The Aerospace Performance Factor (APF)

Presentation by Steve Smith, FAA, & Tony LICU, EUROCONTROL
Contributions by Imperial College, easyJet and the US Naval Safety Center
What Is The Concept and Challenge?

- Assessing the impact of many different factors and events into a cohesive measurement tool.
  - Aviation operations, safety, and performance are too complex to be gauged by just one or two elements.
- Combining *tangible* + *intangible* elements to determine their *influence* on the overall system enhances the measurement.
  - Because humans are involved, “safety”, “efficiency” and “effectiveness” can become intangible due to different experience and perspectives.
Aerospace Performance Factor (APF)-What Is It?

- The APF presents a graphical view of performance.
  - based on historical indicators (lagging) from multiple databases.
- Allows organization to have a macro-system-wide view of performance.
  - then “drill down” into data to search for causal factors.
- Tracks organizational performance over time.
  - using safety, operational, and/or equipment metrics.
- Does not focus on a single metric to measure performance.
- Incorporates organizational judgment and experience of factors.
  - Measures intangibles
- Allows for analysis and search for precursors.
- Can function as a model for decision making & is expandable in size and scope.
Who’s Involved

- FAA ATO Safety +
- Imperial College, UK
- easyJet Airlines, UK
- U. S. Navy’s Aviation Safety Center, Norfolk VA
- Southwest Airlines, US
- TAROM Romanian Airlines

- EUROCONTROL ESP + Air Navigation Service Providers From:
  - Ireland
  - Romania
  - Germany
  - France
  - Poland
  - Netherlands
  - United Kingdom
  - Hungary
# Classic Method of Presenting System Performance

## “Legacy” FAA Incident Data

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2004</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft Accidents</td>
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<td>Air Carrier</td>
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<td>29</td>
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<tr>
<td>Air Taxi/Commuter</td>
<td>92</td>
<td>73</td>
<td>-19</td>
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<td>1835</td>
<td>1614</td>
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<td>237</td>
<td>145</td>
<td>-92</td>
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<td>2628</td>
<td>709</td>
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<td>OE</td>
<td>1139</td>
<td>1216</td>
<td>77</td>
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<td>VPD</td>
<td>547</td>
<td>263</td>
<td>-284</td>
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<tr>
<td>Surface Incidents</td>
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<td>882</td>
<td>-514</td>
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<tr>
<td>Runway incursions</td>
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<td>310</td>
<td>-116</td>
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<tr>
<td>Aircraft Operations</td>
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<tr>
<td>Air Carrier</td>
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<td>24,278,000</td>
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<tr>
<td>Air Taxi/Commuter</td>
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<td>10,029,000</td>
<td>1,865,000</td>
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<tr>
<td>GA</td>
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<tr>
<td>Military</td>
<td>4,178,000</td>
<td>4,071,000</td>
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<tr>
<td>Aircraft Hours</td>
<td>318,000,000</td>
<td>273,000,000</td>
<td>-45,000,000</td>
</tr>
</tbody>
</table>

**Can We Really Measure Total Organizational Change?**
Snapshot of APF Methodology: Includes Trends, Performance Baselines & Operational Parameters for Goal Setting
Step 1: Identify Elements and Build a Mindmap
The First FAA Mindmap: A Simple Version

APF Mindmap
8/15/2007 - v13

Airborne Events

Flight of two
OD
MVA
PE
Enroute
Terminal

Surface Incidents

PD
RI
VFPD
PD
PD

Other than Rls

Commercial
VFR
IFR
NMAC
GA
Military

Commerical
VFR
IFR
GA
Military

C:\Documents and Settings\AG\My Documents\APF Mindmaps\APF Mindmap_v13.mpp
Current EUROCONTROL MINDMAP (abbreviated version)

- Airspace Infringement
  - Near Controlled Flight into Terrain
  - Level Bust
- Prolonged Loss of Communications
  - A/C Deviation from ATC Clearance
  - A/C Deviation from ATM Procedure
  - A/C Deviation from ATM Regulation
- Potential/Near Collisions Air
- Inadequate Separation
  - Separation Minima Infringement
- Air Incidents
- Ground Incidents
  - Runway Incursion
  - All Ground Incidents which are not Runway Incursion
- ATM Specific Occurrences
  - Failure of Communication Function
  - Failure of Data Processing Function
  - Failure of NAV Function
  - Failure of Surveillance Function
  - Failure of Information Support Function

