The Possibilities with Good Data

Nancy Rockbrune
Head, Safety Management
Data Sources

- Mandatory reporting systems
- Voluntary reporting systems
Data Sources

Note 1.— SDCPS refers to processing and reporting systems, safety databases, schemes for exchange of information, and recorded information including but not limited to:

a) data and information pertaining to accident and incident investigations;
b) data and information related to safety investigations by State authorities or aviation service providers;
c) mandatory safety reporting systems as indicated in 5.1.2;
d) voluntary safety reporting systems as indicated in 5.1.3; and
e) self-disclosure reporting systems, including automatic data capture systems, as described in Annex 6, Part I, Chapter 3, as well as manual data capture systems.

Annex 19, 2nd Ed.
“to measure is to know – if you cannot measure it, you cannot improve it”
– Lord Kelvin
Use of Data

 sæ Conduct analysis on clean defensible data / information
  • Identify hazards and risks
  • Prioritize risks and subsequent actions to mitigate
  • Measures process performance
  • Identify and prioritize contributing factors to process performance
  • Measure and predict process performance improvements

 sæ Communicate findings as appropriate
Data Management Principles

- Managing by averages leads to flawed decision making - not accounting for process variation
- If measurement system variation is too large there is an increased risk of:
  - Rejecting good data
  - Accepting bad data
- Important to know how much of the observed variation of a process is due to the actual process itself
Data Management Principles

- Operational definitions (includes taxonomies) help reduce subjectivity and variance in a measurement system (data).

- Operational definitions can be:
  - A written statement
  - Templates
  - Display of comparisons (colour chart)

- Operational definitions should be:
  - Something people can really use
  - Enables different people to reach the same conclusion (repeatability)
  - Enables the same person to reach the same correct conclusion at different times (reproducibility)
Taxonomy / Operational Definitions

- Controls data inputs
- Reduce subjectivity
- Reduce variation
- Means for integration (internal and external)

5.1.5 **Recommendation.** — *The safety database should use standardized taxonomy to facilitate safety information sharing and exchange.*

*Annex 19, 2nd Ed.*
Measuring Safety Performance ~ SPIs

- Set measureable (SMART) safety objectives
  - Verify safety performance
  - Validate effectiveness of safety risk controls
- Track performance
- Compare against targets
- Achievement of a target consequently represents an improvement in performance
Metrics

- Typically focused on number of serious accidents / incidents
- High profile
- Easy to measure
- Reactive
  - Does not expose systemic issues or hazards
System Approach

- Managing at the process level is the basis of a “System” approach
- Considers all processes, their interrelationships and interactions
System Approach

- Direct relationship between inputs and outputs
- Therefore to improve the output, changes or improvements to the inputs are required
Control Charts

- Displays the control of a process
  - In control process shows random variation
  - Out of control process shows unusual variation due to special causes
- Help to determine where to focus problem-solving efforts by distinguishing between common and special-cause variation
Sample ~ Control Chart

Upper Control Limit (UCL)

Centre Line

Lower Control Limit (LCL)
Measure process improvements

If distributions are normal can estimate the performance if new procedures are put in place
Why is Process Control Important?

- Higher quality
- Increased efficiency
- Lower costs
- Fewer errors
- Leaner organization
- Sustained profitability
- Performance goals tied to business priorities
- Performance competencies ~ tools used to achieve goals
Process Control Example ~ ELC
Process Control ~ Example
Other Examples

- Unstable approach criteria
  - Studies being made to evaluate the FSF initiative to reduce the height to 300ft before Go-Arounds
  - Data will identify if feasible or not

- RNAV vs Visual Approach
  - Comparing the approach tracks and monitor how many flights flying visual app vs RNAV results in Go-Arounds
  - Airline can then quantify the cost, review their processes
WHAT DATA AND INFORMATION
Proactive Shift

- SPIs measure performance of safety controls
  - Preventative
  - Recovery
- Shift focus to precursors
# IATA SPI GROUP: Draft SPI Candidate

<table>
<thead>
<tr>
<th>SPI / Safety Objective (SO)</th>
<th>Long Landing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Safety Concern</td>
<td>Organizational</td>
</tr>
<tr>
<td>Safety Aim</td>
<td>Zero instances of long landings</td>
</tr>
</tbody>
</table>
| Definition(s)               | Threshold ~ touchdown >x m from runway threshold  
                                   Distribution ~ distance from runway threshold at landing |
| Possible Data/Information Source(s) & (Expected Reliability for Source) | FDM (High)  
                                   Touchdown point  
                                   Length of Runway |
| SPI Data Source(s)          | Distance from runway threshold at landing |
| Reporting Period and Interval | As determined by operator |
| Output format               | As determined by operator |
| Alert Level                 | Each operator to determine their own alert level |
| Safety Performance Target   | Each operator to determine their own target |
| Safety Action Plan(s)       | Each operator to determine their own safety action plan |
| Notes                       | Can do comparisons if carriers have same threshold limits |
Sample SPI ~ Long Landing

