Introduction

Why are we talking about Root Cause?

- To comply with the regulation
- Preventing repeat findings and repeat incidents
- To understand the problem
- To investigate the causal factors
- To learn from the event
- To make future improvements
- To support CAA’s performance based regulation of industry
- To support an organisation having an effective SMS
Definitions

Root Cause:
The fundamental reason for an event, which if corrected, would prevent recurrence. (The last cause in the chain.)

Specific Corrective Action:
Action taken to correct or improve the condition noted in the event by changing the direct cause or the direct cause and the effect.

Root Cause Analysis and Corrective Action Process:
An effective tool for finding the true or actual cause of events, facilitating effective corrective action and preventing their recurrence.
History – 1950’s

- 5 Whys - developed by Sakichi Toyoda (founder of Toyota)

- Used for development of Toyota’s manufacturing processes in 1958
History – 1960’s

- NASA - Management Oversight Risk Tree (MORT)

Complex, time consuming and expensive

Reserved for the highest risks and most mission critical activities

- MORT is also used by U.S. Department of Energy - Nuclear industry
History – 1960’s

U.S. DOE
MORT chart
History – 1970’s

- Federal Aviation Administration (FAA)

- Aviation Safety Reporting System (ASRS) introduced in 1975
  - ASRS is funded by the FAA, but administered by NASA
History – 1980’s

Motorola
Six Sigma Quality
1986
History – 1990’s

Exxon Valdez oil spill – 1989

1990’s - Exxon Mobil develops new strategies and safety processes
History – 2000’s

- Root Cause Analysis has been called a reactive process:
  - It is performed after the adverse event occurs.

- However, once Root Cause Analysis is applied thoroughly:
  - It soon becomes a proactive mechanism.
    - It predicts problems before they occur.

- Moving into the 21st Century……
  ......we have Exxon Mobil and BP, similar history, different results……….
History – 2007

- In 2007 Exxon abandoned an ultra-deep well known as Blackbeard, 32,000 feet below the sea floor in the gulf in shallow water and walked away from a $200M investment.

- Exxon’s drillers were concerned about drilling complications, extreme pressures and temperatures, and conditions suggesting a blowout was possible.

- The decision to stop drilling went all the way to the top. Exxon senior management supported the drillers’ concerns.

- At the time, they were criticized that they “didn’t have the guts” to finish the well.
History – 2009/2010

- 100 miles east of Blackbeard was the BP Macondo well being drilled by the Deepwater Horizon drilling rig.

- They encountered difficulties very similar to Exxon's Blackbeard well.

What did BP do?
They carried on drilling………. 
History – April 2010

- 11 fatalities
- 4.9 million barrels
- $53.8 billion
History – 2010’s

- Comments made about Exxon Mobile:
  - “Now, after the BP blowout, the Exxon decision looks different”.
  - “Exxon’s ‘lack of guts’ looks a lot more like justified conservatism and prudence, and an awareness that safety, caution and catastrophic risk avoidance would be key themes as oil companies were forced to push the envelope in the search for new oil”.
  - “The fact is that Valdez pushed Exxon to the highest safety standards in the industry.”

Today, Exxon stands out among its peers for its obsessive attention to safety, according to analysts and industry insiders.
History – 2010’s

- Aviation legislation now requires Root Cause Analysis…...
What does ICAO say?

ICAO Safety Management Manual (SMM)

\begin{itemize}
  \item ……contribute to the continuous improvement of the aviation system by providing the \textit{root causes} of accidents/ incidents and lessons learned.
  
  \item ……appropriate follow-up action is expected, such as further analysis to determine source and \textit{root cause} of the abnormal incident……
  
  \item ……quality and safety practitioners are trained on various analysis methods including \textit{root cause analysis} and statistical trending analysis.
  
  \item ……an SMS is supported by QMS processes such as auditing, inspection, investigation, \textit{root cause analysis}, process design, statistical analysis, and preventive measures……
\end{itemize}
What does EASA say?

- ……existing systems quite often fail to properly establish the root cause or causes and contributing factors……
  ……which leads to ineffective corrective actions.