Federal Aviation Administration

EUROCONTROL
Step 2: Balancing The Factors: Weighting & Expert Judgment

- The Denominator~ Accounts for positive outcomes
  - Total flight operations, or:
  - Total flight time, or;
  - For an airline, total flight segments
- Weighting of the elements ~
  - Incorporates quantitative value of expertise and judgment.
  - “Importance” or “influence” or “risk” associated with a data element as perceived by the organizations experts
  - APF utilizes concepts of the Analytic Hierarchy Process (AHP) created by Dr. Thomas Saaty to establish weighting.
    - Additional information on AHP @ www.ahpacademy.com
A ranking process based on multiple, heterogeneous criteria;

Uses expert judgment from Subject Matter Experts (SME) to prioritize, or weigh, the criteria.

- This is how intangible elements are weighted:
  - Assessing “importance” or “influence” of the elements to the overall goal.

Easiest way to do it: pairwise comparison;

- Between criterion A and criterion B, which one is more important, or has the most influence, with respect to the goal/objective?
- By how much? This question is the key which incorporates SME experience into the equation.

The result: each criterion gets a numerical value between 0 and 1 that reflects the judgment of the SMEs.
All criteria are equal, but some are more equal than others;
Example:
  - Goal is to make a decision of which is the best car to buy based on a combination of criteria such as cost, safety, style, capacity.
    - Importance of each criterion is assessed;
    - Influence of sub-criteria is determined;
    - Expert judgment then yields numerical values which are the weights
    - Then each alternative car is evaluated based on those weights.
  - With the APF, since no decisions are made, alternatives are not assessed. SME determined criteria values become the weights.
A Non-Aviation Example of Weighting

Choose the best car for the Jones family

1.000

Cost .504

Safety .237

Style .042

Capacity .217

Purchase Price .250

Fuel Costs .250

Maintenance Costs .250

Resale Value .250

Cargo Capacity .500

Passenger Capacity .500

6 Cars

6 Cars

6 Cars

6 Cars

6 Cars

6 Cars

6 Cars

6 Cars
Weights ~ An Example of Aviation Results

- Air Incidents
- Separation Minima Infringement
- Inadequate Separation
- Ground Incidents
- Runway Incursion
- Potential Near Collisions Air
- Near Controlled Flight Into Terrain
- AC Deviation from ATM Clearance
- Level Bust
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- Failure of Comm Function
- Failure of Surveillance Function
- Failure of Data Processing Function
- Failure of NAV Function
- Failure of Information Support Function
### Step 3 ~ Validation of the Weighting Results

- Very important: Subject Matter Experts;
- Well prepared, good definitions, well explained;
- Consistent weighting validates the assessment and level of inconsistency. Sample below is actual SME results showing uniformity.

<table>
<thead>
<tr>
<th>Runway Incursion</th>
<th>All Ground Incidents which are not Runway Incursion</th>
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Legend:
- Blue: Runway Incursion
- Red: All Ground Incidents which are not Runway Incursion

*Note: This table shows the uniformity of weightings across different subject matter experts (SMEs).*
Conclusions & Caveats

- The APF is not a stand alone tool-
  - Current measurements must be maintained.
- The APF identifies “what” is happening, “where”, and “when” thru both trending and diagnostics:
  - As additional metrics, with greater granularity, are introduced into the APF, it will enable the quest for “why.”
- The APF is not a direct indication of risk.
  - But does reflect the organizations assessment of relative risk within the operation.
- The APF can be used to measure efficiency & effectiveness depending on what measures are used.
Step 4: The Actual APF Demonstration

- **Baseline**
  - Time frame selected by the organization.
  - Can be modified

- **Trending**
  - Shows performance over time to see changes
  - Includes subordinate measures that aggregate into overall APF

- **Performance parameters**
  - “Min-Max-Mean” from baseline performance accepted by organization
  - Executive level parameters (color codes)

- **Diagnostics**
  - The search for causal and contributing factors.