- Identify touchdown points of ALL flights
Example ~ Long Landing

Identify touchdown points of ALL flights
## Sample FDM Parameters

| Parameter Description | FDM Parameters | ...
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed over the threshold</td>
<td>Speed on ground</td>
</tr>
<tr>
<td>Long Landing</td>
<td>X</td>
</tr>
<tr>
<td>Runway End Zone Ground Speed</td>
<td>X</td>
</tr>
<tr>
<td>Runway Turn Off Speed</td>
<td>X</td>
</tr>
<tr>
<td>Sink Rate Before Touch Down</td>
<td>X</td>
</tr>
<tr>
<td>Tail Clearance at Take Off</td>
<td>X</td>
</tr>
<tr>
<td>Tail Clearance on Landing</td>
<td>X</td>
</tr>
<tr>
<td>Bank Angle During Landing</td>
<td>X</td>
</tr>
<tr>
<td>GPWS - Pull-Up</td>
<td>X</td>
</tr>
<tr>
<td>Rejected Take Off (RTO)</td>
<td>X</td>
</tr>
<tr>
<td>a. Environmental Risk</td>
<td>X</td>
</tr>
<tr>
<td>b. Runway Site Excursion</td>
<td>X</td>
</tr>
<tr>
<td>c. Runway Over-Run</td>
<td>X</td>
</tr>
<tr>
<td>Taxi Speed Exceedance</td>
<td>X</td>
</tr>
<tr>
<td>TCAS RA</td>
<td>X</td>
</tr>
<tr>
<td>Unstable Approach Continued</td>
<td>X</td>
</tr>
<tr>
<td>Height that stabilization achieved</td>
<td>As above</td>
</tr>
<tr>
<td>Proximity to Alpha Max</td>
<td>X</td>
</tr>
<tr>
<td>Unusual Attitude - Pitch</td>
<td>X</td>
</tr>
<tr>
<td>Unusual Attitude - Bank Angle</td>
<td>X</td>
</tr>
<tr>
<td>In-Flight Shut Down (IFSD)</td>
<td>X</td>
</tr>
<tr>
<td>Landing Below Final Reference Fuel</td>
<td>X</td>
</tr>
</tbody>
</table>
Sample SPI ~ Long Landing

This multi-vari chart shows condition of runway surface is a contributing factor.
Sample SPI ~ Long Landing

Outlier (750’) at night with a wet runway surface ~ only 1 instance
Runway Approach & Landing

The Approach and Landing Accident Reduction page contains metrics on go-around, long landing, tailwind, stopping distance events and other KPVs. Currently displaying all event levels.
ADS Flight Operations and Safety Track

- How data and information can be used to increase operational efficiency and improve safety performance
- Role of technology
  - “Intelligent Engines” and “Connected Aircraft”
- Dark Data
- Real-life examples of data and information usage
Thank you!
Safety Performance Indicator (SPI)


Annex 19 – Safety Management
Runway Safety

Loss of separation

- Aircraft landing/take-off
- Runway crossings

... with other aircraft/vehicle
... with edge of runway

Collisions
- Dual aircraft
- Single aircraft

Excursions

Weather
Airport layout
Aircraft attitude
Runway condition
Gaining Insight

• Level 1
  – Reactive analysis and investigation of high consequence events (accidents, serious incidents)

• Level 2
  – Real-time monitoring of everyday operations and hazards in a proactive manner
  – Define separate and track normal vs abnormal operations
Level 2 Data Analysis Process

Sources of hazard data:
- Oversight audit results
- NOTAMs
- METARs

Analysis:
- ADS-B ground tracks
  - Latitude, longitude
  - Heading
  - Ground speed
  - Flight ID
  - Aircraft type

Indicators

... by the second
Circle size is proportional to speed
Circle center is aircraft position
Circles are spaced by one second
Speed Marks

Exit speed
43kts

Airport A
Runway Remaining

Monitor the distance from (separation with) runway end
Distances after which it is not possible to stop before the end of the runway at the given speed and deceleration.
One aircraft was at 60kts with 1000 feet remaining

Number of landings vs speed and remaining distance for 1 day in Airport B
Reduced Separation with Runway End

