The Use of Bowties to Aid the Management of Risk in the Mining Industries

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Risktec Solutions

- Independent and specialist risk management consulting and training provider
- Part of the TÜV Rheinland Group
- We help clients to manage health, safety, security, environmental (HSSE) and business risk in sectors where the impact of loss is high
- 250+ employees across 14 offices worldwide
- 50+ FTE associates embedded in client organisations
- …working in 7 diverse market sectors
- …delivered over 5,500 projects to over 1,200 clients in over 75 countries
- …providing practical solutions (no two assignments are the same!)






TÜV Rheinland

- 20,000 people in 500 locations in 65 countries
- World leading independent provider of technical services for testing, inspection, certification, consulting and training to the industrial, transportation and healthcare sectors

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Our consulting services

RISK ENGINEERING

- Hazard Identification
- Physical Effects Consequence Modelling
- Qualitative Risk Assessment
- Bowtie Risk Management
- Quantitative Risk Assessment
- Functional Safety
- ALARP Assessment
- Availability, Reliability & Maintainability

RISK MANAGEMENT

- Asset Integrity Management
- Process Safety Management
- HSSE Management Systems
- HSSE/ Safety Cases
- Independent Review & Auditing
- Incident Investigation
- Emergency Planning & Crisis Management
- Business Continuity Management
- Security Risk Management

CULTURE & BEHAVIOUR

- Safety Leadership
- Cultural & Behavioural Improvement
- Human Factors
- Competency Management
- Workplace Safety
- Training & Education
  - MSc
  - RPQ
  - In-house & public training

Products (reseller) – BowTieXP, Investigator-3

TÜV Rheinland provides a broad range of testing, inspection, certification and training services, significantly extending the services offered to our clients

From small work packages to large, complex projects

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The Mines Regulations 2014

Regulation 7 – General Duties of the Mine Operator

1) The mine operator must take the necessary measures to ensure, so far as is reasonably practicable, that the mine and its equipment are designed, constructed, equipped, commissioned, operated and maintained in such a way that persons at work can perform the work assigned to them without endangering their own health and safety or the health and safety of others.

22 The mine operator should employ a risk management approach to identify the measures which are required to secure workers' health and safety. A typical risk management system would usually include the following elements:

(a) identifying the hazards;
(b) quantifying the risks;
(c) examining the control options available and their merits, including the human factor aspects, and setting appropriate control measures;
(d) implementing the control measures;
(e) monitoring the effectiveness of the control measures and revising where necessary.

26 The mine operator and all those in the management structure should appreciate the difference between major hazard risk SPIs and those relating to non-major hazard risks. Commonly used measures of safety performance such as accident, ill-health or incident statistics (lagging indicators) are not reliable indicators of how well the measures to prevent major hazard incidents are working.

