ICAO/ASPA Regional Seminar
TEM, LOSA & NOSS – Essential SMS Tools
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LOSA Data Analysis: From Diagnostic Counts to Targets for Enhancement

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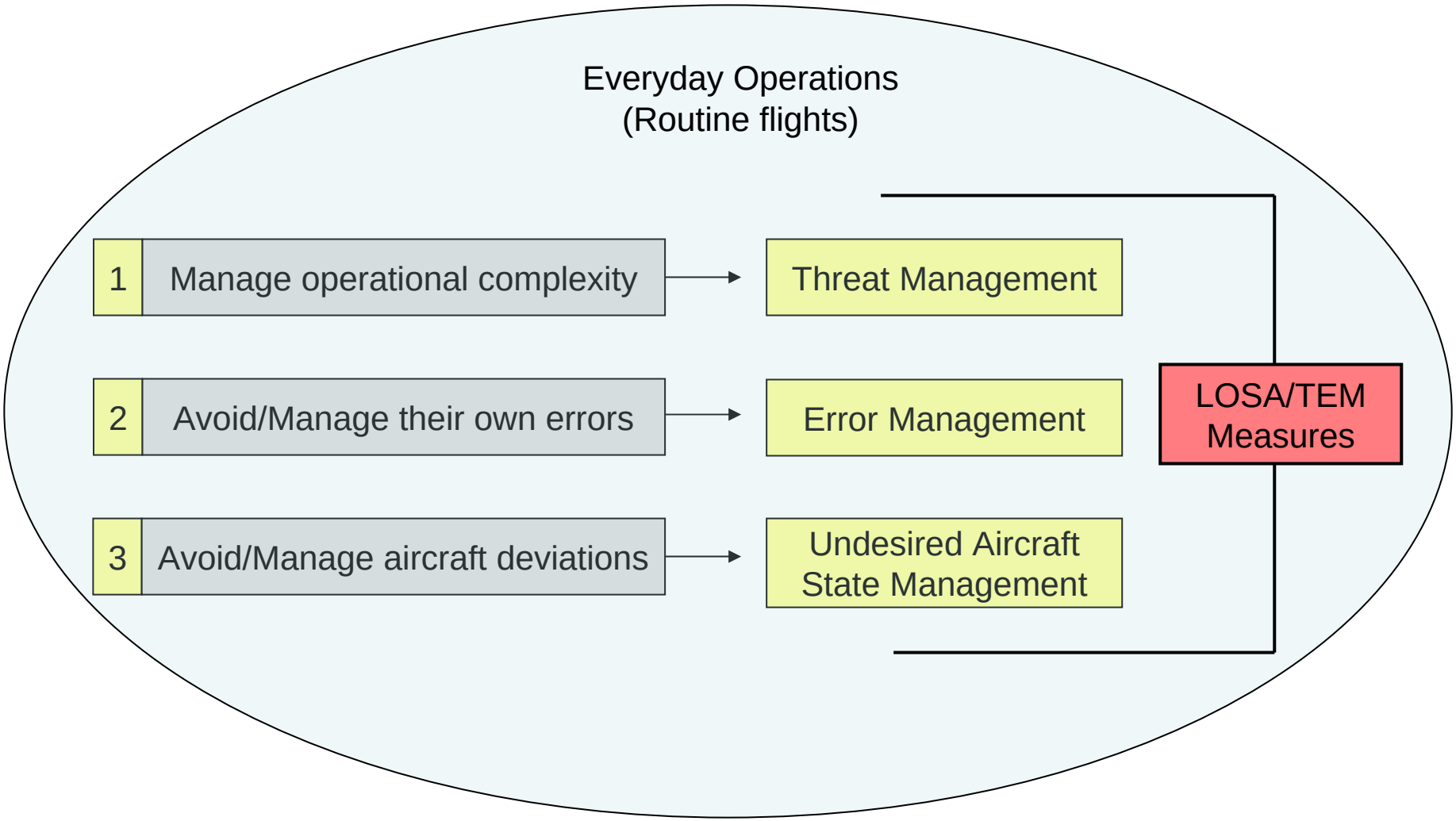
Introduction

- Based on our LOSA experience, airlines are:
  - *Overdeveloped* in data collection – too many tools
  - *Underdeveloped* in the capability to analyze and use data in their safety management systems
- LOSA uses TEM flight crew performance data to diagnose system safety performance strengths and weaknesses
- Long term LOSA success is dependent on how data are translated to meaningful findings that an airline can act on

