



Root Cause Analysis

Matt Lillywhite and Paul Dyer

29 June 2016

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.



Root Cause Analysis History and Regulation

Paul Dyer

History – 1950's

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



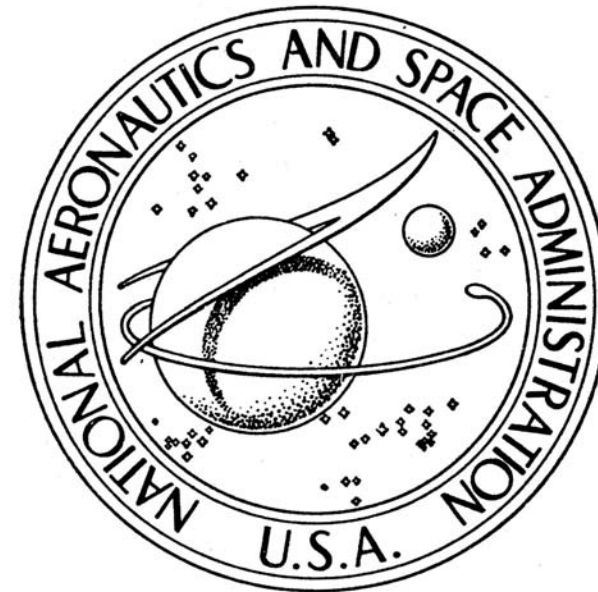
- Used for development of Toyota's manufacturing processes in 1958

History – 1960's

- NASA - Management Oversight Risk Tree (MORT)

