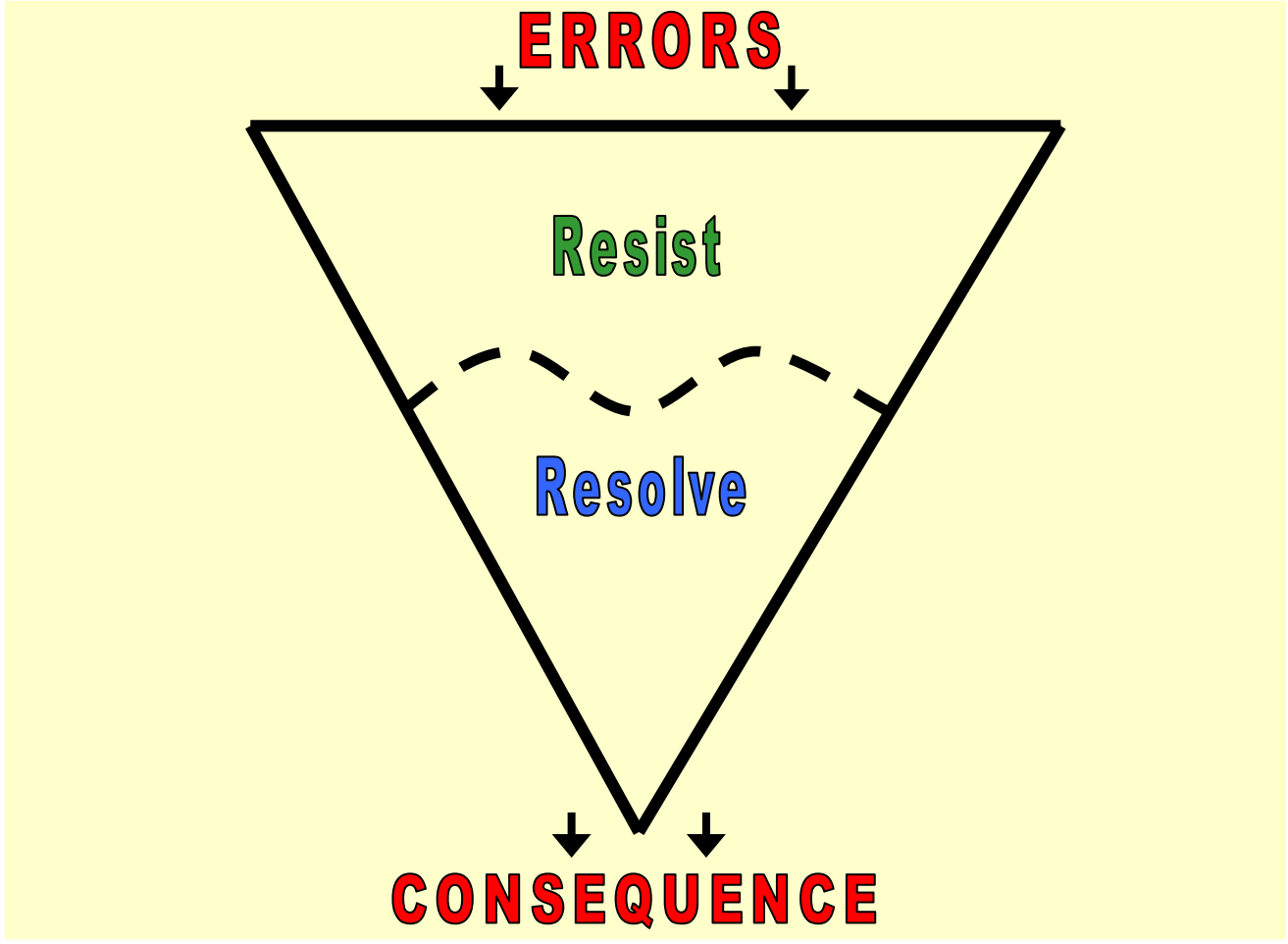
- 1st year
  - LOSA and data analysis followed by course development
- 2nd & 3rd years
  - Training course for all crewmembers, Check Airmen training and imbedding of TEM into courseware, policy & procedures, etc.
- 4th year
  - Preparation for next LOSA and targeting areas to be measured and new areas to be emphasized.

Line Observation Safety Audit
LOSA 1996

Error Management's early focus was:

Managing *crew error*

Error Management



Line Observation Safety Audit
LOSA 2000

LOSA 1996 vs. 2000

- A 70% reduction in Checklist errors
- A 60% reduction in unstable approaches (confirmed by FOQA data)
- Overall improvement in crew performance
- Still a need for improvement in Leadership skills