Threat and Error Management Review

Threat and Error Management (TEM)



Threats Defined

- Threats – External events or errors that occur outside the influence of the flight crew but require their attention to maintain adequate safety margins

Environmental Threats

- *Adverse Weather*
- *Airport*
- *ATC*
- *Environmental Ops Pressure*

Airline Threats

- *Airline Operational Pressure*
- *Aircraft*
- *Cabin*
- *Dispatch / Paperwork*
- *Ground / Ramp*
- *Ground Maintenance*
- *Manuals / Paperwork*

Error Types and Codes

- Errors – Observable crew action or inactions that leads to a deviation from “organizational” or “flight crew” expectations

Aircraft	*Procedural*	*Communication*
• *Aircraft Handling*	• *Checklists*	• *Pilot to Pilot*
• *Automation*	• *Callouts*	• *Crew to ATC*
• *Flight Controls*	• *Briefings*	
• *Systems / Radio / Instruments*	• *SOP Cross-verification*	
• *Ground Navigation*	• *Documentation*	
	• *PF/PNF Duty*	

LOSA Undesired Aircraft States

- Undesired Aircraft States – Crew-error induced aircraft state that increases risk and decreases safety margins

Aircraft Handling	Vertical, lateral or speed deviations Unnecessary weather penetration Unstable approach Long, floated, firm or off-centerline landings
Ground Navigation	Runway/taxiway incursions Wrong taxiway, ramp, gate, or hold spot Taxi above speed limit
Incorrect Aircraft Configuration	Automation, engine, flight control, systems, or weight/balance events

LOSA Data Analysis

LOSA Data Analysis

- LOSA provides two types of data:
  1. Text data - Phase of flight narratives / TEM descriptions / in-flight crew interviews about organizational issues
  2. Numerical data - TEM categorical coding

- Three stages of LOSA data analysis
  1. TEM organizational profiles (prevalence/mismanagement rates)
  2. Drill-down analyses into LOSA narrative and categorical data
  3. Targets for enhancement (Swiss cheese holes that need plugging)

TEM Organizational Profiles

- Objective: Provide airlines with a general overview of TEM performance on a typical day in flight operations

- Profiles are built on two primary types of data indices:
  1. Prevalence – Percentage of flights with threat, error, or undesired aircraft state

  2. Mismanagement – Percentage of threats, errors, or undesired aircraft states leading to flight crew error

- TEM organizational profiles are only a starting point in LOSA data analysis

Example: Threat Organizational Profile

Threat Categories	Threat Prevalence Index	Prevalence Archive Average	Threat Mismanagement Index	Mismanagement Archive Average	Raw Counts
ATC	61%	54%	8%	14%	27/342
Adverse Weather	61%	58%	6%	13%	18/304
Environmental Operational Pressure	51%	44%	2%	8%	4/228
Airport					
Aircraft (Malfunctions, MELs, a					
Cabin					
Airline Operational Pressure	18%	21%	5%	10%	3/60
Dispatch/Paperwork	12%	12%	2%	8%	1/44
Ground Maintenance	8%	8%	3%	8%	1/32
Ground/Ramp	8%	13%	4%	10%	1/27