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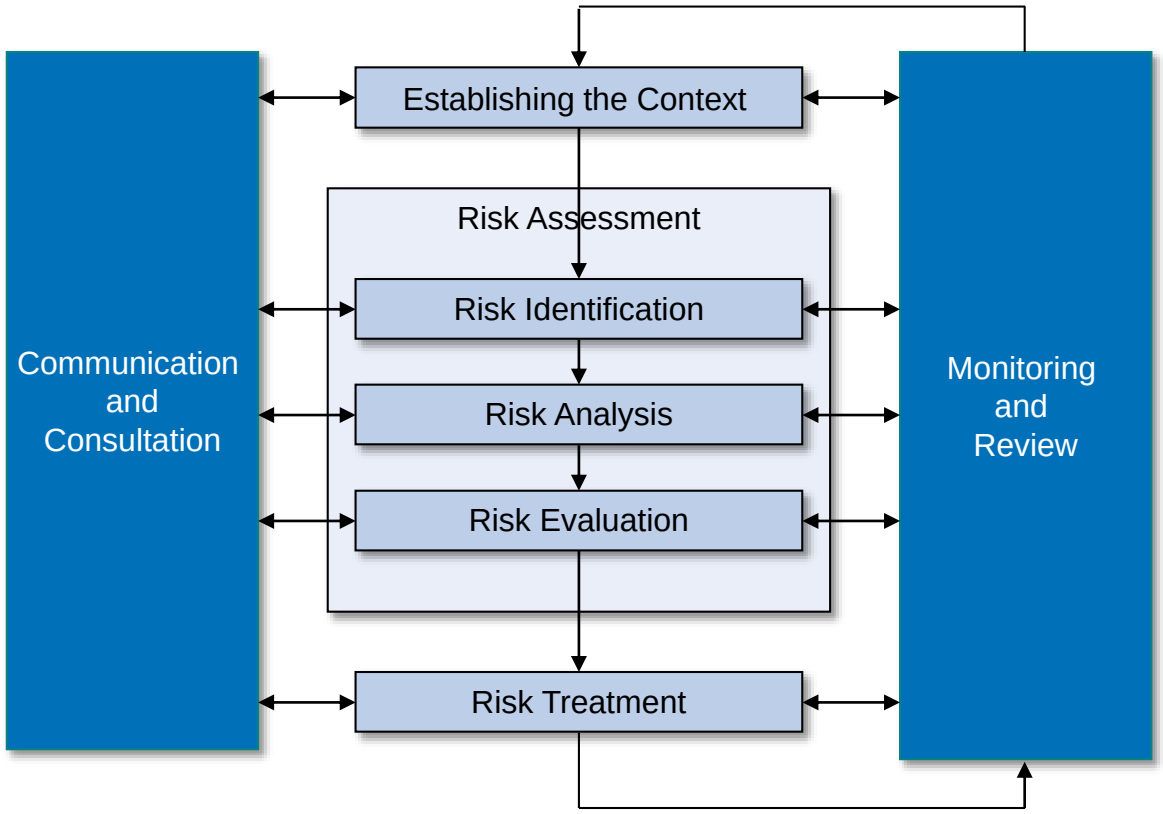
Risk management process



Ref. ISO 31000:2009 Risk management – Principles and guidelines

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Risk management

✓ Is this tolerable?
? Can we do anything more?

IDENTIFY

Are people, environment, assets or reputation exposed to potential harm?
What could go wrong?

ASSESS

What are the causes and consequences?
How likely is it?
How bad will it be?
What is the risk and is it ALARP?

CONTROL

Can the causes be eliminated?
Is there a better way?
How can it be prevented?
How effective are the controls?

RECOVER

Can the potential consequences be limited?
What mitigation measures are needed?
Are recovery capabilities suitable and sufficient?

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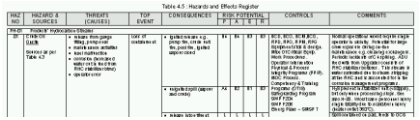
Where do Bowties fit in?

Identify Hazards

Risk Management



Develop Risk Scenario

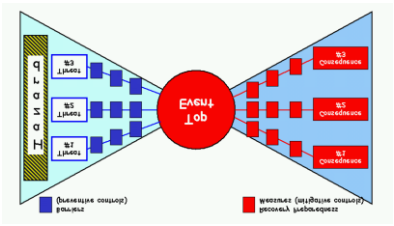
Severity	CONSEQUENCE				FREQUENCY				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of incident in the industry	Has occurred in industry	Has occurred in company	Occurs several times per year in company	Occurs several times per year at location
0	No injury	No damage	No effect	No impact					
1	Slight injury	Slight damage	Slight effect	Slight impact					
2	Minor injury	Minor damage	Minor effect	Limited impact					
3	Major injury	Localised damage	Localised effect	Considerable impact					
4	1 – 3 fatalities	Major damage	Major effect	National impact					
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