Exit speed

20kts

1300 feet

2000 feet

Airport B
Runway Crossings

Airport B

2

Airport B

0

Airport A

1
One day at Airport A RWY 1 per no. of operations every 15 min

Monitoring Usage

Ops mix

Operations

- No. of crossings
- No. of landings
- No. of take-offs

Runway availability

\[ F(\text{Landings + Takeoffs}) = \frac{\text{Landings} + \text{Takeoffs}}{\text{Crossings}} \]
Monitoring Separation

One day at Airport A RWY 1
per no. of operations every 15 min

Seconds between landings and take-offs

Seconds between crossings and landings and take-offs
SIMS
Safety Information Monitoring System

Horizontal Flight Efficiency

Ramp Inspection

Hazard Registry

Runway Event Monitoring
This application monitors landings with a tailwind exceeding 5 knots and landings where remaining runway distance at 60 knots is less than 3000 feet.

Runway safety events were identified as one of the main high-risk accident categories, and ICAO is coordinating a global effort to improve runway safety.
What is SIMS?

- A web-based information system
- Generates indicator analysis through various applications
- Supports implementation of State Safety Programmes (SSP) and Safety Management Systems (SMS)
Aviation Data Symposium
The Data4Safety Programme

Erick Ferrandez
EASA Safety Intelligence and Performance
20 June 2018
Berlin

Your safety is our mission.
Out there!

Collaborative Analysis Platform

Aviation Experts and Data Analysts

Connect Safety Intelligence with actions

Know where to look
See it coming
Act!

Support a performance-based environment

Data
Flight Data
Air Traffic data
Safety Reports (occurrences)
Weather, and more...

Data Technologies

Expert Knowledge

Big Data Platform

Know where to look
See it coming
Act!

Support a performance-based environment
What is D4S implementation roadmap?

A step approach with a Proof of Concept phase to test and demonstrate

Operational Phase
(as of 2020)

Proof of Concept Phase
(3 years)

Setup Phase
(Feasibility Study)

Here we are

21/06/2018
EASA Safety Intelligence and Performance
D4S Founding Members

AESA, Airbus, Boeing, British Airways, DGAC France, EASA, easyJet, ECA (European Cockpit Association), IAA (Irish Aviation Authority), Iberia, Lufthansa, Ryanair, UK CAA
What do we want to deliver with D4S?

A set of outputs to produce actionable safety intelligence

- Metrics
- Blind Benchmarking
- Directed Studies
- Vulnerability Discoveries
Key elements of D4S

- **A voluntary and collaborative partnership amongst all stakeholders**
- **Independent governance** to reflect the partnership and collaborative approach (dual management authorities/industry)
- Data Processing Organisation to manage the Big Data solution
- **Outcome shared** for the benefit of the whole community (Risk identification and analysis)
- Linked with other international initiatives (ASIAS, FDX, ...)

21/06/2018
Thank you
Advancing Safety Through Information Sharing

COMMERCIAL AVIATION SAFETY TEAM (CAST)
AVIATION SAFETY ANALYSIS AND SHARING (ASIAS)

Michael Quiello, Industry Co-Chair CAST
Vice President, Corporate Safety United Airlines
In the United States, our focus was set by the White House Commission on Aviation Safety, and The National Civil Aviation Review Commission (NCARC)

1.1 . . . Reduce Fatal Accident Rate . . .

- . . . Strategic Plan to Improve Safety . . .
- . . . Improve Safety Worldwide . . .
CAST brings together key stakeholders to cooperatively develop and implement a prioritized safety agenda.

**Representing P&W and RR**

**Observer**

A4A  
AIA  
Airbus  
ALPA  
ACI-NA  
CAPA  
IATA**  
NACA  
Boeing  
GE*  
RAA  
FSF  

DOD  
FAA  
NASA  
ICAO**  
TCCA  
NATCA  
NTSB**  
EASA**  

* Representing P&W and RR  
** Observer

Commercial Aviation Safety Team
CAST Goal

CAST came together in 1997 to form an unprecedented Industry-Government partnership...

- Voluntary commitments, Consensus decision-making, Data-driven risk management, Implementation-focused.

Goal:

**Original** Reduce the US commercial aviation fatal accident rate by 2007.

**New** Reduce the U.S. commercial aviation fatality risk by at least 50 percent from 2010 to 2025.
CAST Safety Strategy

Data Analysis

Agree on problems and interventions

Set Safety Priorities

Achieve consensus on Priorities

Implement Safety Enhancements – United States

Influence Safety Enhancements - Worldwide

Integrate into existing work and distribute
Study Prioritization
(Fleet Risk)

Risk Level Appropriate for Monitoring
1 accident in 20 yrs

Risk Level Appropriate for Study

Fatality Accident Expectation @ Current Accident Rate

RR SEs Risk Levels

Risk Level – Rapid Response
What is ASIAS?