Threat and Error Management

Threat and Error Management

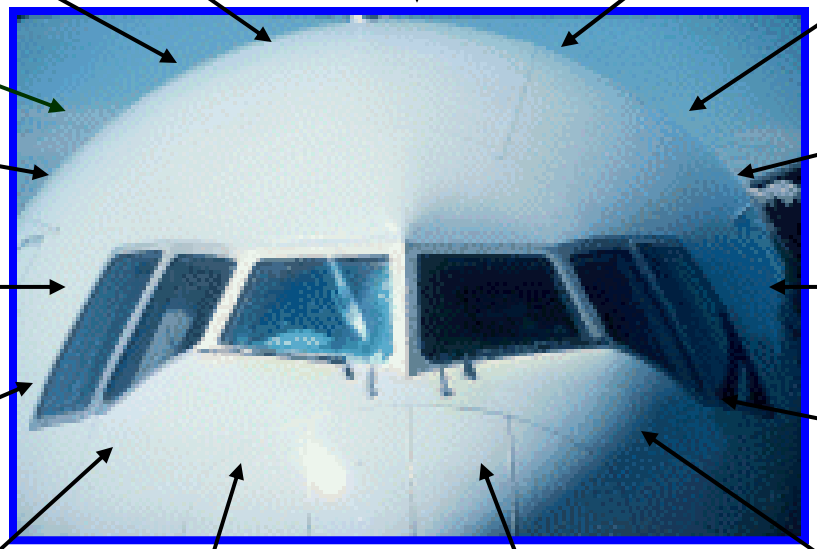
Threat

- Event that occurs outside the influence of the flight crew, but which requires crew attention and management if safety margins are to be maintained

- Increases the complexity of the operation

THREATS

Influences that can lead to crew error



Threat and Error Management

Threat Management

Strategies/Countermeasures

(Industry, Corporate and/or Personal)

- To reduce the number of errors
- To improve the error management process by increasing the awareness of potential errors
- Is managing your future

Threat and Error Management

Error

- Actions or inactions by the flight crew that lead to deviations from intention or expectation

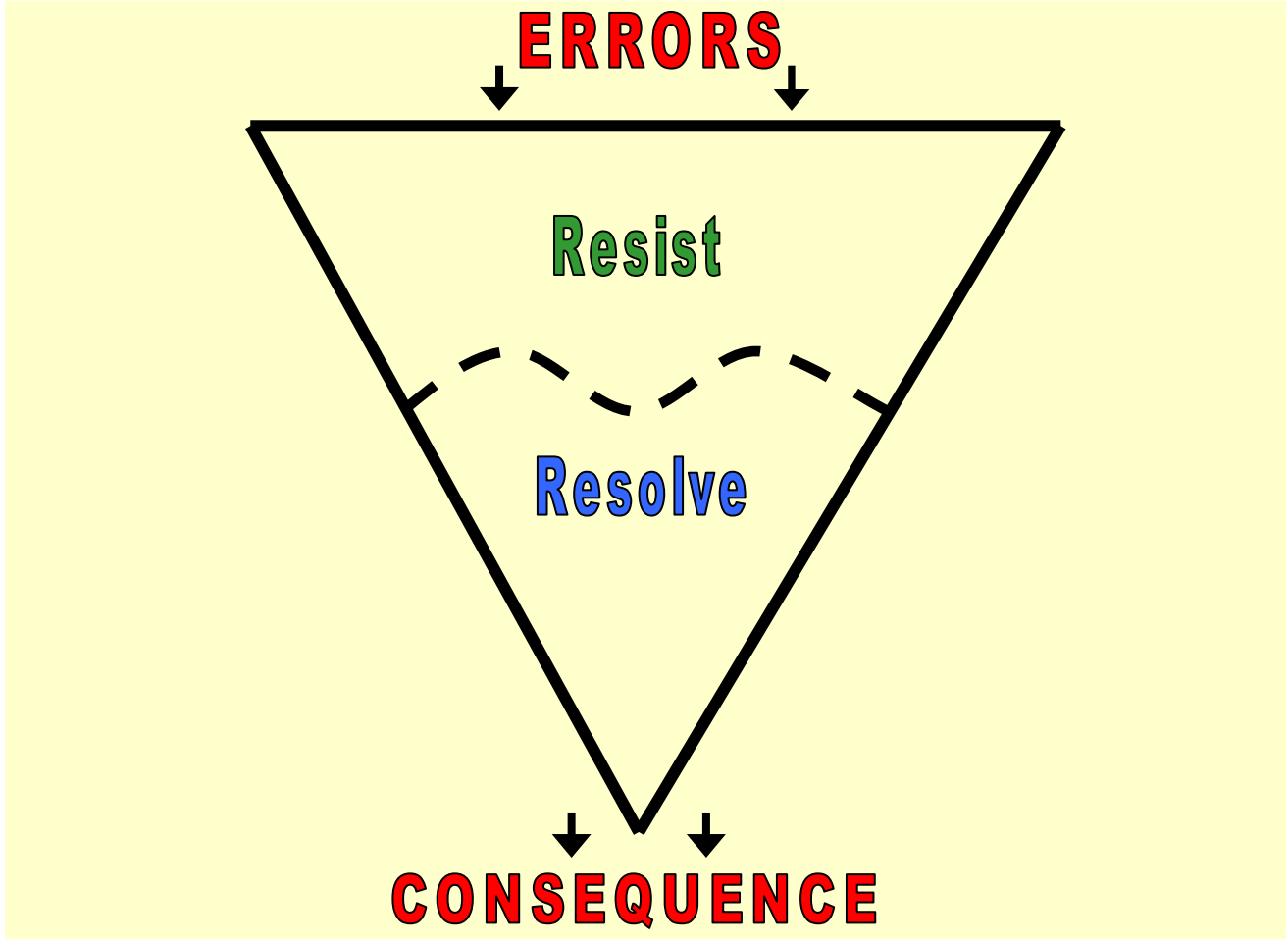
- Intentional non-compliance is not an error