Complex, time consuming and expensive

Reserved for the highest risks and most mission critical activities

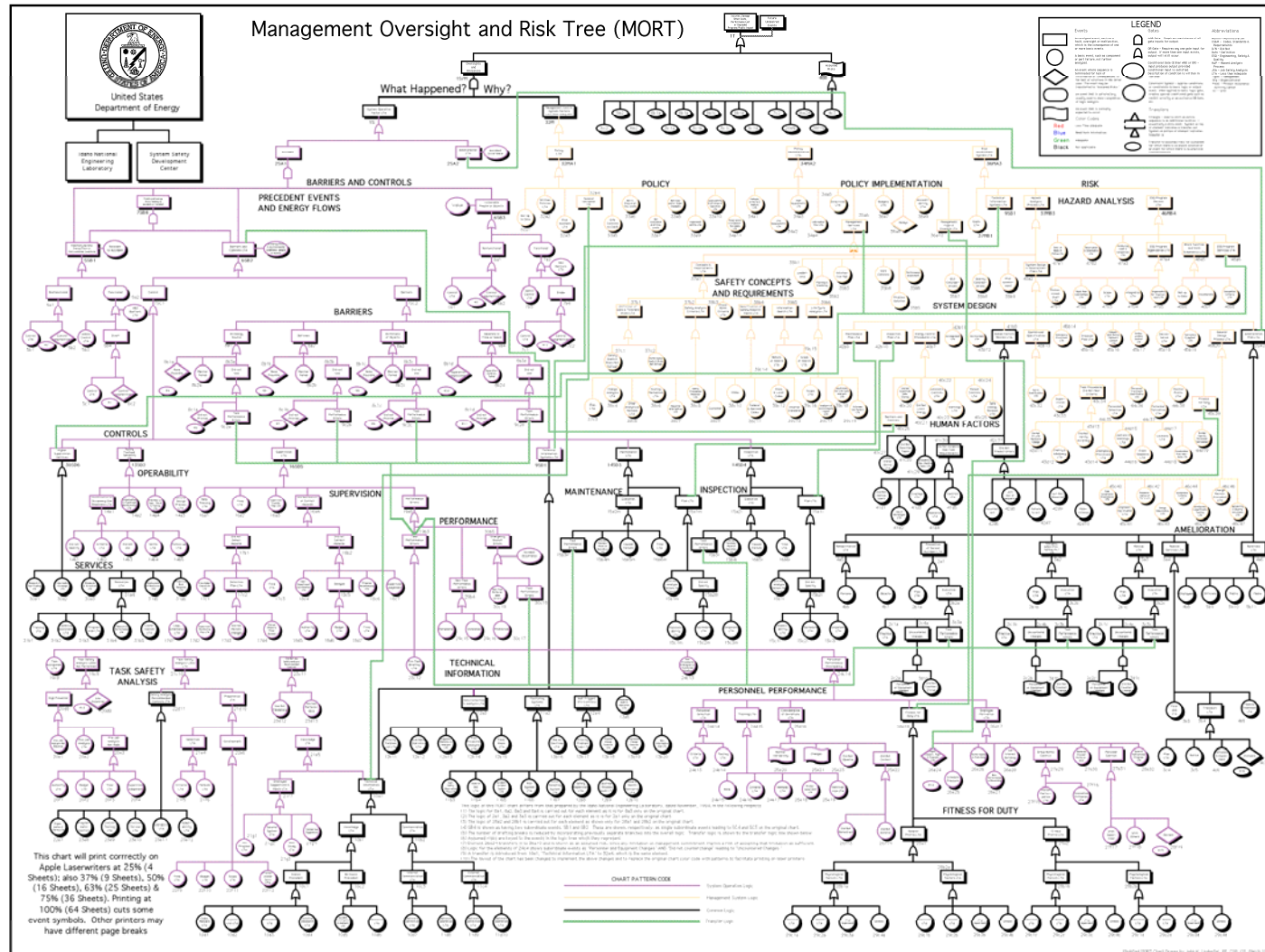


- MORT is also used by U.S. Department of Energy - Nuclear industry

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



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.....

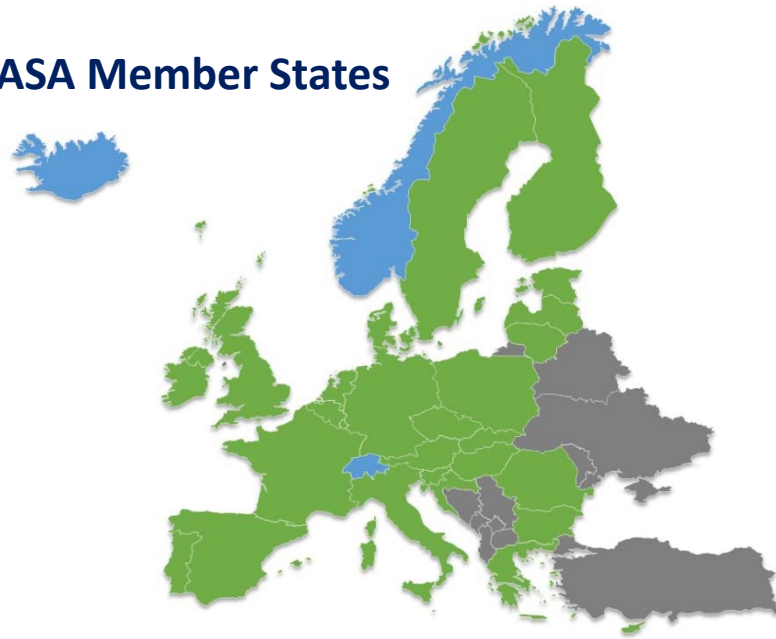


INTERNATIONAL CIVIL AVIATION ORGANIZATION
A United Nations Specialized Agency



EASA
European Aviation Safety Agency

EASA Member States



Stakeholders



What does ICAO say?

ICAO Safety Management Manual (SMM)

-contribute to the continuous improvement of the aviation system by providing the **root causes** of accidents/ incidents and lessons learned.
-appropriate follow-up action is expected, such as further analysis to determine source and **root cause** of the abnormal incident.....
-quality and safety practitioners are trained on various analysis methods including **root cause analysis** and statistical trending analysis.
-an SMS is supported by QMS processes such as auditing, inspection, investigation, **root cause analysis**, process design, statistical analysis, and preventive measures.....

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”.

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" méthode).
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.



