Big Data: SMS + FDM = Safety Assurance*

Orlando, FL
March 3-4, 2015

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FDM Systems Manager
SkyTrac Systems
JHSIT Member – Systems & Equipment WG Chair
Global HFDM Steering Group – IHST Liaison
Safety Space

- Welcome
- Safety Brief:
  - Emergency Exits, Fire, Severe Weather, etc.
- PEDs:
  - Please limit distractions by silencing ringers.
- Format
  - Interactive workshop – a top level overview that links two important safety programs w/ Q&A
Welcome and thank YOU!
• **Who are we?** A team of government and industry leaders formed to address the factors affecting an unacceptable civil helicopter accident rate.

• **Vision:** A civil helicopter community with zero accidents

• **Mission:** Establish partnerships with significant helicopter operations and encourage development and implementation of safety interventions by sharing lessons learned through accident analysis.

• **Goals:**
  - Zero Tolerance + Zero Accidents
  - Reduce civil the helicopter rate by 2016,
  - Reverse any negative trend and improve safety culture in the helicopter industry.
  - Promote safety publications and toolkits to operators across the country for maximum awareness of the USHST message.
US Helicopter Fatal Accident & Fatality Rates

*CY 14, Jan-Jul Only*
Introduction(s)

- 121 PF/PM Career
  - Civilian trained – Kent State University
  - “Typical” career progression including 4 airlines
  - Current 757/767
  - Union safety work
    - FOQA | ASAP
    - LOSA
    - Safety Publications
    - Accident Investigation

- “PNF” Career (Kipp 3.0)
  - SkyTrac Systems
    - Implementation of FDM in non-scheduled ops
    - Acquire, analyze and create applications for flight data
  - Industry volunteer
    - IHST, USHST, GHFDM
    - Trade publications
    - Pro Pilot, Vertical, etc.
  - Consulting
    - Avionics
    - Safety Programs (FAA, HAI, etc.)
Linking or “connecting” safety

121 Safety

Background in airline safety including

- FOQA, ASAP and (now) LOSA
- Aviation Safety Information Analysis and Sharing (ASIAS - original NASA DNFA participant)
- FAA InfoShare
- Accident investigation

Rotorcraft Safety

Industry safety volunteer and consultant

- IHST/USHST FDM WG Lead (now Systems and Equipment WG Lead) [HeliShare vision]
- IHST HFDM Toolkit, HUMS Toolkit and HFAP(P)
- FOQA I&O plans (Air Log [now Bristow] and ACH)
- FDM hardware, software and program development (formerly CAPACG, CAE and now SkyTrac)

HAI HFDM|PEGASAS

Joint industry and gov’t program to improve rotorcraft safety

- FAA-funded [participants include industry (HAI and others), gov’t (FAA) and academia (GA-Tech, Purdue, UND)
- HAI HFDM WG (Goal to gather SMEs to provide industry input leading to enhanced HFDM system & processes)
- Sharing (building on HeliShare success leading to formal inclusion in R-ASIAS program [finally])
Guest: Scott Collins: CTO Collcomp Consulting, LLC.

R-ASIAS Data Model
• Matchmakers – our role:
  – Connect SMS and FDM
  – Turn data into actionable information
  – Share information to improve helicopter safety

• Ground rules – yours:
  – Have fun
  – Participate
  – Ask questions
  – Meet your neighbor
  – Network

_Caveat_: Our goal is to provide a thoughtful presentation to improve safety in your operation – it is not an all encompassing course on SMS and FDM (see next).
SMS and FDM resources:
FDM and SMS: An enemy of safety?

Question: **Is FDM and SMS an enemy of safety?**

1. **No**, a properly implemented FDM program within a SMS will improve safety.

2. **Yes**, if the programs aren’t managed properly.

3. **No**, I’m pretty sure I’m in the wrong classroom and this guy is nuts.