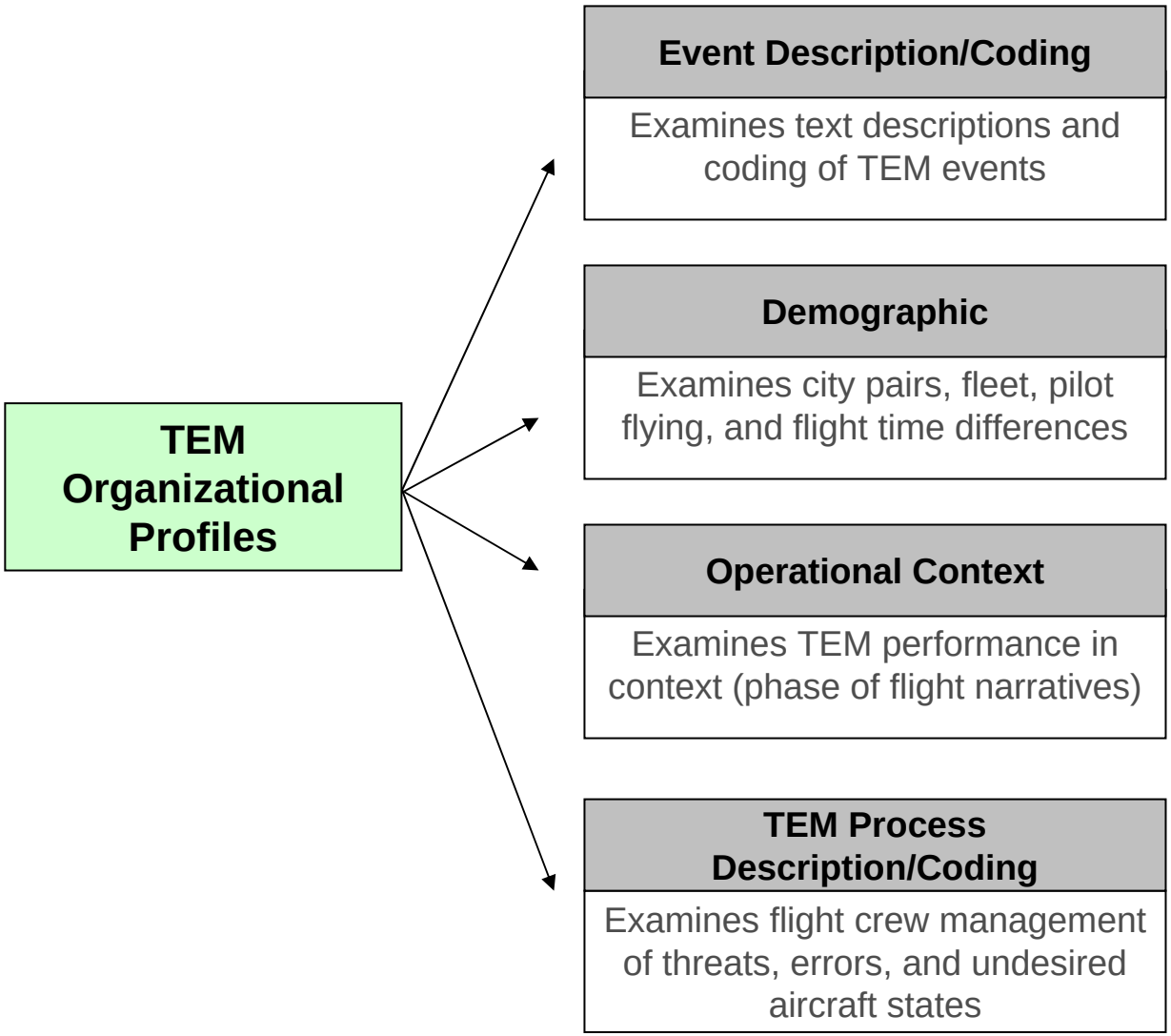
Threat Pre
Percentage of LOSA f

61% of flights had
(Archie average =

Threat Mismanagement
Percentage of threats linked to flight crew error

8% of ATC threats were mismanaged
(Archive average = 14%)

Primary LOSA Drill-Down Analyses



Example: Event Coding Drill-Down

What type of aircraft threats are most prevalent?

Aircraft Threats	Threat Prevalence Index	Threat Mismanagement Index	Raw Count
MEL with operational implications	36%	8%	14/178
Malfunction unexpected by the flight crew	20%	13%	12/96
Automation event/anomaly	5%	6%	1/16
Total	52%	9%	27/290

Example: Demographic Drill-Down

Are there fleet differences with aircraft threats?

Fleet	Threat Prevalence Index	Threat Mismanagement Index	Raw Count
Fleet 1	56%	6%	3/52
Fleet 2	49%	9%	7/77
Fleet 3	61%	3%	2/70
Fleet 4	52%	6%	2/32
Fleet 5	47%	22%	13/59

Example: Event Description Drill-Down

LOSA Observation #21 **Fleet Three** **Pilot Flying: First Officer** **Threat #1**

Threat Description
APU amber fault light came on during taxi-out.

Threat Management Description
FE checked the operational manual and attempted to recycle the APU switch but the light was still on. This was linked to a flight crew error of failing to run the abnormal checklist (Quick Reference Handbook) and resulted in an undesired aircraft state of operation with an unresolved MEL. Consequently, the crew discussed the fault and diagnosed it as being caused by a slightly opened or not flushed APU air inlet door. The crew took off with the light on where it remained on until landing.