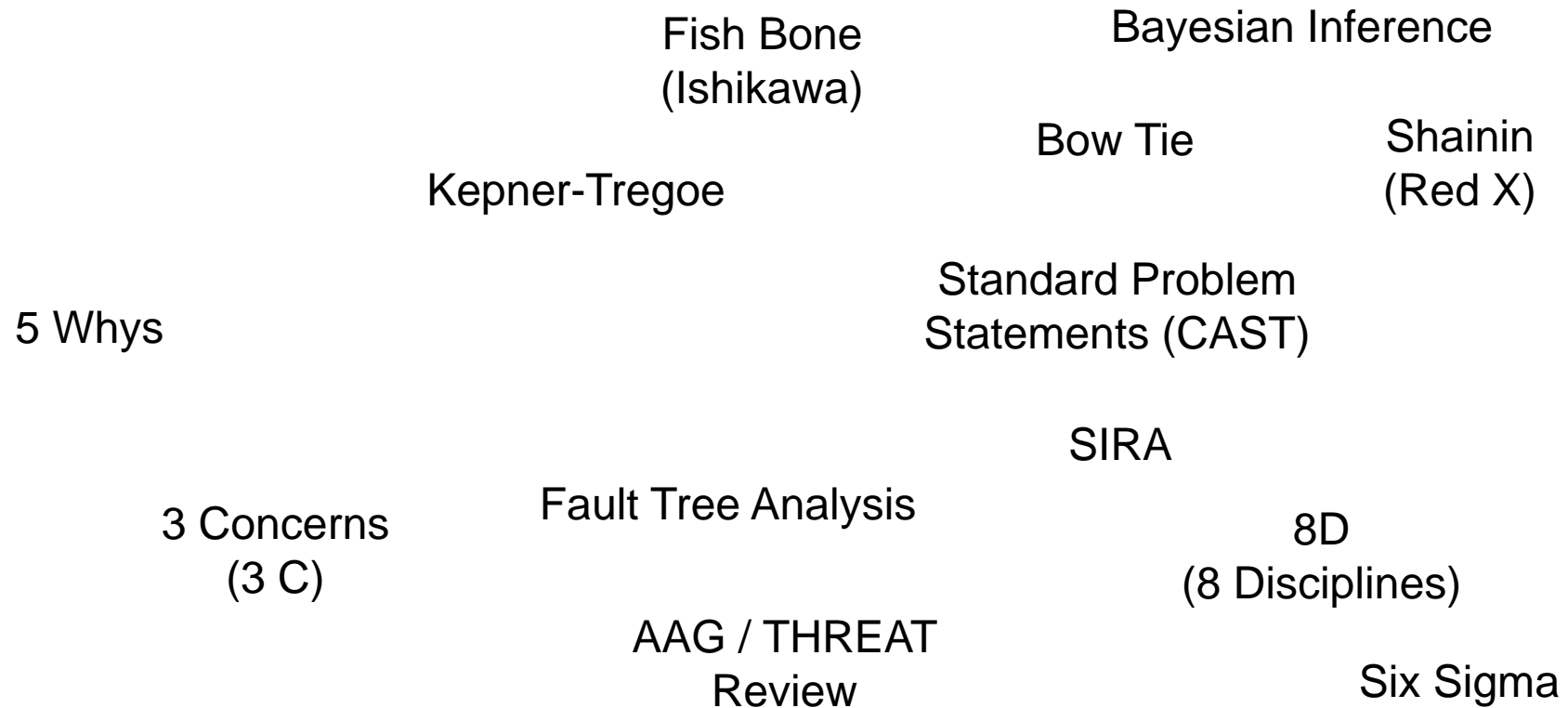
Root Cause Analysis Techniques

Matt Lillywhite

Possible Techniques



Increasing Complexity of Finding / Incident / Problem / Accident