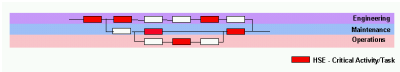
Manage for continuous improvement

Incorporate risk reduction measures

Intolerable

Assess Risk





Detailed Analysis of Significant Risks

Usually, but not always. Establish the objective of the bowties before you start

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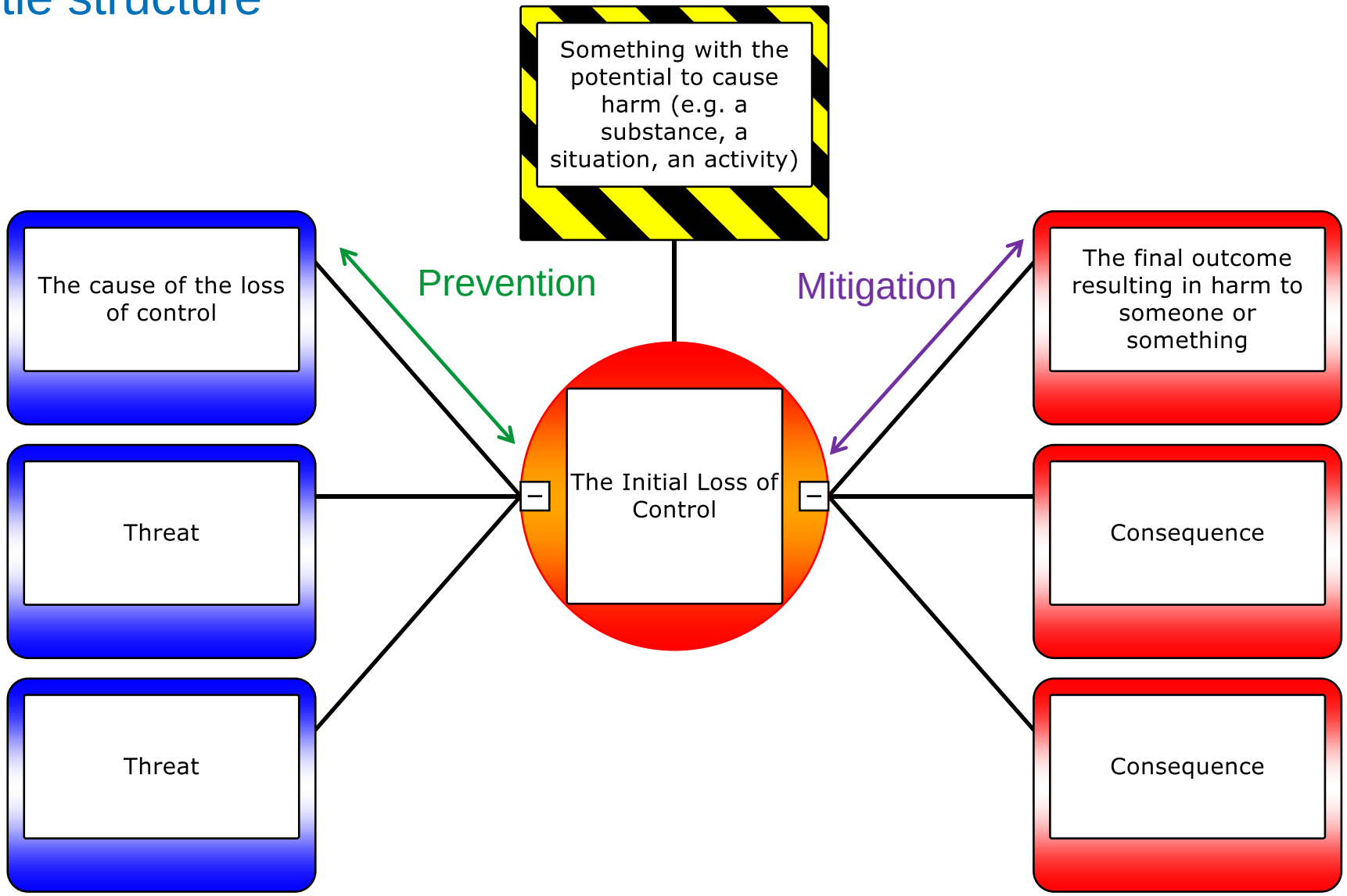
Bowtie Methodology

A short History…

- Exact origins of bow-tie methodology are hazy – believed to originate from ICI in the late 1970's
- Royal Dutch/Shell Group first major company to integrate bow-ties fully into business practices
- Use of bow-ties now widely spread between companies, industries, countries and from industry to regulator, e.g.:

  - UK Health and Safety Executive
  - Civil Aviation Authority
  - French Government
  - Australian State Regulator
  - Land Transport Safety Authority of New Zealand
  - International standards (e.g. ISO 17776:2000)
  - International Association of Drilling Contractors (IADC)