- A collaborative Government-Industry initiative on safety data analysis & sharing

- A risk-based approach to aviation safety, identifying & understanding risks before accidents or incidents occur

- Timely mitigation & prevention
ASIAS Is Governed by Formal Principles

Data used solely for advancement of safety

Voluntary submission of safety-sensitive data

Carrier/OEM/MRO data are de-identified

Transparency – knowledge of how data are used

Procedures & policies established through collaborative governance

Analyses approved by an ASIAS Executive Board
<table>
<thead>
<tr>
<th>CAST Recent Safety Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go-Around (underway)</td>
</tr>
<tr>
<td>Takeoff Misconfiguration</td>
</tr>
<tr>
<td>Runway Excursions (RE)</td>
</tr>
<tr>
<td>RNAV Departures and STAR Operations</td>
</tr>
<tr>
<td>Airplane State Awareness (ASA)</td>
</tr>
<tr>
<td>Traffic Collision Avoidance System (TCAS)</td>
</tr>
<tr>
<td>Terrain Awareness Warning System (TAWS)</td>
</tr>
</tbody>
</table>
LEVERAGING DATA FROM ACROSS THE INDUSTRY PROVIDES VALUABLE INSIGHTS

**Traffic Tracks**
Source: FAA National Offload Program

**Minimum Vectoring Altitudes**
Source: Air Traffic Control

**Airport & Airspace Procedures**
Source: Air Traffic Control

**Safety Event Focus**
Source: Digital Flight Data, Safety Reports

**Terrain Source:** National Elevation Data
Impacts of Data Sharing

Safety insight gained from ASIAS is invaluable, as it is not possible through other means and gives us the ability to—

- Identify systemic risks
- Detect the degradation of safety barriers
- Monitor the effectiveness of deployed mitigation strategies
- Understand the impact of changes in the aviation system

CAST has adopted 22 safety enhancements to address systemic risks based on non-accident data from ASIAS
Summary

- Unprecedented partnership and positive impact
- Long-term industry and government commitment
- Committed to continue to drive future safety improvements through information sharing
Community

noun

1. a group of people living in the same place or having a particular characteristic in common
2. the condition of sharing or having certain attitudes and interests in common
FAL A350

4700 IT systems
FAL A350

4700 IT systems

40 non-conformity databases
4700 IT systems

40 non-conformity databases

30 days to gather data required for 30 minute decision
Our journey to date

Exponential User Growth

- 9 Airlines
- 3.3 petabytes of data
- Airbus & 3rd Party Devs > Foundry Devs
- Le Bourget Official Skywise Launch
- 100 terabytes of data
- A320 Manufacturing Expansion
- Airline Maintenance Platform Live
- A350 Manufacturing Live
- A350 Manufacturing Pilot
Today, more than 3 petabytes of data are already connected to Skywise.
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3,000+ aircraft
11.3M+ flights
Today, more than 3 petabytes of data are already connected to Skywise

- 3,000+ aircraft
- 11.3M+ flights
- 24M+ tech logs
Today, more than 3 petabytes of data are already connected to Skywise

- 3,000+ aircraft
- 11.3M+ flights
- 24M+ tech logs
- 70+ systems
Today, more than 3 petabytes of data are already connected to Skywise

- 3,000+ aircraft
- 11.3M+ flights
- 24M+ tech logs
- 70+ systems
- 5,000+ users
Connecting our industry
Connecting our industry

**SUPPLIERS**
- Demand forecasting and reduce missing parts

**ENGINEERING & DESIGN**
- Improving future aircraft design
- Accelerating root cause analysis from months to days

**COMPONENT MANUFACTURING & ASSEMBLY**
- Resource management and burn down rate monitoring
- Improving logistics coordination and planning
- Accelerating repair speed from weeks to hours

**SERVICES**
- Preventative maintenance models
- Reliability reporting
- New route development

**OPERATORS**
- Component reliability
- Maintenance optimization

Connecting our industry
Connecting our industry

**OPEN**
Other OEM data is being hosted on Skywise
Operators are driving cross fleet workflows using Skywise

**SECURE**
Best in class technology from Palantir ensures secure handling of data
Robust permissions and access controls can be configured to operator requirements

