BIG DATA FOR AVIATION SAFETY

FLIGHT STANDARDS DEPARTMENT
CAAC
CAPT. JIANG RUI
蒋睿
Basic Data of Administrative Counterparts (FSD CAAC)

48 Large airplane air transport carriers (CCAR121)
40 small aircraft commercial transport carriers (CCAR135)
168 foreign air transport carriers
164 general operators
138 domestic and foreign pilot training schools and centers
47 maintenance personnel training organizations
4 aircraft dispatchers training organizations

420 operators, 1006 organizations
296831 professional personnel

42578 pilots
80000 Maintenance personnel
5137 Dispatchers
169116 Medical certificate

817 domestic and foreign maintenance Organization
A total of 628 flight standards inspectors, accounting for 27% of the total number of civil aviation inspectors:

- **High Workload** may lead to poor oversight
- **Unsustainable** vs High Growth

**Risks in the Horizon**
SAFETY CHALLENGE

The continuous rapid growth of China Civil Aviation

A/C No. >2700

total turnover of air transportation
2014: 7.42 Billion ton-kilometer
  Growth Rate >10%
2015: 8.504 Billion ton kilometer
  Growth Rate 13.7%

VS.

The limited resources

Inspectors
  Quantity/qualification

Safety Oversight

Tools
Start of operations

Ramp checks
regular document checks
other safety indicators

Finding?
Yes
Further investigation, audit
(as per 1.4.4 of Part VI)
No
Finding?
Yes
Additional measures:
withdraw approval or
other action
No

foreign operator approval maintained/renewed

Additional inputs:
findings or deficiencies
from safety programmes
(USOAP, FAA-IASA,
EU-SAFA, etc.)

ICAO DOC 8335
DATA DRIVEN SAFETY

The objectivity and scientificness of oversight lies not only in the regulation-based management, but also in the combination with airline’s SMS. Risk management and safety decisions SHOULD from inspectors’ OVERSIGHT (OUTSIDE) data, and a additional input of AIRLINES’ (INSIDE) data.

- SSP
  - Data Collection
  - Analysis and Assessment
  - Decision
  - Making Proprietary DATA
  - Self-reliance

- SMS
  - Data Collection
  - Safety Risk Reports, Flight Quality Assurance Program, etc (FOQA)
  - Reference and Incorporation
  - Practice by yourself before decision!
CAAC SOLUTION
(INNOVATION & COOPERATION)

- FSOP (Flight standards oversight program)
- CAAC FOQA STATION (additional data)

BIG DATA
The Core of FSOP (Phase I) is creating an IT system as a working tool for Airlines’ (CCAR121) certification and continual Surveillance, supported by pilots qualification, maintenance management, E-regulation, medical certification, plan as whole for total 12 subsystems.
Give a man a fish and you feed him for a day. Teach him how to fish and you feed him for a lifetime. - Lao-Tzu

(Capacity building)
WHY FOQA

- The air carrier is, instead of the Administrator, responsible for delivering safe product;
- The Administrator does not perform quality control or quality assurance for the air carriers;
- These are functions of operators’ SMS!
- FOQA is important part of SMS(tool/EI)

USOAP/CMA-SSP-SMS
## FOQA in China

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>• Start basic research</td>
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| 1997 | • Launch QAR Project (FOQA program is mandatory for Airlines)  
• On Sept.17, CAAC issued the AC on Quick Access Recorder Installation |
| 2000 | • On Dec.15, CAAC issued MD(administrative provisions ) on Flight Operation Quality Assurance Management  
• On Mar.19, CAAC issued Aviation Safety Guidance – guidance about implementing “FOQA Criteria of Boeing and Airbus aircraft” |
| 2007 | • On Jan.4, CAAC brought FOQA requirement in the regulation: Operations Certification: Large Airplanes Air Carrier (CCAR-121-R4-28) |
| 2010 | • On Feb.15, CAAC issued Implementation and Management of Flight Operation Quality Assurance (FOQA) Advisory Circular |
| 2013 | • On Dec.26, CAAC approved the Project of CAAC FOQA Station |
| 2015 | • On June /Sep, CAAC updated the FOQA AC to add training demand for FDA and organized 4 training sessions for 100 person-time |
BACKGROUND OF FOQA

FDR/CVR

Accident Investigation 事故调查 PASSIVE

QAR

Accident Prevention 事故预防 PROACTIVE

/WQAR

快速存取记录器

/无线快速存取记录器

2016年6月

COSCAP-NA

13
New technology realized

- **Wireless QAR**
- **Advanced communication, network and computer Technology**
- **Big-data technology**
- **From QAR to WQAR**: Data will be acquired more conveniently, timely, and low cost
  - **Network**: transfer data faster.
  - **Computer**: Huge Storage, Running Faster for search
    - 1TB=1024GB, 1PB=1024TB, 1EB=1024PB=1 BILLION GB ……ZB/YB/BB!!
  - Big data has become intelligent, could be used in everywhere
  - We could collect and store more data from more airlines simultaneously and longer time.
  - **FOQA station**—Start with 800TB……
FRAMEWORK of CAAC FOQA STATION
Data Collection:

- Aircrafts operated under CCAR-121.
- All the QAR data are collected by CAAC FOQA Station.
- The QAR data are transferred to the data center of airlines directly by 2G/3G, and then are pushed to the data center of CAAC FOQA station via internet automatically or manually.
Data Process and Analysis

- **Back up**: All the QAR data are back up to the data storage.
- **Dispatch**: All the QAR data are dispatched to 10 FDA workstations by the specified Techniques tool.
- **Analysis**: All the QAR data are analyzed for the FOQA, ROMs, etc.
- **Export**: The results or some engineering data are exported to the data platform.
Statistical Analysis and Data Mining

- **Hardware**: Data Warehouse Appliance and Hadoop cluster.
- **Data**: structured data stored in the database, engineering data or other data stored in the Distributed File system.
- **Analysis Techniques**: Statistical Analysis, Trend Analysis, dependency analysis, Cluster analysis, Map Reduce, etc.
**Data Analysis Service**

- Integrated platform, Website or Apps
- Schedule data analysis report
- Special analysis report
- On-line analysis
- Data de-identification (privacy protection)
Milestones 里程碑

Aug 6, 2012
Start 开始

Jan 24, 2013
Feasibility Study 可行性研究

Oct 9, 2013
Approved 批准实施

Dec 26, 2013
Preliminary Design 初步设计

Investment: 43.54 Million RMB
总投资4354万； 50% Subsidy for modification, Giant Pool of Money (40m)
建设周期三年。
STAKEHOLDERS

Civil Aviation Administration of China

Aviation Safety Office, CAAC

Flight Standard Dep., CAAC

Aviation Safety Institute, CAST

CAAC North Regional Administration
- Air China
- Air China Cargo
- BEIJING CAPITAL AIRLINES
- China United Airlines
- China Postal Airlines
- Okey Air
- Hebei Airlines
- Grand China Air

CAAC East Regional Administration
- China Eastern
- Shanghai Airlines
- China Cargo Airlines
- Spring Airlines
- Juneyao Airlines
- Yangtze River Express
- Shandong Airlines
- Xiamen Airlines
- Zhejiang Loong Airlines
- Fuzhou Airlines
- Qingdao Airlines

CAAC Central and South Regional Administration
- China Southern
- Hainan Airlines
- Shenzhen Airlines
- SF Airlines
- 9 Air
- Donghai Airlines
- Uni-top Airlines

CAAC Southwest Regional Administration
- Sichuan Airlines
- CHENGDU AIRLINES
- Kunming Airlines
- Ruili Airlines
- Tibet Airlines
- Lucky Air
- West Air
- China Express Airlines
- YingAn Airlines

CAAC Northwest Regional Administration
- Dalian Airline

CAAC Northeast Regional Administration
- Joy Air

CAAC Xinjiang Regional Administration
- Urumqi Air

ALL CCAR121 OPERATORS
2700 AIRCRAFT
# Main Functions of CAAC FOQA Station

## Analysis
- **Quick Search**
  - 快速查找
- **Special Analysis**
  - 特殊数据分析
- **3D Simulation**
  - 三维仿真

## Events Detection
- **Event Definition**
  - 事件定义
- **Logic Set**
  - 逻辑设置
- **Trend Statistics**
  - 统计分析
- **Information Publication**
  - 信息发布

## Routine Operation Measurement
- **Parameter Extract**
  - 参数提取
- **Parameter Value Distribution**
  - 参数数值分布
- **Abnormal Detection**
  - 异常探测
- **Parameter Application**
  - 参数应用
2. Data Analytics Application Scenarios Design

**Statistical Analysis**

- **3 Classes Events No.** 超限事件数
- **3 Classes Events Ratio** 超限事件率

**Dimensions** 统计分析维度：

- **Time** 按时间
- **M/M/S** 按机型
- **Route** 按航线
- **Airport** 按机场
- **Event Type** 按超限事件
- **Event Class** 按超限等级
- **Flight Phase** 按飞行阶段

**WHY/HOW**

**ANALYSES/MITIGATION**
1. Report 报告
   (1) Regular Report: weekly, monthly, yearly
       分析报告: 周报、月报、年报
   (2) Warning Report: published as needed
       预警报告：需要时发布

2. Website 网站
   (1) Insert CAAC Safety Website
       嵌入民航局安全信息网
   (2) On-Line date browse and analysis
       实时数据浏览和在线分析
APPLICATION of BIG DATA

DEFINE ACCEPTABLE
LEVEL OF SAFETY
PERFORMANCE
（Average line）

- warning Line
- red line /bottom-line
Considering that people can learn from their mistakes, the best thing to do is to learn from the mistakes of others.
NEW APPLICATIONS

- Aircraft Performance 飞机性能分析
- Fuel Consumption 燃油消耗分析
- Engine Performance 发动机性能分析
- Operation Performance 运行性能分析
- Flight Procedure 飞行程序分析
- Runway/Airport Performance 机场/跑道性能分析
- Plateau Operation 高原运行分析
- PBN Operation PBN运行分析

QAR Data QAR数据
◆ OPEN SYSTEM
◆ PARTICIPANT WELCOME
◆ WIN-WIN COOPERATION
◆ CONtribute to REGIONAL AVIATION SAFETY
THANK YOU

Why not learning the best practices of others?