Available in-house Techniques

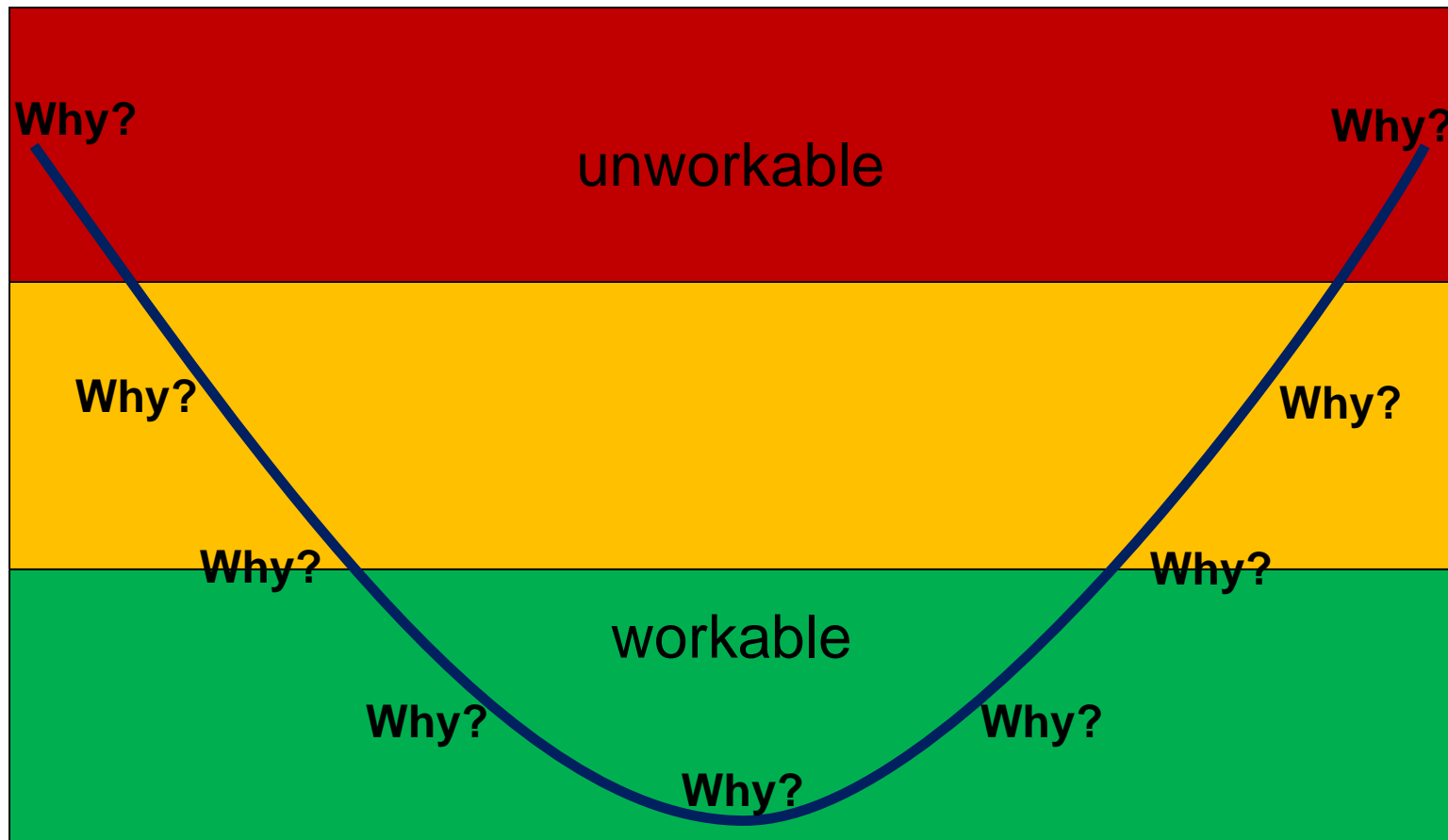
The complexity of the organisation determines the in-house capability for advanced techniques