Error Management

Actions taken to deal with errors committed by either

- Detecting and correcting them, or by
- Containing and reducing the severity
- Is managing your past

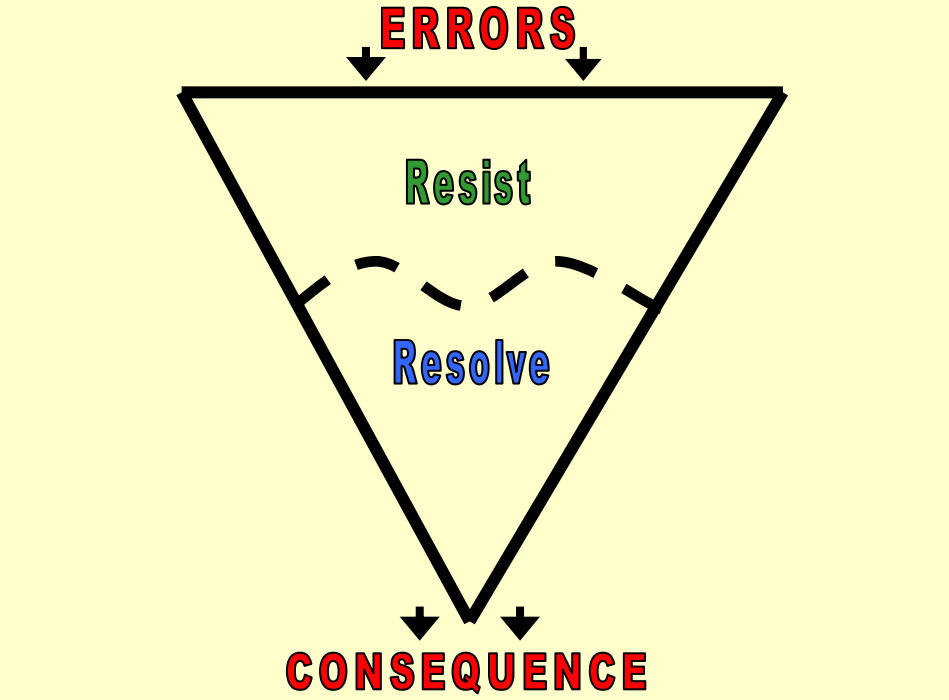
Error Management



Error Management

RESIST

HARDWARE & SOFTWARE THAT EXISTS BEFORE THE HUMAN ENTERS



RESISTANCE

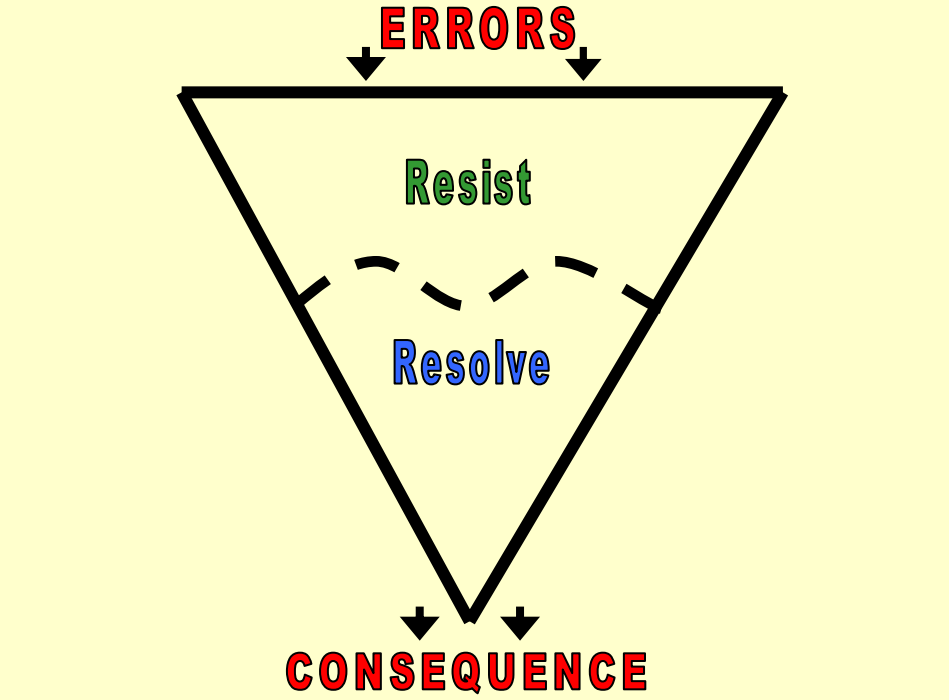
HARDWARE & SOFTWARE THAT EXISTS BEFORE THE HUMAN ENTERS

- GPWS