- Thorough analysis of causes and contributing factors will enhance an organisation’s capability to perform proper risk assessment.

- Proper understanding of past problems is important for the ability to think about hazards and risks.
  ……What happened? ……what could happen?
  ……Why did it happen? ……could it happen again?
  ……What were the direct causes? ……contributing factors?
Legislation – EASA
Standardisation/Accreditation

COMMISSION IMPLEMENTING REGULATION (EU) No 628/2013

- Article 2, Definitions, (8) …… ‘corrective action’ means an action to eliminate the cause of a finding of non-conformity with the applicable requirements in order to prevent recurrence;

- The competent authority shall report to the Agency in due time on the completion of corrective actions and provide evidence thereof.

“During the audit it could not be demonstrated by the UK CAA that a process that covers all of the organisation is in place in order to analyse the root cause of findings raised to organisations supervised by the UK CAA on behalf of EASA”.

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Legislation – Parts M, 145, 147, 21

- **M.A.905(c)** appropriate corrective action to prevent reoccurrence of the finding and its root cause
- **AMC M.A.403(b)** analysis necessary to identify the root cause of the defect
- **AMC M.B.104(f)** to determine the root cause
- **M.A.619(c) - M.A.716(c) - M.A.905(c) - 145.A.95(c) - 147.A.160(c) - 21.A.125B(c) - 21.A.158(c)** corrective action to the satisfaction of the competent authority
- **M.A.712(a)** ensure corrective action as necessary
- **M.B.605(a) - M.B.705(a) - 145.B.50(a)** until successful corrective action has been taken by the organisation subject to a satisfactory corrective action plan.
- **M.B.903** shall require appropriate corrective action the corrective action required by the competent authority
- **145.A.60(b)** corrective actions taken or to be taken by the organisation
- **145.A.65(c)** ensures proper and timely corrective action is taken in response to reports
Legislation - Occurrence Reporting

Regulation (EU) No 376/2014
on the reporting analysis and follow up of occurrences in civil aviation

- The follow up requirements are not intended to jeopardise the quality and thoroughness of an occurrence analysis. It may be detrimental to safety if rushed in order to be completed within the encouraged three months period without properly establishing root cause and determining relevant remedial action.
Future Legislation – EASA NPA’s

NPA 2013-01 (A)
Embodiment of Safety Management System (SMS) requirements

- NPA 2013-01 (B) ‘Part-M’  18 instances of Root Cause in document

- NPA 2013-01 (C) ‘Part-145’  13 instances of Root Cause in document
Other National Aviation Authorities

- **DAC:** Root cause is part of inspector training.
  During our operators meetings, we gave some example of root cause analysis tools.
  We challenge the operators when receiving answers to findings.

- **DGAC:** We mention the Ishikawa diagram method
  (or fishbone diagrams, cause-and-effect diagrams, "5 M" méthod).
  The other method often mentioned and very simple to use is the "5 why method".
  We are not in the step to recommend a particular method to perform the root cause analysis but it's clear this issue is a very interesting one.

- **LBA:** 5-Why-Method and Ishikawa diagrams is encouraged to determine root causes.
  We are very interested in your project and would be delighted to establish an exchange of ideas with CAA UK on that matter.

- **STA:** We have not a special method in the procedures, but we mostly use the “Why” method.
  We want to see the RCA the organisations has done, to see they have found the causal factor/s.
  Then we focus on the corrective action to see it solves the causal factor so they create a change and not just only a correction (“quick fix”).
What does the CAA intend to do:

We now intend to:

- Engage with you with respect to Root Cause Analysis.

- Collaborate with EASA and the other NAA’s to standardise and share best practice for Root Cause Analysis in Europe.