The complexity of the problem determines the choice of appropriate technique

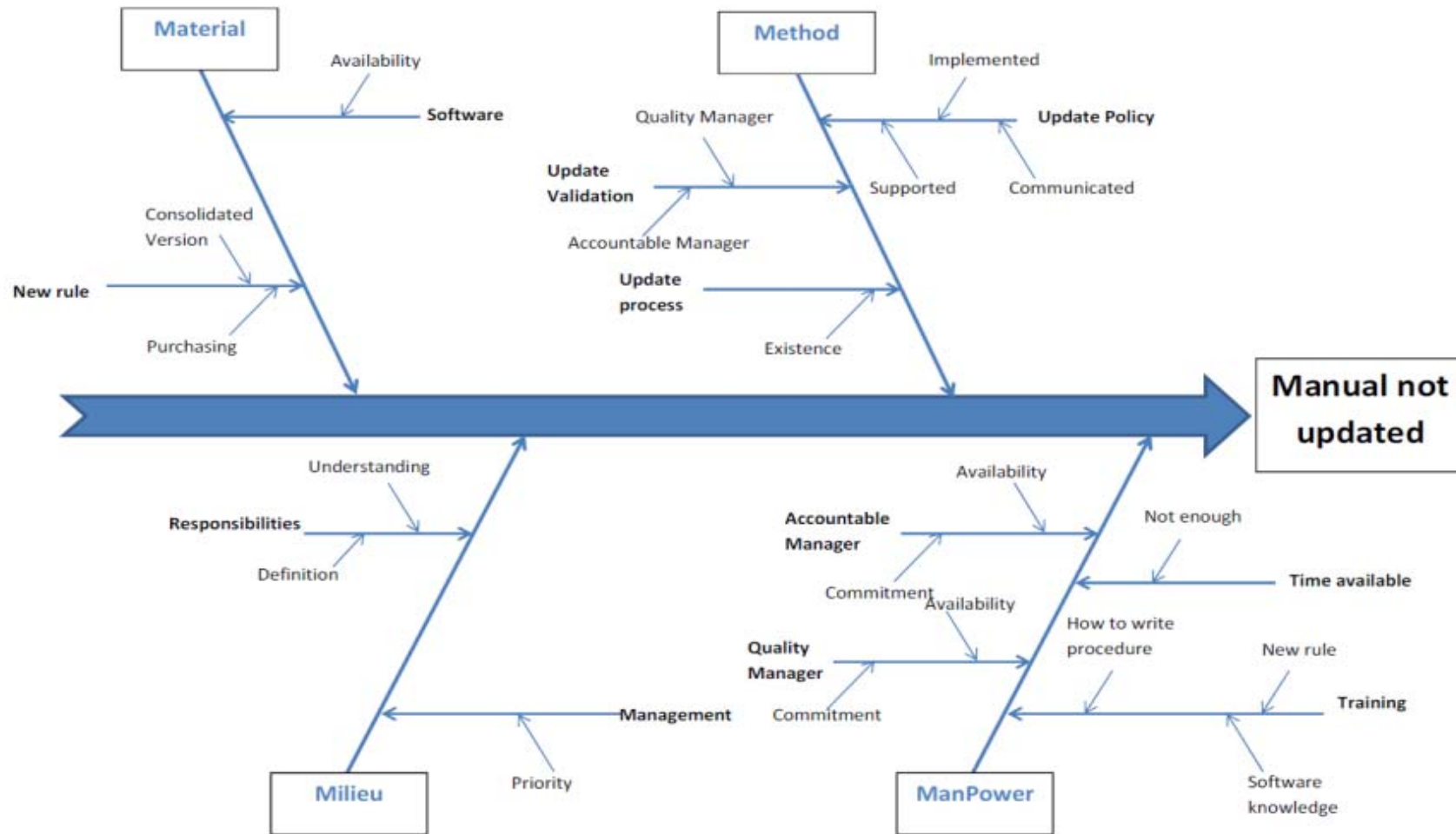
You may need external assistance for advanced techniques