- TCAS
- TRAINING
- MANUALS
- SOP's
- CHECKLISTS
- AUTOMATION
- ATC

Error Management

RESIST

HARDWARE & SOFTWARE THAT EXISTS BEFORE THE HUMAN ENTERS



RESOLVE

WHAT THE HUMAN BRINGS TO THE SYSTEM

RESOLVE

WHAT THE HUMAN BRINGS TO THE SYSTEM

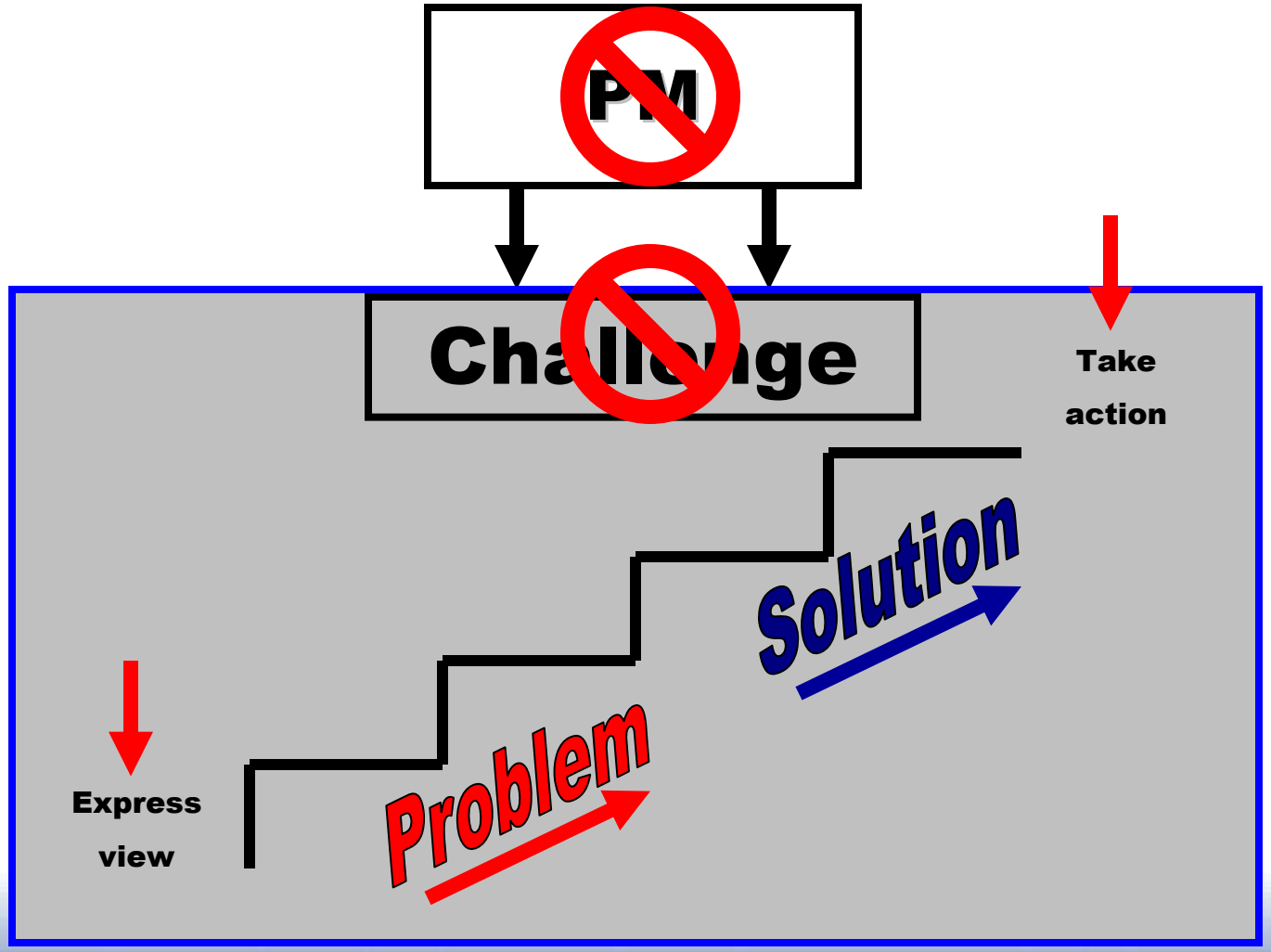
- PROFICIENCY
- VIGILANCE
- ASSERTIVENESS
- MONITORING & CROSSCHECKING
- DECISION MAKING
- EXPERIENCE
- LEADERSHIP
- SIT. ASSESSMENT
- CHECKLIST DISCIPLINE