*We will be publishing information (which is currently in draft) for guidance on Root Cause Analysis.*
Possible Techniques

Increasing Complexity of Finding / Incident / Problem / Accident

- 5 Whys
- 3 Concerns (3 C)
- Fish Bone (Ishikawa)
- Kepner-Tregoe
- Bayesian Inference
- Bow Tie
- Shainin (Red X)
- Standard Problem Statements (CAST)
- SIRA
- Fault Tree Analysis
- 8D (8 Disciplines)
- AAG / THREAT Review
- Six Sigma
Available in-house Techniques

The complexity of the organisation determines the in-house capability for advanced techniques

The complexity of the problem determines the choice of appropriate technique

You may need external assistance for advanced techniques
Technique example: 5 Whys


unworkable

workable
Technique example: Fishbone (Ishikawa)
### Technique example: 8D (Disciplines)

#### Problem Solving (8D) - Peer Review Checklist

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 0</td>
<td>Implement Immediate Containment and Prepare for 8D</td>
<td>5</td>
</tr>
<tr>
<td>Step 1</td>
<td>Form The Team</td>
<td>5</td>
</tr>
<tr>
<td>Step 2</td>
<td>Define The Problem</td>
<td>5</td>
</tr>
<tr>
<td>Step 3</td>
<td>Develop Containment Actions</td>
<td>5</td>
</tr>
<tr>
<td>Step 4</td>
<td>Implement Permanent Fix</td>
<td>5</td>
</tr>
<tr>
<td>Step 5</td>
<td>Verify Fix</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: For the level of detail chosen, all "Actual" scores on the Criteria Scoring sheet must be at or above 2 for the investigation to meet the minimum expected standard.
CAA Techniques: Bow Tie

- Planned or unplanned interruption in task by engineer (Break in Task)
  - No current oversight activity
  - Policy and procedure for interrupting engineers working
    - MRO
    - Elimination
    - Poor
    - Policy/Procedure
    - +
  - Planning of tasks and identification of required materials and resource
    - MRO
    - Prevention
    - Good
    - Policy/Procedure
    - +
  - Use of checksheets/job cards/AMM by engineer to retrace action taken on task
    - MRO
    - Prevention
    - Good
    - Policy/Procedure
    - +
  - Shift handover procedure between personnel
    - MRO
    - Prevention
    - Good
    - Policy/Procedure
    - +
  - Ad hoc task handover procedure between personnel
    - MRO
    - Prevention
    - Poor
    - Policy/Procedure
    - +

- Insufficient time to complete effectively

- Incorrect Maintenance Action

Engineering Performance: UK 145 A Rated Base Maintenance Operation

31
CAA Techniques: MORs

ECCAIRS 5 - MORS Closure

File Number: 201600003
Safety Data Section: 3D1.0ip
Aircraft Type: A380 • A330 • B747
Registration: G-VSY
Operator: Virgin Atlantic Airways
Executor: AW/ Large Airworthiness Orgs Gatwick

Occurrence Date: 16/01/2016
Occurrence Grade: C

Recorded maintenance:
Tonight I have come to work to take over the E check. I have again found that I will be expected to clear 30 cards minimum that have been worked mainly by 3rd party contractors. A total of about 70 man hours. I have not seen these people 1 do not know who these people are 1 do not know if the work has been done. If this work has been carried out, who supervised and were they competent. All work should be supervised by a fully qualified Certifying engineer responsible for the work.

EXECUTOR CLOSURE STATEMENT
The Executor must justify the reason(s) for recommending the Closure. Please provide a concise statement, which must outline the investigation findings, root cause and action taken to rectify the Occurrence. Reference made only to an attached report is NOT acceptable as a Closure Statement - An appropriate justification Closure must still be provided. Where appropriate, an assessment of the Human Factors involved would be appreciated.

Name: DGancie
Line Manager Approved: 

Investigation Findings
Root Cause Remedial Actions Supplementary Info
Finally

- Proper establishment of the **root cause or causes** and contributing factors……
  
  …… leads to effective **corrective actions**.

- Effective **corrective actions**……
  
  …… lead to reduced **repeat findings** and **incidents**.

- Reduced **repeat findings and incidents**……
  
  …… lead to **increased safety** and **reduced costs**.
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John McColl
Kevin O’Connor
Peter Moule
Mark Swift

Airbus
Rolls Royce

EASA

DAC - Luxembourg
DGAC - France
LBA - Germany
STA - Sweden

Any Questions?
So then they skipped root cause analysis and jumped right to solutions and were surprised when the problem kept occurring..