Phase of Flight: Preflight/Taxi **Threat Type:** Aircraft Malfunction

Threat Code: Aircraft malfunction unexpected by crew

Threat Outcome: Linked to Flight Crew Error (Procedural error – Failure to execute an abnormal checklist)

Example: Operational Context Drill-Down

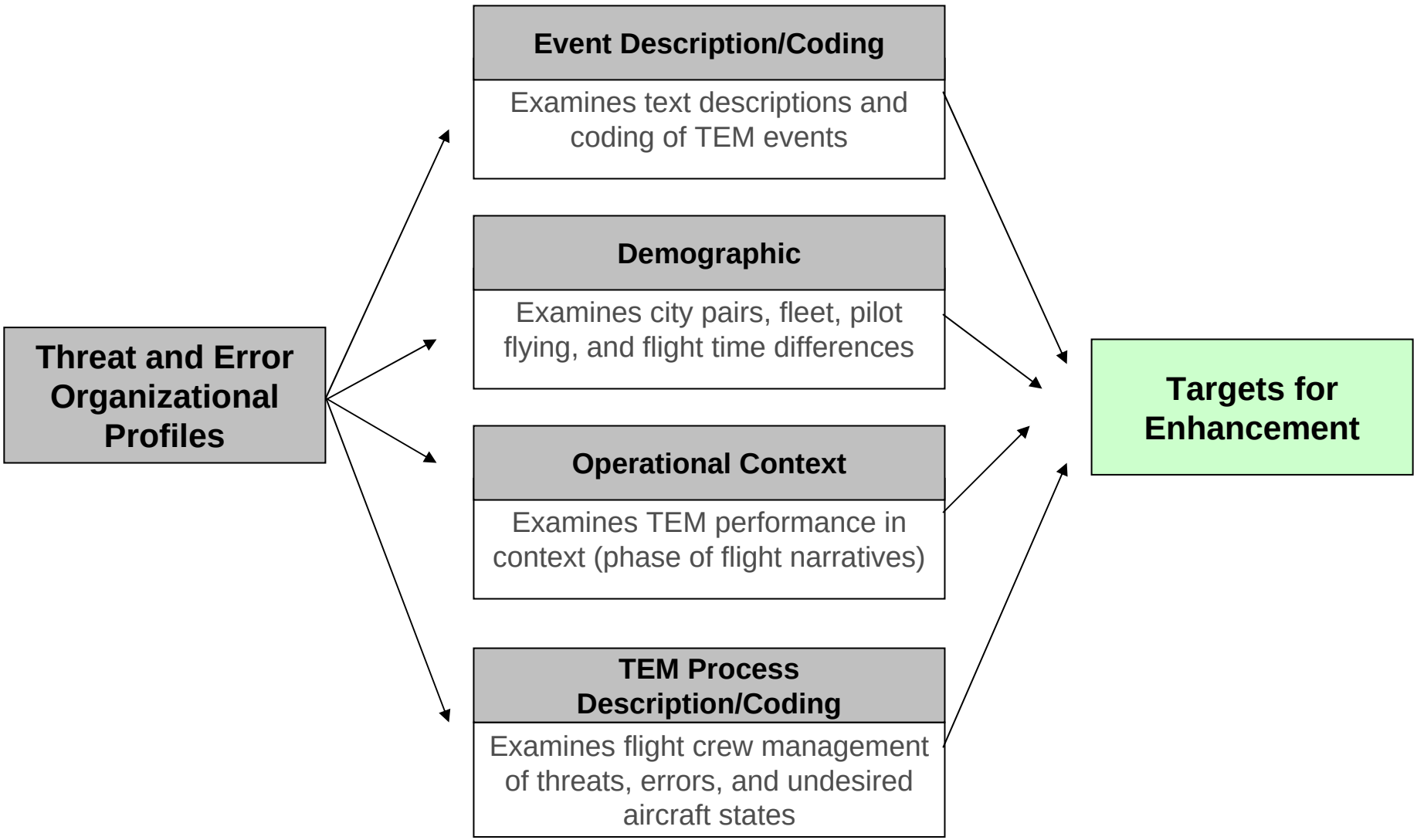
Predeparture/Taxi-Out Narrative
Observation #21 Fleet Three Pilot Flying: First Officer

It was a very early morning departure, i.e., even the observer's pick-up was at 3:30 AM local time. All respective duties were done with everyone 'working–in–sync'. While the Flight Engineer (FE) was still busy with his work/scan, the Captain (CA) offered to make a round of drinks, which was accepted by First Officer (FO).