NASA Guidelines

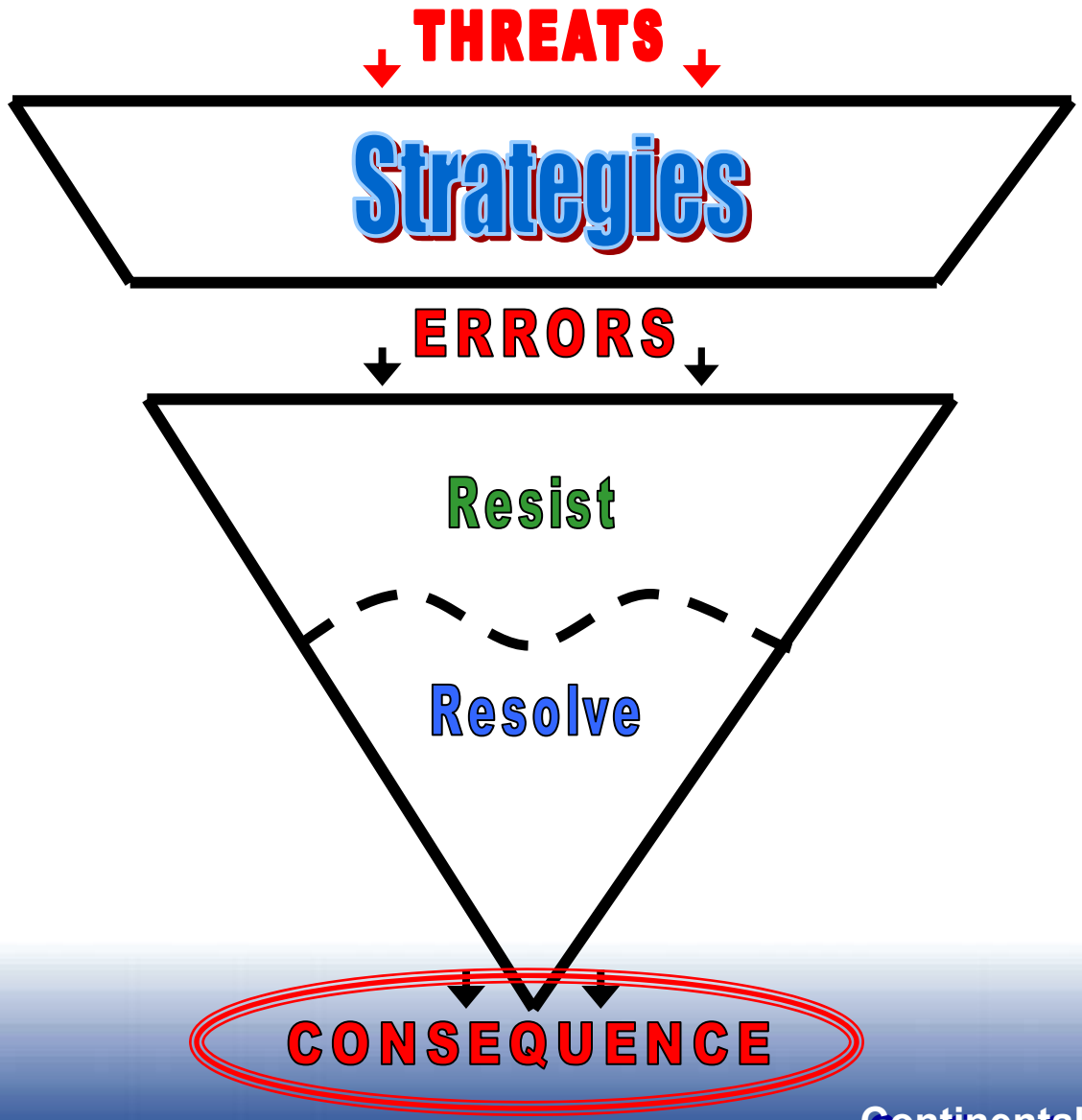
Monitoring & Crosschecking

- Positively delegate flying and monitoring duties
- Monitoring is as important as flying
- Flying pilot does not become involved with secondary tasks
- When conflict arises-resolve with outside source
- When in doubt-must express!

Monitoring & Crosschecking



Threat and Error Management



Consequences

Undesired Aircraft State (UAS)

Threat and Error Management

Case Studies

"Look in the mirror first"

Threat and Error Management

Case Study

NTSB “37 Accidents”
US 121 Airlines 1978-1990

- Captain was Flying Pilot-------- **81%**
- First Day of Trip ---------- **73%**
- First Flight---------- **44%**
- F/O Time in Position/Aircraft
  - Average **419** hours/seat
  - **50%** First Year
- Time Since Awake (TSA)
  - Captain **12** plus hours
  - FO **11** plus hours

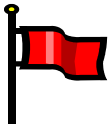
NTSB STUDY

Late or behind schedule 55%

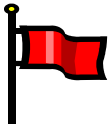
Time of Day	Operations	Accidents
0600 - 1400	44%	27%
1400 - 2200	43%	43%
2200 - 0600	13%	30%

ADDITIONAL “RED FLAGS”