Technique example: 5 Whys

Why – Why – Why – Why - Why



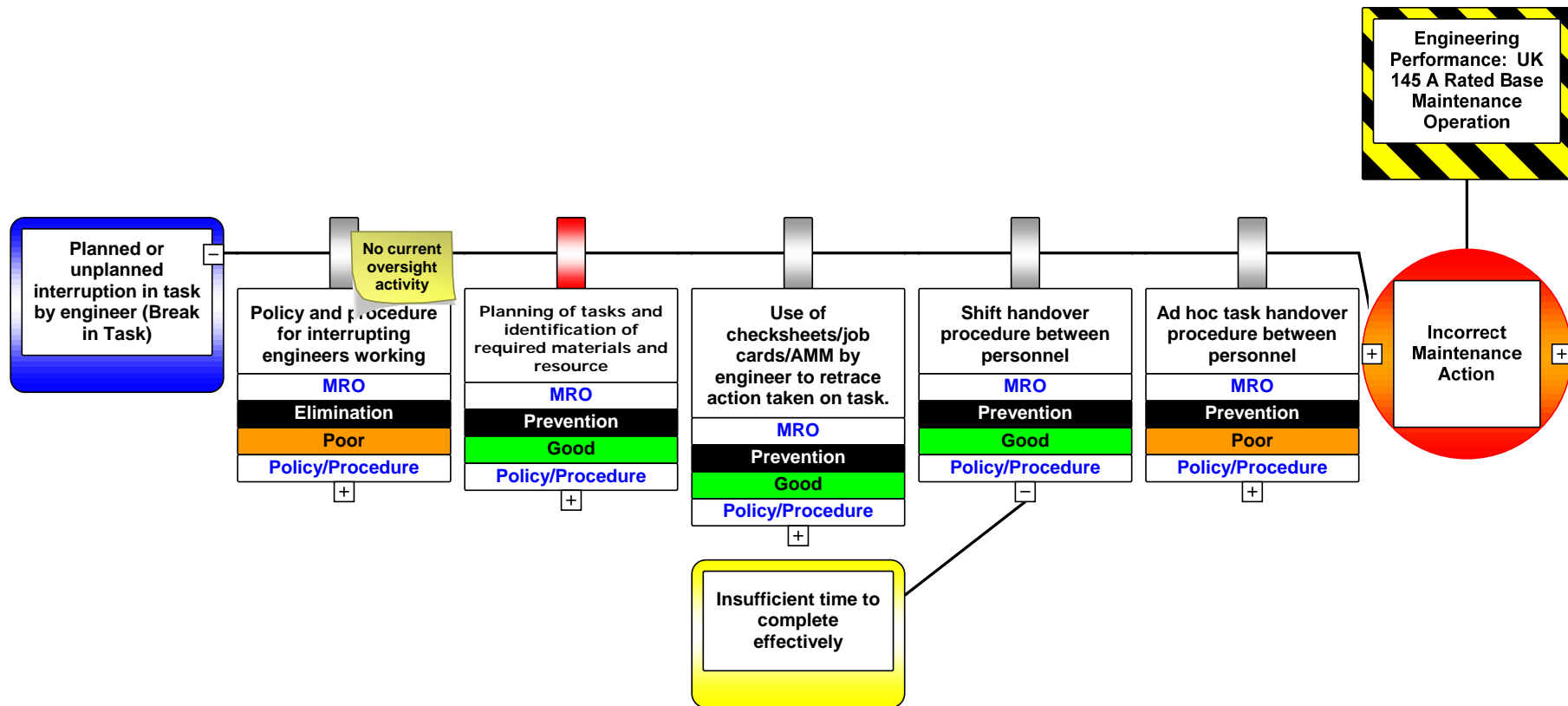
Technique example: Fishbone (Ishikawa)



Technique example: 8D (Disciplines)