4. **Yes**, this guy is a fan of Sydney Dekker (a “contrarian’s view”).

5. **All of the above**
Success: “an enemy of safety”

- According to Sydney Dekker, “Herein lies the current safety industry's biggest problem: by turning safety into a goal to achieve statistically, companies worry more about "looking good" than actually reducing illness and injuries.”
Caveat: Communicating safety

- Background = buy-in
- Be proactive – get out in front of the issue
- **Promoting past successes does little to ensure future safety.**
- Success is the enemy of safety \(\rightarrow\) (counterintuitive, but true.)
Communicating Safety Poorly: Use SMS as the playbook.

1. Risk identified
2. Risk Defenses
   1. **Physical Defenses** are objects that discourage or prevent inappropriate action or mitigate the consequences of events.
   2. **Administrative defenses** include procedures and practices that mitigate the probability of an accident.
3. **Order of Precedence for Hazard Control**
   1. Modify the system – design the hazard out
   2. Physical guards or barriers
   3. Warning or Alert signal
   4. Procedural or training change
   5. **Advise people** – placards, notices, briefings, etc.
Big Data: SMS+FDM=Safety Assurance

• Problem statements:
  – 1 (Micro): How to grow from a safety department into an organizational safety enterprise?
  – 2a and 2b (Macro): How best to share critical safety info between operators, segments and continents?
Problem statement #1: Pre-SMS, organizational safety structures were not “connected.” (micro)

Each operated in individual silos with different objectives, agendas, profit centers, etc…
Problem statement #2a: HFDM programs (Pre 2009) were “disconnected” operating in individual “silos.” (macro)

Each organization operated in a “vacuum” unwilling to share safety information with each due to competitive concerns (and a lack of understanding).
Problem statement 2b: Between 2009-2014 HeliShare began connecting larger* operators in the US, while the small** operator is still not represented (macro).

*HeliShare is US centered – org’s such as HeliOffshore are promoting expanded sharing.

**Small operators account for 80% of all operators – R-ASIAS hopes to capture some of that data.

HeliShare “connected” a core group of operators in the Gulf of Mexico (OGP) and has grown to now include some HEMS operators.
Big Data: SMS+FDM=Safety Assurance

• The Agenda (and solutions):
  – Big picture overview…using really big pictures
Big Data: It’s everywhere…

GE’s fuel studies are great example of an application of FDM.
Big Data: SMS+FDM=Safety Assurance

Using wine, parenthood and Pringles – we’ll demonstrate how other industries are employing analytics to improve their business.
Big Data: **SMS+FDM=Safety Assurance**
Definition of SMS

“A safety management system (SMS) is an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. “

(ICAO SMM)
Canada’s TSB on SMS:

A safety management system is a businesslike approach to safety. It is a systematic, explicit and comprehensive process for managing safety risks. As with all management systems, a safety management system provides for goal setting, planning, and measuring performance. A safety management system is woven into the fabric of an organization. It becomes part of the culture, the way people do their jobs.
Big Data: SMS+FDM=Safety Assurance

- **Current Intervention Point**: 1 crash
- **FDM Intervention Point**: 300 unreported incidents
- **Hazards**: 300 near misses, incidents and events go unreported...
- The accident that finally occurs.

**FLY** ➔ **CRASH** ➔ **FIX**

**Big Data: SMS+FDM=Safety Assurance**
Flight Data Monitoring defined

• Flight Data Monitoring (FDM) is the technology and methodology for collecting and analyzing data recorded in flight.* (FAA)

• “A systematic method of accessing, analyzing and acting upon information obtained from digital flight data records of routine operations to improve safety”*

*In a just, non-punitive, culture.
SMS provides a path to “act upon” safety information
Big Data: SMS+FDM=Safety Assurance

1. Safety policy and objectives
   1.1 – Management commitment and responsibility
   1.2 – Safety accountabilities of managers
   1.3 – Appointment of key safety personnel
   1.4 – Coordination of emergency response planning
   1.5 – SMS Documentation

2. Safety risk management
   2.1 – Hazard identification processes
   2.2 – Risk assessment and mitigation processes

3. Safety assurance
   3.1 – Safety performance monitoring and measurement
   3.2 – The management of change
   3.3 – Continuous improvement of the SMS

4. Safety promotion
   4.1 – Training and education
   4.2 – Safety communication

SMS is your organization’s “Safety Play Book,” use it!
Big Data: Data rich, information poor, etc.