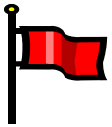
Night



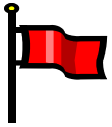
Weather



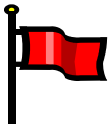
Late runway change



Unfamiliar Airport

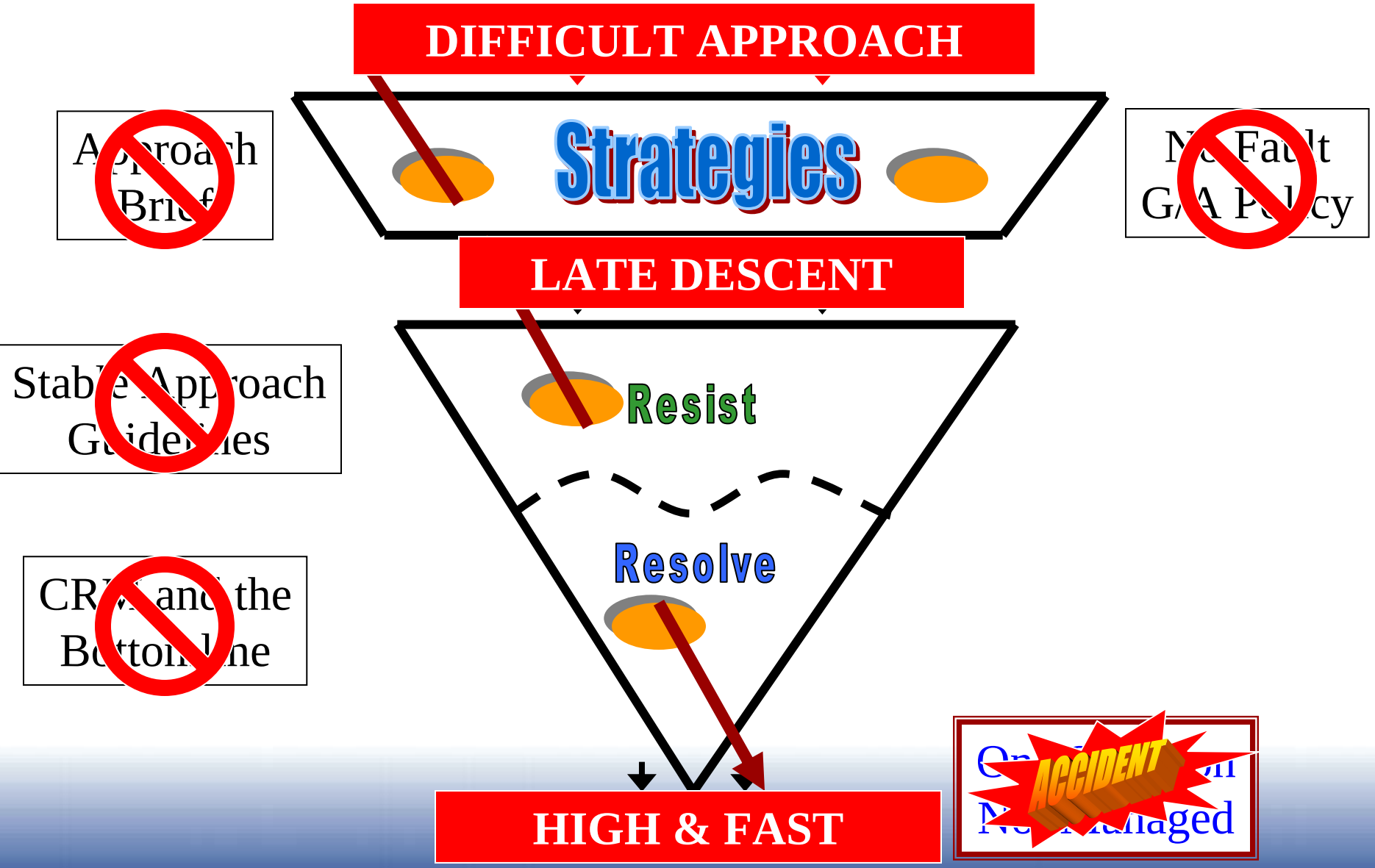


Operational Pressure



Reason's Swiss Cheese Model

THREAT AND ERROR MANAGEMENT



Threat and Error Management

TEM
"the challenge"

How to improve

"Threat & Error" identification

"Get it on the RADAR"

Distraction

Flight Test Case Study

Threat and Error Management

DECISION-MAKING

"Plan, Review, Monitor & Modify"

Decision Making

Tactical

Perceive Situation

Situation Assessment

Select a Course of Action

Monitor Results

Situation Assessment

The Nature of the Threats

Proper Threat Identification to Enhance Situational Awareness

Leadership

What have you seen?

Threat and Error Management

"Training"

TEM & Automation

To ERR is Human

To REALLY screw up you need a computer!

