Transport Canada
Commercial and Business Aviation

Flight Data Monitoring within an Integrated Safety Management System

CASS 2004
Presentation Overview

- Historical perspective of safety
- Overview of SMS
- SMS Components
- Overview of FDM
- FDM integrates with the SMS
- From Theory to Practice
  - Capt. Michael Dilollo, Air Transat
Airline Scheduled Service*

- 1947
  - 21 million passengers carried
  - 34 fatal accidents
  - 590 persons lost their lives
  - Accident rate of 3.12 passenger fatalities per 100,000 passenger-kilometers flown

*Worldwide
Airline Scheduled Service*

- 1999
  - 1.6 billion passengers carried
  - 20 fatal accidents
  - 489 persons lost their lives
  - Accident rate of .02 passengers fatalities per 100,000 passenger-kilometers flown

- Worldwide
How has the Accident Rate been Improved?

• Early Years
  – Improvements primarily **Technical**

• Seventies
  – Emphasis placed on **Human Error**
    • Attempts to *eliminate* human error through design
    • Focused on the *individual* (training, regulations)

• Eighties
  – we began to focus on the human as a social being
  – Cockpit Resource Management
How has the Accident Rate been Improved? (cont’d)

• Nineties to present day
  – Systemic view of aviation safety
    • Interactions among people
    • Between people and technology
    • Between people and the organizations to which they belong
  – Safety concerns addressed from an organizational perspective
  – Role of, and the relationship between, management and safety scrutinized
Management

• Sets out how work is done

Management System

• Is a group of related, integrated processes that sets out how work is done in an organization
Management Systems

• Evolution of Quality Management
  – What is Quality?
  – Quality Control (Operator, Foremen, Inspector, Statistical)
  – Total QC = Quality Assurance (QA)
  – Total Quality Management (TQM)
  – TQM + QA = QMS
  – Quality Systems (ISO 9000 Series)
Quality Management System (QMS)

• Is a group of related, integrated processes that set out how work is done in an organization that has a focus on quality and continuous improvement
Safety Management System (SMS)

• Consists of systematic, explicit and comprehensive processes for the management of safety risks, that integrates operations and technical systems with financial and human resource management, for all activities related to an air operator or an approved maintenance organization.
Safety Management System (SMS)

• Should **not** be considered a stand-alone management system
• Identifies requirements (policies, processes and procedures) and principles that **integrate safety awareness and management into an existing management system**
Safety Management System

• Components
  – Safety Management Plan
  – Documentation
  – Safety Oversight
  – Training
  – Quality Assurance
  – Emergency Response Plan
Definition of Flight Data Monitoring*

Flight Data Monitoring (FDM) is the routine collection and analysis of digital flight data generated during line operations to provide more information about, and greater insight into, the total flight operations environment

* Also known as Flight Operations Quality Assurance (FOQA)
Objectives of FDM

- Identify and define existing and changing operational risks
- Assess risk
- Mitigate risk by rectifying deficiencies
- Confirm effectiveness of remedial action
Flight Data Monitoring

Aircraft Systems

Flight Data Acquisition Unit (FDAU)

Flight Instruments

Flight Data Recorder (FDR)

Quick Access Recorder (QAR)

Tape, Optical Disc, PCMCIA Card
Replay and Analysis

- Tape, Optical Disc, PCMCIA Card
- Ground-based Data Replay and Analysis System (GDRAS)
- Data Plots, Spreadsheets, etc.
- Flight Animation
Types of Information

• Exceedence Detection
  – Flap O/S, unstable approach, heavy landing

• Routine Data Measurements
  – T/O weight, flap pos’n, T/O / Ldg speed, fuel consumption

• Incident Investigation Data
  – TCAS/GPWS events, RTOs, system failures

• Continued Airworthiness Data
  – Engine perf., brake/ldg gear usage, system perf.
FDM and the SMS

- SMS Components
  - Safety Management Plan
  - Documentation
  - Safety Oversight
  - Training
  - Quality Assurance
  - Emergency Response Plan
Safety Oversight

– Is fundamental to the safety management process
– Requires an organization to critically review its existing operations, proposed operational changes and additions or replacements, for their safety significance
– Achieved through two principal means
  • Reactive – Occurrence/hazard reporting
  • Proactive – Safety awareness
Elements of Safety Oversight

- Systems for reporting hazards, events or safety concerns
- Systems for analyzing data, safety reports and any other safety related information
- Methods for the collection, storage and distribution of data
- Corrective action and risk reduction strategies
- On-going monitoring
- Confirmation of the effectiveness of corrective reporting
Where does FDM fit in?