"Wisdom is not a product of schooling but of the lifelong attempt to acquire it."

Source: Cisco IBSG, April 2011
Big Data: It’s more than charts and graphs
Big Data: Knowledge and Wisdom = Value
FDM supports SMS

- In the Safety Management Systems (SMS) context of risk management strategies, FDM is reactive (past events), proactive (seeks identification of hazards) and predictive (identifies future problems/trends). Safety risk management is assured by using objective flight data to support an SMS. FDM allows the operator to objectively establish the context or level of risk and then identify, analyze and evaluate risks.
Essentially, FDM is the tactical component of a strategic SMS. By monitoring routine flight data, the organization can achieve greater insight into the flight operation and provides additional information to enhance safety.
Introducing Mr. Scott Collins:

- **Chief Technology Officer**
  *Collcomp Consulting, LLC.*

- Provides a unique “non-aviation” perspective at a complex problem of handling, processing and analyzing data from very different sources.

- Scott.collins@collcomp.com

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**IT Architecture**

**Presentation / Web Tier**

- Web server presenting pages to end users and dispatching/scheduling workload to the application layer

**Application Layer**

- Query data, provide analysis and return results to presentation layer

**Data Tier**

- RDBMS Cluster
- Hadoop MapR Cluster
- File Server cluster

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**R-ASIAS Data Feeds**

- **FDR Open Data**
  - From operators FDR systems via web interface

- **FDR-de-Identified Operator Data**
  - List of aircraft models and operational limits for each FDR parameter

- **Mission Types**
  - i.e., Testing, training, etc. Already defined and available through HAI

- **Unified Query of all available Databases**

- **Maintenance Data**

- **Weather Data**
  - SOAP interface to NOAA (30 years available)

- **FDR BLOB Data**
  - Video
  - Audio
  - Waveform

- **FDR Database**
  - List of all FDR vendors and models with full parameter list

- **Mission Parameters**

- **R-ASIAS Data Feeds**

- **External Data Sources**
From the dawn of civilization until 2003, humankind generated five exabytes of data. Now we produce five exabytes every two days ... and the pace is accelerating.

Eric Schmidt,
Executive chairman, Google
What kind of data are we talking about for this industry?

- Discreet numeric values from flight data recorders
- Weather data
- Flight traffic data
- Geographic and topographic data
- Aircraft performance characterizations
- Video Data
- Voice Data
- Vibrational Data / Noise
Big data is about challenges and opportunities

**Characteristics**
- Growing quantity of data
- Quickening speed of data generation
- Increase in types of data
- Veracity of the data

**Opportunities**
- Making better informed decisions
- Discovering hidden insights
  - Anomalies, forensics, patterns and trends
- Automation
Example 1: The Grapes of Math

Opportunity
• Advise vintners on Wine Spectator scores & competitions and how to improve winemaking

Data & Analytics
• Database of hundreds of thousands of wines including chemical analysis of 100+ chemical compounds
• Proprietary method (pattern matching, machine learning) for sampling and analyzing grapes

Results
• Ability to predict Wine Spectator scores and simulate tasting notes
• Winemakers improve wine scores, and optimize inventory, pricing and promotion
Example 2: An Infamous Retail Tale

**Opportunity**
- Target consumers with promotions based on their determined life situation

**Data & Analytics**
- Transaction receipts and other undisclosed information
- Inference engine to predict future needs based on shopping and purchase pattern changes