The ground crew completed the pushback but did not call for the CA to set the parking brakes. After some time, the CA asked the ground crew if he wanted the brakes on, which was quickly acknowledged with an affirmative answer. All checklists were read with the correct procedural protocol with everyone verifying and cross-checking each switch position.

On taxi out, the FE noticed the Auxiliary Power Unit (APU) Fault light was ON (Aircraft malfunction threat unexpected by the crew). The FE informed the rest of the crew. The CA ordered the FE to check the ops manual and to recycle the switch. However, there was no luck as the light was still on. Consequently, this led to the crew discussing this fault and it was diagnosed as being caused by a slightly opened or not flushed APU air inlet door. Although all crew had a consensus on this, the FE was still very much bothered with it and waited for it to disappear all the way to entering the runway. No abnormal checklist was performed (flight crew error) and the light remained on throughout the flight.

Targets for Enhancement



Targets for Enhancement

- After reviewing the LOSA results, one question should come to mind for safety managers

- What are the holes in the Swiss cheese that need plugging?

- Unfortunately – There is no software or magic data analyzer that points to Swiss cheese holes and tells airlines what to do

- Suggested format for presenting LOSA results and targets:
  - LOSA Finding
  - Potential Swiss Cheese hole (Systemic and driven)
  - Target for Enhancement

Simple Example: Findings to Targets

- LOSA Findings:
  - 13% of all “aircraft malfunctions unexpected by the crew” threats were mismanaged
  - Drill-down analyses shows many flight crews failed to properly reference the QRH – mostly occurring on Fleet #5
  - Further analysis – Interviews with crews about QRH issues

- Potential Swiss Cheese Hole – Aircraft malfunctions and QRH usage

- Sample Target for Enhancement - Improve the management of aircraft malfunction threats that were unexpected by the flight crew before the next LOSA

Example: Error Profile

Error Type	Error Prevalence Index	Error Mismanagement Index	Mismanaged Error/Error Count
System/Instrument/Radio	18%	34%	22/65
Automation	18%	24%	16/66
Manual Handling/Flight Control**	15%	77%	41/53
Ground Navigation	3%	NC*	6/9
Callout	32%	5%	8/149
Checklist	20%	15%	13/88
SOP Cross-Verification	18%	14%	9/66
Briefing	15%	4%	2/55
PF/PNF Duty	10%	3%	1/35
Documentation	4%	NC*	2/11
Crew to External	20%	7%	5/72
Pilot to Pilot	3%	NC*	1/9

LOSA Case Study

LOSA Case Study

- 1st LOSA results – Targets identified:
  1. Improve energy management issues during descent/approach/land
     - *18% of flights with a speed deviation undesired aircraft state*
  2. Lower the prevalence of unstable approaches
     - *11% of flights with an unstable approach*
  3. Lower prevalence of checklist errors
     - *50% of flights with a checklist error*
  4. Improve monitor/cross-checking performance
     - *38% of errors went undetected (not responded to by the flight crew*)
  5. Improve ATC threat management
     - *22% of ATC threats were mismanaged - linked to flight crew error*

LOSA Case Study Two

Targets	1st LOSA	2nd LOSA
1. Improve energy management during DAL	**18% of flights with speed deviations**	**6% of flights**
2. Unstable approaches	**11% of flights**	**4% of flights**
3. Checklist errors	**50% of flights**	**24% of flights**
4. Monitor/cross-checking performance	**38% of errors (crew fail to respond/undetected)**	**61% of errors (crew fail to respond/undetected)**
5. ATC threat management	**22% mismanaged**	**13% mismanaged**

Proactive safety change …….

Over one year, approx 182,500 flights, 4% rate = 7,300 unstable – much better than 11% rate = 20,075 unstable

Concluding Remarks

- From a large sample of observations, LOSA generates a “flight operations” snapshot of strengths (thick cheese slices) and weaknesses (cheese holes)

- Some say LOSA is just an error counting exercise – They’re wrong – it’s just the start in data analysis!

- LOSA allows airlines to measure the effectiveness of their safety improvements across time (Target for enhancements)

- LOSA is just one SMS tool that allows operators to become proactive in their safety efforts

Muchas Gracias