**COLLABORATIVE**
Multi stakeholder workflows to connect operators, suppliers and major OEMs
Group collaboration and data sharing are possible
Airline spotlight

Over 2 trillion rows of sensor data for one national carrier alone
Enriched with faults and maintenance information
500+ users in the design office conducting root cause analysis and partnering with airline engineers
Unprecedented speed to investigate and resolve issues: from years to weeks
Airline spotlight

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Identified root cause of fuel pump issues in 3 weeks
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- Identified root cause of fuel pump issues in 3 weeks
- Reduced NFF events from 13 per month to 3 per month
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- Identified root cause of fuel pump issues in 3 weeks
- Reduced NFF events from 13 per month to 3 per month
- Diagnosed root cause of fuel pump that had been replaced 15+ times
Beyond Sensors & Big Data
How AI Drives Prediction and Optimization on Less Connected Aircraft

Mark Roboff
Vice President, Aerospace & Automotive
AI Systems
Work Like A Human Brain

- Process Information
- Draw Conclusions
- Codify Instincts and Experience Into Learning
AI systems

Significant benefits for the industrial world

- Improved Accuracy
- Scalability
- External Factors
- Adaptability
- Security
- In-Context Remediation
AI system for maintenance optimization

Prediction
Aircraft Sensor Data (ACARS, DAR, QAR)

Diagnostic
Content from Hangers (Maintenance logs)

Optimization
Content from Flight Ops (Scheduling)

Advisory
Content from Hangers (Service Manuals)

What is going to fail? How do I fix it? Where are the parts?
Where is the labor? What are the right instructions?
Addressing the maintenance life cycle

REQUIRES BIG DATA SENSOR PLATFORMS
Today’s big data sensor platforms

Problem: Only the newest aircraft have sensor platforms on the scale of big data
Prognostics and Health Management from MX Logs
Benefits of cognitive diagnostics

Compared to Traditional ACARS-Driven Aircraft Health Management, Cognitive Diagnostics Covers...

The Whole Fleet
• Covers all types in a mixed fleet with one deployment
• Provides the same high level of analytics for all aircraft types, regardless of age

The Whole Aircraft
• Provides rich analytics and recommendations across all ATA chapters
• Identifies long term trends and patterns for quality in non-ACARs-reporting components, i.e. seats

Tribal Knowledge
• Delivers corrective actions across all ATA chapters from an airline’s own maintenance history
• Embeds tribal knowledge for when reality differs from “by the book”
Example

Seat health management
Maintenance Advisor Leverages Maintenance Manuals to *Deliver the Right Instructions, to the Right Person, at the Right Time*
Advisor – Aiding the technician

1. Guides the technician step-by-step on what to do to fix problems

2. Trusted solution with confidence ratings to provide a path toward resolution

3. Quick search allows natural language questions to find relevant tasks and information from anywhere in the manuals

Case inbox is split into sessions. Each session represents a chunk of work to be done for a given aircraft tail number.

Technician selects a session and finds the faults or work that needs to be done for that aircraft.

Technician selects a fault and finds historical information on which corrective actions have been successful most often in the past.

A quick search using natural language returns the relevant AMM tasks for the top corrective action.

How do I replace the RH inboard temp sensor? Start
Advisor – Aiding the technician

1. Guides the technician step-by-step on what to do to fix problems

2. Trusted solution with confidence ratings to provide a path toward resolution

3. Quick search allows natural language questions to find relevant tasks and information from anywhere in the manuals

Starting a repair send the technician into a step by step process. Next steps are delivered in appropriate sections to the technician and feedback is collected. Connected devices become a powerful data collection and stakeholder communication device. Store notes to share learnings. In Design: Automate Repair reports and store in the cloud.
Who we are

SparkCognition is an enterprise AI company with software solutions that help customers

- Analyze increasingly complex data stores
- Reveal actionable insights
- Identify and automate optimal responses

Closed Series B funding of $56.5M in venture capital in February 2018
Customers, partners, and awards

Customers

Invenergy

Dover

Duke Energy

Honeywell

Boeing

Defense Innovation Unit Experimental

Flowserve

MHPS

Army Be the Best

U.S. Department of Energy

Partners

IBM

Google

OSIsoft

PTC

GE

National Instruments

Deloitte

Relayr

Awards

Frost & Sullivan

Nokia Open Innovation Challenge 2015

CNBC Disruptor 50

AI 100

Gartner 2016 Cool Vendor

Red Herring 100

50 Fastest-Growing Companies in Central Texas

Austin A-List
Mark Roboff
Vice President, Aerospace & Automotive
mroboff@sparkcognition.com