**Result**
- Identified woman was pregnant; even estimated her due date
- Woman was a pregnant teen; her father didn’t know until coupons arrived
- Coupons now sealed
Example 3: Flight of the Pringle

**Opportunity**
- All worldwide Pringles are made in 1 of 3 plants using the same process adapted from other baked goods in N. America, Europe and Asia
- As production rates ramped up, almost 20% of production was lost due to broken chips

**Data & Analytics**
- Using big data analytics, they were able to correlate chip breakage with specific spots in the production line and correlated that to aerodynamic effects of the Pringles on conveyors at speed
- They then used supercomputing combined with big data analysis to redesign the shape of the Pringle to make it more aerodynamically sound

**Result**
- Failure / breakage rate dropped from ~20% to ~3% saving over $7 million dollars per plant annually in lost revenue.
Big Data: SMS+FDM=Safety Assurance

• Problem statements:
  – 1 (Micro): How to grow from a safety department to an organizational safety enterprise?
  – (Solution) SMS provides tools and processes for an organization to grow its safety enterprise.
Problem statement #1: Pre-SMS, an organization’s safety structures were not “connected.” (micro)
A short story…

• **Purpose**
  • Provide historical perspective of modern safety systems.
  • Frame session material

• **Promise**
  • It’s fiction; names and identities have been changed to protect the innocent.
  • No small animals or children were harmed in anyway…

• **Working Title**
  • Next →
Analyst Confessions: “back in the day”
Setting: there were many different silos…

Each with different objectives, agendas, profit centers, etc…
“Characters:” The safety forum
The plot: A desire to “bend” the story
(and a few other silly questions):

- Safety Manager: “Can we “adjust” the event
definition at XYZ to decrease the rate of
unstable approaches?”

- Fleet Supervisor: “That can’t be…we’ve flown
these aircraft for years. We’re no different
than other fleets! The data must be wrong.”

- Etc…
The answer
(NO: it’s objective flight data)
Projects: Unstable Approaches (UA)

Briefing the stable approach - avoiding the traps

- No approach
- Non-precision approach

Unstable Rate Obsession

Unstable Rate

Unstable Rate

Q1
Q2
Q3
Q4

5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Characteristics of a UA

80% of UA were either a non-precision approach or non-standard ILS w/:
- Steeper than normal glideslope
- Short distance from FAF to TDZ (<4 nm)
- High elevation airport (= high TAS)
- Steep or no PAPI/VASI
- Etc.

**NOTE:** Qrt/Qrt improvement in UA rates (below 2%) / Only 5% of UA flew a Go-Around (95% non-compliance w/ policy)
Recommendation: Mitigation strategy

Introducing: The amazing AB-RAT

- Approach Briefing Risk Analysis Tool (AB-RAT)
  - It enhances safety
  - Decreases the number of unstable approaches
  - Improves situational awareness
  - Encourages the use of CRM

As Seen on TV

It’s AH-mazing

Epic fail!
Big Data = Big Roadblock (No support)
Why? (How can it be fixed?)

No formal process to take action on meaningful info…
Answer: SMS provides a path...
ICAO SMS Framework: A formal approach to safety management

1. Safety policy and objectives
   1.1 – Management commitment and responsibility
   1.2 – Safety accountabilities of managers
   1.3 – Appointment of key safety personnel
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SMS is your organization’s “Safety Play Book;” use it!
Definition of Safety (ICAO)

• Safety is the state in which the risk of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.
Safety Risk

• “The assessment, in terms of probability and severity, of the consequences of a hazard, taking as reference the worst foreseeable situation.”
What is Safety Risk Management (SRM)

- A formal process within the SMS
  - describes the system
  - identifies the hazards
  - assesses and analyses the risk and causes
  - controls the risk to **as low as reasonably practicable**
  - monitors the changes to ensure effectiveness