The Continental Airlines Automation Policy

Verbalize
Verify
Monitor

TEM

"the challenge"

Improve "Threat & Error" identification by using

Verbalize, Verify, Monitor

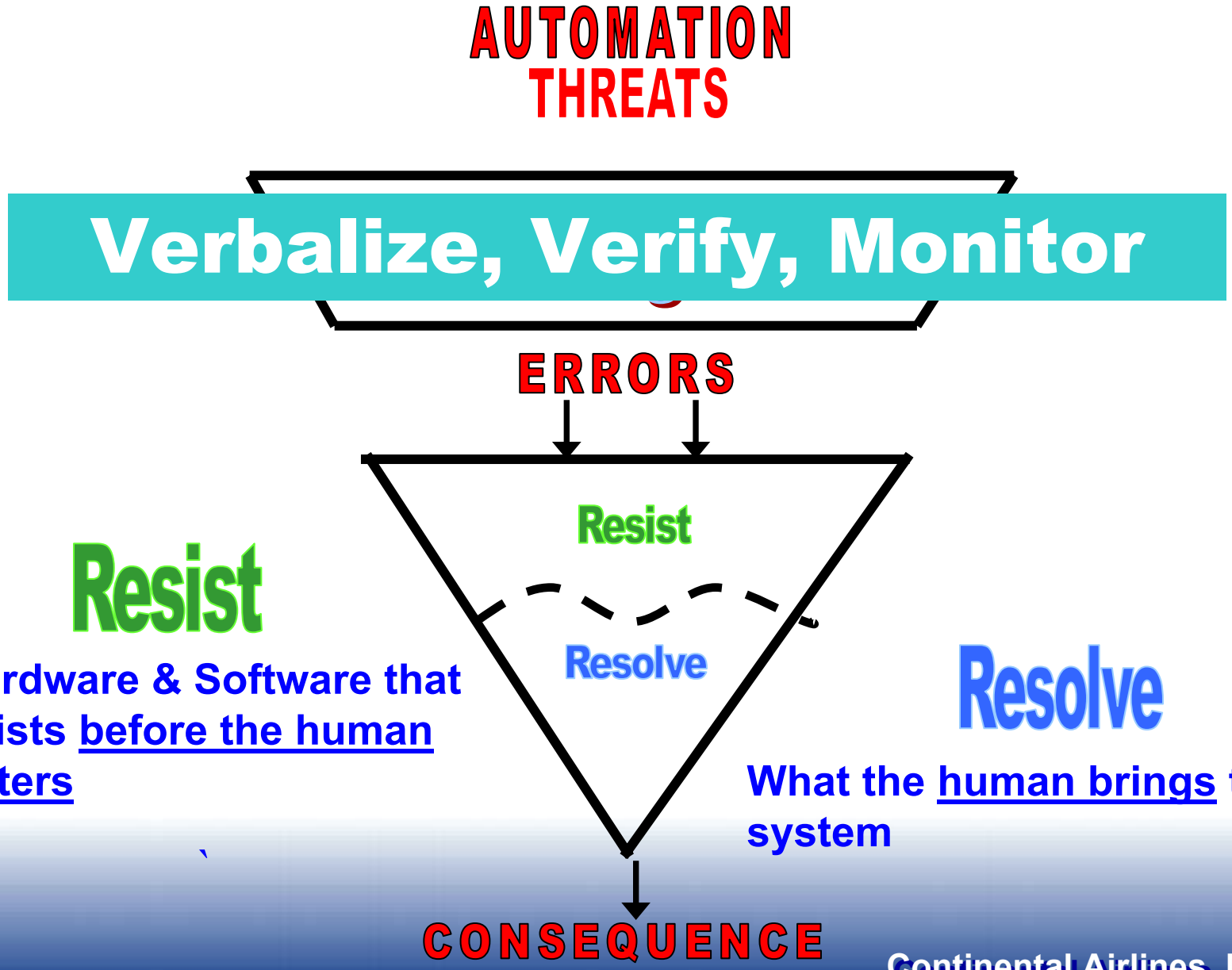
To help "Get it on the RADAR"

Industry FOQA/ASAP Information Sharing

- Several airports were identified that due to ATC, environment, etc. put crews in a high-energy or potential unstabilized approach situation.
- MCO selected as the “pilot” project to establish process for FMS visual approaches.
- Industry and MCO TRACON worked together and established an FMS visual procedure.
  - Steve Ruckman – MCO TRACON
  - Jim Carmen – Delta Airlines
  - John Anderson – Continental Airlines
- HNL, ABQ, EWR are being developed.

Managing Automation

Threat and Error Management



Resist

Hardware & Software that exists before the human enters

Resolve

What the human brings to the system

Threat and Error Management

TEM Applied to Incident & Accident Analysis

TEM Toolkit
for
Incident & Accident (IA)
Analysis

IATA Safety Advisory Committee

Incident & Accident analysis

Human Factors Working Group

THREAT AND ERROR MANAGEMENT (TEM):
ANALYTICAL TOOLKIT

Introduction

The TEM Analytical toolkit has been developed for Safety Managers to facilitate presenting and sharing events and lessons learned. The toolkit is comprised of this document, explaining the TEM concept, and the presentation template. For more information on Threats and Errors and LOSA, refer to ICAO's LOSA Manual, Doc 9803.

Background

Threat and Error Management (TEM) is proposed as a useful tool to analyse incidents and occurrences. Using this model naturally leads to prevention strategies, remedial actions and countermeasures. The model helps to reinforce positive strategies and highlights areas and issues that need to be addressed. It also helps to keep the focus on the relevant lessons learned from the event, moving away from the who and what and towards understanding the WHY.