- FDM is a “reporting node” to the Safety Oversight component of the SMS that analyses reported information and applies the required risk management processes.
- Other “reporting nodes” include:
  - Voluntary reports
  - Line Operational Safety Audits (LOSA)
  - Inspections and audit results (internal, 3rd party)
  - Incident/accident reports
- FDM especially useful as it provides objective information pertaining to an event.
Safety Management System

• Occurrence and Hazard Reporting
  – Voluntary Safety Reporting
  – Operations Safety Audits (LOSA/DOSA/MOSA IOSA)
  – **Flight Data Monitoring (FDM)**
  – Advanced Qualification Program (AQP)
  – Others systems
    • BASIS
    • AQD
Safety Management System

• Data Collection Procedures (FDM)
  – Collection devices used (QAR, OQAR, etc)
    • Incl. handling instructions and device care
  – Downloading procedures
    • Incl. frequency, locations, etc.
  – Transmission procedures (to analysis centre)
    • Incl. security and confidentiality protocols
    • Return to service policy for data medium (flashcard, optical disc, etc.)
Safety Management System

• Incident analysis
  – Description of data flow within company
  – Listing of event sets (including exceedance parameters)
  – Role and responsibility of analysts, event review teams, etc.
  – Flight crew contact protocols
  – Training requirements
  – Hazard/risk management
Hazard / Risk Management

- Risk Analysis
  - Risk identification
  - Risk estimation
- Risk Assessment
  - Risk evaluation
- Risk Control
- Monitoring (feedback / follow-up)
Hazard / Risk Management

- Risk is defined as the combination of probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

- Category
  - Catastrophic (loss of an a/c, multiple fatalities)
  - Hazardous (serious or fatal injuries to small number of occupants, major aircraft damage)
  - Major (injury to occupants, damage to aircraft)
  - Minor (nuisance, op limitations, deviation to SOPs)

- Probability
  - Extremely improbable (less than $10^{-9}$ per flight hour)
  - Extremely remote (between $10^{-7}$ and $10^{-9}$ per flight hour)
  - Remote (between $10^{-5}$ and $10^{-7}$ per flight hour)
  - Probable (between 1 and $10^{-5}$ per flight hour)
## Risk Analysis Matrix

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<tr>
<th></th>
<th>Catastrophic</th>
<th>Hazardous</th>
<th>Major</th>
<th>Minor</th>
<th>Extremely Improbable</th>
<th>Extremely Remote</th>
<th>Remote</th>
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<td>review</td>
<td>review</td>
<td>unacceptable</td>
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<tr>
<td><strong>Probability</strong></td>
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</tbody>
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Quality Loop

- Continuously Identify and Quantify Risks
- Are risks acceptable?
  - Yes
  - No
- Was action effective?
  - Yes
  - No
- Take Remedial Action
Safety Management System

• Documentation
  – Company Control Manual
  – Quality: The emphasis with assuring quality should be more on process than the product because a stable, repeatable process is one in which quality can be an emergent property
    • Note: There is no such thing as a stable, repeatable process that hasn’t been documented first. In fact, it got that way because it was documented.
  – Refer to Chapter 2 of SMS implementation guide
FDM Within A SMS

- FDM will provide greater benefits when FDM is linked to other reporting systems or programs
  - Voluntary safety reports, LOSA, AQP, int. audits, etc
- Other information gives context to FDM information
- FDM will provide quantitative information to other reports that would otherwise be based on less reliable subjective information
  - Air Transat model (LOSA, QSAP and FDM)
  - Air Canada (AQP, IOSA)
Benefits of FDM to the SMS

• Insight into daily operations - actual rather than assumed
• Depth of knowledge beyond accidents/incidents
• Indicates trends as well as levels, potential as well as actual threats
• Provides risk modeling information
• Feedback of improvements
• Provides data to cost-benefit studies
• Continuous audit of safety standards