Knowledge Driven Risk Management

DSAC Symposium – Novembre 24th, 2011

“From event processing to risk management”

Andrew Rose – on behalf of UK CAA
We have huge amounts of data that has the potential to tell us how our ‘system’ is performing

but we use it in a piecemeal way

so what it tells us through its individual parts is nothing compared to what it would tell us as part of a homogenous picture
Effective risk management requires us to monitor the performance of our system. But it also requires us to understand what affects that performance and how we can influence it.

*Our responsibility is to ensure that we make best use of the data available to enable optimum risk management decisions.*
A Risk Management Perspective

Outcome Risk Performance

Demand/Expectation

Resources/Capability
If demand increases but our capability remains the same then we would expect our risk performance to deteriorate.
If we increase our capability for the same demand then we would expect our risk performance to improve.
If demand increases but we also increase our capability to match then we would expect our risk performance to remain the same.
By identifying data and measures to support each of these three variables in the system we can bring them together to form a Consolidated Risk Picture

Enabling really effective risk management at any level*

* The concept is scalable from the individual right up to the global system level
Historically, as an industry, we have spent most of our time, and effort, in the ‘outcome’ performance area

and within that we have concentrated further still on using employee reporting data

However we are increasingly interested in ‘system generated’ data but in the context of ‘another view’

We should be striving for a better picture: a cohesive picture...
Employee reporting data is a rich source of information but is narrow in its scope.

System generated data is often lacking in detail but wide in its coverage.

*combined they become a powerful source of system performance knowledge.*

"The whole is greater than the sum of its parts." - Aristotle
But there is more...

If we are really interested in a ‘big picture’ then we not only need to look *deeper* within our domains but also *wider* across the functional and global aviation domain

*A truly integrated aviation system needs an integrated view of risk performance*

"The whole is greater than the sum of its parts." - Aristotle
The key to bringing these wide sources of data together is a common understanding:

all these adverse events allude to **risk**; risk in terms of the likelihood of an accident outcome occurring

*Hence they share a commonality that allows us to place them in a common ‘risk space’*
The shared Risk Space
If this event had escalated into an accident, what would have been the most credible accident outcome?

- Catastrophic accident with multiple fatalities >8
- 1-8 fatalities, multiple serious injuries, major damage/loss to the aircraft
- Minor injuries, minor damage to aircraft
- No potential damage or injury could occur

What was the effectiveness of the remaining barriers between this event and the accident scenario?

- Not Effective
- Minimal
- Limited
- Effective

ARMS Event Risk Classification (ERC) Framework
### Probability of the incident progressing to the credible accident outcome

<table>
<thead>
<tr>
<th>Subjective</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholly dependent upon individual user’s knowledge of the system and the event</td>
<td>Wholly dependent upon a predefined model of the system and precise knowledge of the nature of the event and the occurrence rate of its components</td>
</tr>
</tbody>
</table>

- **Subjective**
  - Simply asking the question how close it was to the accident
  - Comparing the incidents to a menu of typical incidents to select the probability
  - Question how many barriers remain
  - Question the effectiveness of the remaining barriers
  - Use Expert knowledge to determine the importance of the barriers in the scenario and then challenge those barriers that remain

- **Objective**
  - Building a complete system model (Bayesian Network?) and letting the model answer the question
  - Developing a fault tree for the system and using system measures to determine how far through the tree the event is
Barrier models provide an ‘accessible’ way to evaluate the probability of an event progressing to an accident (*Safety Margin*).

**Q.** What barriers stopped this event progressing?

**Q.** What other barriers could also have stopped this event progressing?

**Q.** How reliable are those barriers?

Building upon:

- *Risk Analysis Tool (RAT)*
- *Analytical Hierarchy Process from the APF*
Formulating a Barrier Model

Scenario – system has three barriers and a Prob_{OUTCOME} of 10%, thus the barriers stop 90% of all undesirable operational states becoming an undesired outcome.

So what happens if Barrier A is eroded or does not exist?

Barrier A (40%)    Barrier B (30%)    Barrier C (20%)

Outcome (60%)
The Eurocontrol ‘RAT’

<table>
<thead>
<tr>
<th>Unmitigated collision risk</th>
<th>Controllability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict circumstances</td>
<td>Ground controllability</td>
</tr>
<tr>
<td>Separation</td>
<td>Closure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total (LAM) Risk of Collision (1-D)</th>
<th>Total (LAM) Risk of Collision (2-D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation ≥ 120 km</td>
<td>Separation ≥ 120 km</td>
</tr>
<tr>
<td>Separation ≥ 100 km</td>
<td>Separation ≥ 100 km</td>
</tr>
<tr>
<td>Separation ≥ 80 km</td>
<td>Separation ≥ 80 km</td>
</tr>
<tr>
<td>Separation ≥ 60 km</td>
<td>Separation ≥ 60 km</td>
</tr>
<tr>
<td>Separation ≥ 40 km</td>
<td>Separation ≥ 40 km</td>
</tr>
<tr>
<td>Separation ≥ 20 km</td>
<td>Separation ≥ 20 km</td>
</tr>
<tr>
<td>Ground controllability</td>
<td>Airborne controllability</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example output from Midair collision work
ARMS ERC and the Common Risk Classification Framework

**What was the effectiveness of the remaining barriers between this event and the accident scenario?**

If this event had escalated into an accident, what would have been the most credible accident outcome?

- **Catastrophic accident with multiple fatalities >8**
- **1-8 fatalities, multiple serious injuries, major damage/loss to the aircraft**
- **Minor injuries, minor damage to aircraft**
- **No potential damage or injury could occur**

What are the barriers in this scenario, how important is each barrier, and what is the status of each of the barriers in this case?
A common way to assess outcome probability: CRCF barrier model approach
+ application to the ERC risk space
= a comparable and combinable output in terms of risk with which…

Aerospace Performance Factor type tracking

European Safety Performance Indicators

...
What is Touchstone?

ASMT Workshop - Belgocontrol
27th-28th October 2011
Touchstone concept
‘Big Picture’ in terms of outcome/system performance

ATM Risk Data sources
Report Data
Conflict Data
TCAS events
Separation

Expert knowledge
Risk ref. data (SSR codes etc)

Risk Inference Model

Understanding the Past
Business-level: Easy Access to Information

ASMT Workshop - Belgocontrol
27th-28th October 2011
Understanding the Past
Unit-level: Easy Access to Data

ASMT Workshop
27th-28th October

NATS
Understanding the Past
Unit-level: Easy Access to Data

ASMT Workshop - Belgocontrol
27th-28th October 2011
The key to effective Risk Management is knowledge of how our system functions and how it is performing.

We need a better, and bigger, Risk Picture for outcome performance: bigger means both depth (data) and breadth (industry).

The ECAST CRCF work is an enabler to a common risk performance space that will facilitate that bigger picture.
Questions and Further Information

Questions

Contacts:

Andrew Rose – andrew@llanbury.co.uk

Joji Waites – joji.waites@caa.co.uk