Problem Solving (8D) - Peer Review Checklist					v2.4 04th Nov 2015
High		level of peer review detail selected.		click here to EMAIL completed Peer Review into Global Quality	
Note : For the level of detail chosen, all "Actual" scores on the Criteria Scoring sheet must be to be >2 for the investigation to meet the minimum expected standard.					
This Peer Review has demonstrated that the 8D investigation concerned has not met the minimum expected standard					
<p>1) Choose the Peer Review level of detail required (High or Medium) in the box at the top of this sheet.</p> <p>2) Fill in the appropriate details in the yellow boxes in the "Header Information" - note all fields should be completed.</p> <p>3) Enter "Actual" scores against each Requirement on the sheet with appropriate Comments.</p> <p style="margin-left: 20px;">All items scoring a 1 (=no evidence) or 2 (=some missing or incomplete information) shall have details of the action required to "fix" the issue entered in the yellow comments box. The actions should then be addressed by the Problem Investigation Owner to bring the investigation up to the required minimum standard. Individual items that are scored 3 (=could be clearer) should contain recommendations on clarity/detail. This will not require re-assessment but the guidance given should be taken into account for future investigations. Certain questions may be deemed "Not Applicable" by the assessor. In this case, please score a 3 (could be clearer) and state "Not Applicable" in the comments box. When items score a 4 (=satisfactory) or 5 (=robust evidence), no further guidance or work is required.</p> <p>4) Based on the scoring given, the top of this sheet will indicate if the investigation concerned has met the required minimum standard.</p> <p>5) When Peer review completed click on button at top of sheet to email a copy of the peer review into central Global Quality.</p>					
Header Information					
QN Number :		Date QN Raised :			
Problem Investigation Owner :		Reviewer :			
Sector :		Review Date :			
Plant / Cell / Dept :		Oversight Number :		optional	
Step D0 Implement Immediate Containment and Prepare for 8D	How has it been established if a field action was required as part of the emergency action response (ERA)? How was the emergency response action verified?	5			
	How well has the effect of the issue on the customer and Rolls-Royce been quantified?	5			
	Has the priority (severity, urgency, growth) of the symptom warranted initiation of the 8D process? Is this in line with Company policy e.g. sentencing matrix in QIP QI 2.1?	5			
	Have management committed / dedicating the necessary resources to fix the problem at the root cause level and to prevent recurrence?	5			
Step D1 Form The Team	Has consideration been given to any special skills, experience or team composition that may be required to enable the team to function effectively? e.g. competent coach/practitioner for high impact issues (MQI / DI 50 / DI 25).	5			
	Have the team been given the appropriate time to support the 8D investigation?	5			
	What consideration has been given as to whether a facilitator is needed to coach the process and manage team consensus?	5			
Step D2 Define The Problem	Has a specific Problem Statement been defined (object and defect)? Has it been established what is wrong with what? Is there evidence to show that this has been reviewed and agreed by key stakeholders?	5			
	Has it been established where in the process this problem first appeared? Has a timeline showing the sequence of events been produced?	5			
	Have appropriate tools been used to help identify a solid understanding of the problem and its definition.	5			
	How well has appropriate information been used to define the problem?	5			
Step D3 Develop Containment Actions	Have appropriate Interim Containment Actions (ICA's) been developed? These should include protective measures at the 'escape point(s)' and any field actions as part of the ICA? Is the customer in agreement with these protective measures (when required)?	5			
	Has all potentially affected material been considered? e.g. similar parts in all potential store locations, material currently in production, material in transit (including to the customer), similar customer part numbers etc.	5			
	How well has containment action been implemented? e.g. through implementing temporary changes to control plans, inspection plans, work instructions etc.?	5			

CAA Techniques: Bow Tie



CAA Techniques: MORs

ECCAIRS 5 - MORS CLOSURE

Safety Data Mandatory Occurrence Reporting

CLOSURE RECOMMENDATION OF AN OPEN OCCURRENCE REPORT

File Number:	201600603	Occurrence Date:	19/01/2016
Safety Data Section:	SDU Ops	Occurrence Grade:	C2
Aircraft Type:	AIRBUS - A330 - 300 - 343	*Other Aircraft Type:	
Registration:	G-VSXY	*Other Registration:	
Operator:	United Kingdom - Virgin Atlantic Airways Ltd	*Other Operator:	
Executor:	AW/ Large Airworthiness Orgs Gatwick	Informee(s):	AW/ Resource Planning (Chief Surveyor)

Headline: Unrecorded maintenance.

Narrative Text: 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 I do not know who these people are I 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 assigned to inspection.

EXECUTOR CLOSURE STATEMENT

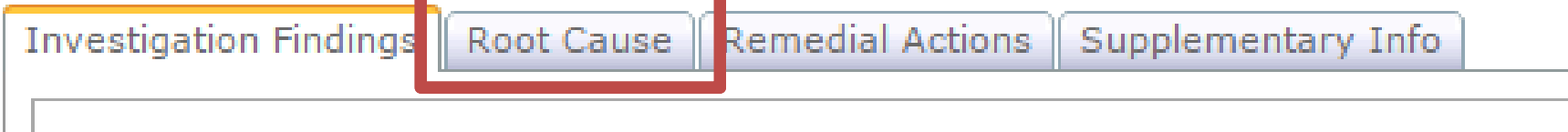
The Executor must justify the reason(s) for recommending the Closure. Please provide a concise statement, which must outline the investigation findings, root cause and action taken to rectify the Occurrence. Reference made only to an attached report is NOT acceptable as a Closure Statement - An appropriate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

Name: J Digance Line Manager Approved:

Investigation Findings | **Root Cause** | Remedial Actions | Supplementary Info

SAVE DETAILS | SUBMIT | CLOSE

ECCAIRS 5 MOR Closure Web Site v.1.0.0.15



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**.

Acknowledgements:

Mark Barker
Dr. Ted Blacklay
Simon Fulbrook
Jonathan Hughes
Catherine Leach
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 suprised when the problem
kept occurring..**