- Integrated within the processes used to provide the product/service

- Data Driven (Safety Reports, FDM, ASAP, AQP, LOSA, etc.)
## CFIT or Approach and Landing Accident

### Loss Potential and Severity Matrix

<table>
<thead>
<tr>
<th>RATING</th>
<th>PEOPLE</th>
<th>ENVIRONMENT</th>
<th>ASSETS</th>
<th>REPUTATION</th>
<th>SECURITY</th>
<th>LIKELIHOOD</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>A Unknown</td>
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<tr>
<td>0</td>
<td>No Injury</td>
<td>Zero Effect</td>
<td>Zero Damage</td>
<td>Zero Impact</td>
<td>Zero Risk</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Slight Injury</td>
<td>Slight Effect</td>
<td>Slight Damage</td>
<td>Slight Impact</td>
<td>Slight Risk</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Minor Injury</td>
<td>Minor Effect</td>
<td>Minor Damage</td>
<td>Limited Impact</td>
<td>Limited Risk</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Major Injury</td>
<td>Local Effect</td>
<td>Local Damage</td>
<td>Considerable Impact</td>
<td>Considerable Risk</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Single Fatality</td>
<td>Major Effect</td>
<td>Major Damage</td>
<td>National Impact</td>
<td>Major Risk</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Multiple Fatalities</td>
<td>Massive Effect</td>
<td>Extensive Damage</td>
<td>International Impact</td>
<td>Extreme Risk</td>
<td>5</td>
</tr>
</tbody>
</table>
Bankruptcy
Catastrophe
HIGH
LOW
COST
RISK
Production
Protection
Perception
Politics
Safety Management System

Fly

Adjust

Analyse
Focus on 3 primary areas of SMS

- Managing Risk
  (James Reason’s 3 elements)
  - Organization
  - Technology
  - People

- Human beings, the technology they operate, and the organization they work within, are the three sets of factors likely to be “implicated in breaching defences put in place to avoid accidents”

- Must read: Managing the Risks of Organizational Accidents (Reason)

- (Also…Just Culture (Dekker))
Accidents (there’s a “Reason”)

Elements of an accident
1. Organization
2. Technology
3. People
4. (Luck)
How accidents happen...

TSB: A lack of an effective transition from a traditional safety management to a functional SMS...prevented an adequate risk assessment of the intro of the Global 5000...

No risk assessment of operating into A 4,800’ RWY...

Low experience in aircraft type, EWH and PAPI understanding, duck-under approach, etc.
Global vs the CL604
Controls to mitigate the threat?

• What controls may have mitigated this accident?
  – Organization?
  – Technology?
  – People?
    • Other…
Types of changes:
1. Organizational Change
   - New people, roles, company structure, <to include operational> etc.
2. Technology
   - New a/c type, construction, new tools, etc.
3. Human Change
   - Personal, emotional, group dynamics.
Big Data: SMS+FDM=Safety Assurance

- **Problem statements:**
  - 2a and 2b(Macro): How best to share critical safety info between operators, segments and continents?
  - (Solution) Sharing and analyzing flight data and other sources of safety information provides operators with apples-to-apples comparisons of “like” operations and provides opportunities for systematic improvements throughout the industry.
Problem statement #2a: HFDM programs (Pre 2009) were “disconnected” operating in individual “silos.” (macro)

Each organization operated in a “vacuum” unwilling to share safety information with each due to competitive concerns (and a lack of understanding).
Problem statement 2b: Between 2009-2014 HeliShare began connecting larger* operators in the US, while the small** operator is still not represented (macro).

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Roadmap for HFDM programs beyond 2015 (R-ASIAS conceptual)

Checkout: Wed, March 4th (1:00-2:00) Room 320E | Developing R-ASIAS: An Overview of HFDM and Research
Thank you!

Flight Data Monitoring
From the Ground Up

Discover the power behind your flight operations data

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