Definitions

Threats: are situations external to the flight deck, that must be managed by the cockpit crew during normal, everyday flights. Such events increase the operational complexity of flight and pose a safety risk to the flight at some level. (See attached list of examples of Threats)

Errors: are actions or inactions by the crew that lead to deviations from organisational or flight crew intentions or expectations. Errors in the operational context tend to reduce the margin of safety and increase the probability of accidents or incidents. (See attached list of examples of Errors)

Undesired Aircraft State: occurs when the flight crew places the aircraft in a situation of unnecessary risk. An undesired aircraft state may occur in response to a crew action or inaction (error).

Managed vs Mismanaged:

- Managed: an active crew response in which a threat, error, or undesired aircraft state is detected and mitigated to an inconsequential outcome.
- Mismanaged: a crew response in which a threat, error or undesired aircraft state is detected but the crew action or inaction allows it to induce and error, additional error, undesired aircraft state, incident or accident; OR; a lack of crew response to a threat, error or undesired aircraft state because it was either ignored or undetected.

Clarification between Threats, Errors and Outcomes:
Errors originated by non-cockpit personnel are considered threats. The following example is used to illustrate the difference between threats, errors and outcomes.

Aircraft B is taxiing to the stand and told to hold short of the active runway. The hold-short lines are poorly painted and very faint. Aircraft B passes over the hold short lines. A runway incursion incident results.

In this scenario:

- The threat is the poorly painted hold-short lines;
- The error is committed by the flight crew of Aircraft B when they taxi onto the active runway;
- The outcome is a runway incursion.

Prevention Strategies

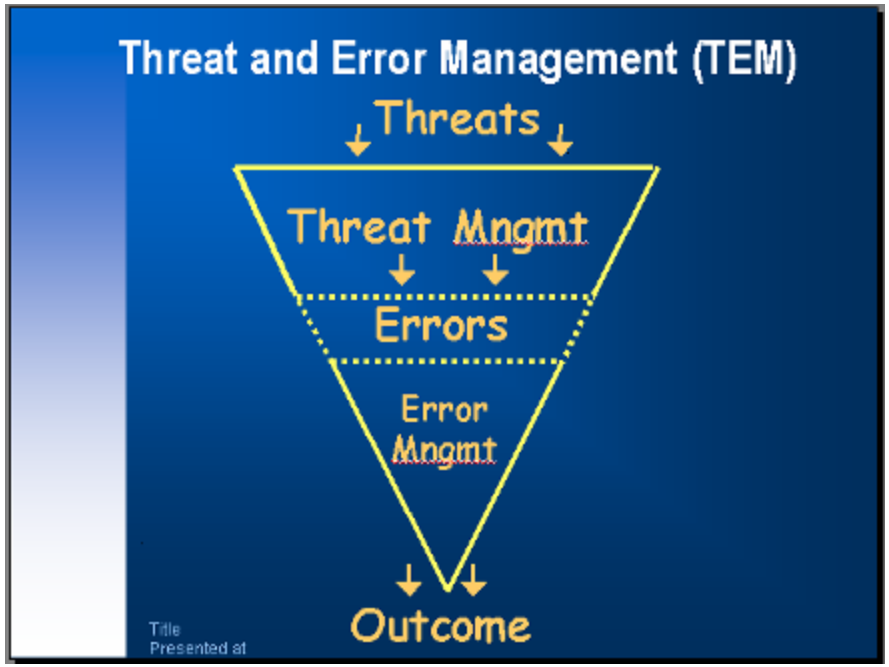
Identifying threats and errors and examining how and if the crew anticipate, recognise and manage the threats and errors, logically reveals prevention strategies, remedial actions and countermeasures. This approach enables safety managers to go beyond the traditional approach of identifying "what went wrong" and fixing it, to a more proactive approach of also determining "what went right" and encouraging that countermeasure.

Examples of Threats and Errors

Threats:

▪ Weather	▪ Missed Approaches	▪ Heavy Traffic
▪ Distractions	▪ Flight Diversions	▪ Similar call signs

TEM Analytical Tool - Updated December 2003



Continental Airlines, May 2006

IATA Safety Advisory Committee

Incident & Accident analysis

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Threat and Error Management (TEM)

Threats

1. List of the Threats
2.
3.
4.
5.
6.
7.
8.

Threat Management

1. Identify the Threat

2.

3.

4.

1. Was the threat managed or mismanaged? How?

2.

3.

4.

Errors

1. List of the Errors
2.
3.
4.
5.
6.
7.
8.

Error Management

1. Identify the Error

2.

3.

4.

1. Was the error managed or mismanaged? How?

2.

3.

4.

Undesired State Management

- List how the Undesired State was managed or mismanaged.

Prevention Strategies

- List initial corrective actions at the present time and any proposed actions.

TEM as an Integral part of a Safety Management System (SMS)

Goal

- Become a better Threat Manager – actively identify threats in your operation
- “Threat Management is managing your future.”
- “Error Management is managing your past”
- Continue building a Safety Culture by encouraging open, honest communications

Threat and Error Management