Basic bowtie structure



This *leads to* **This** *leads to* **That**

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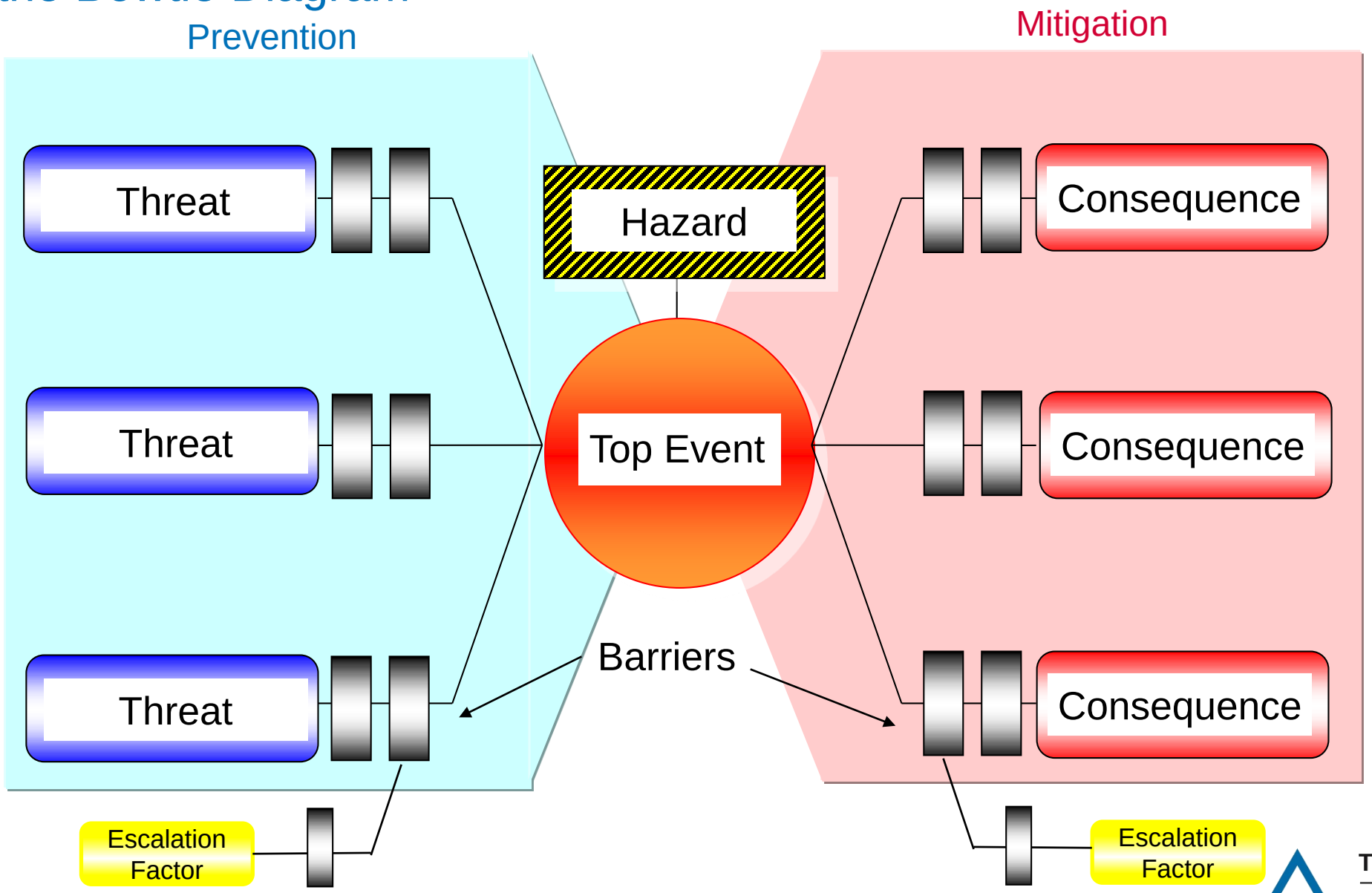
Building the Bowtie Diagram



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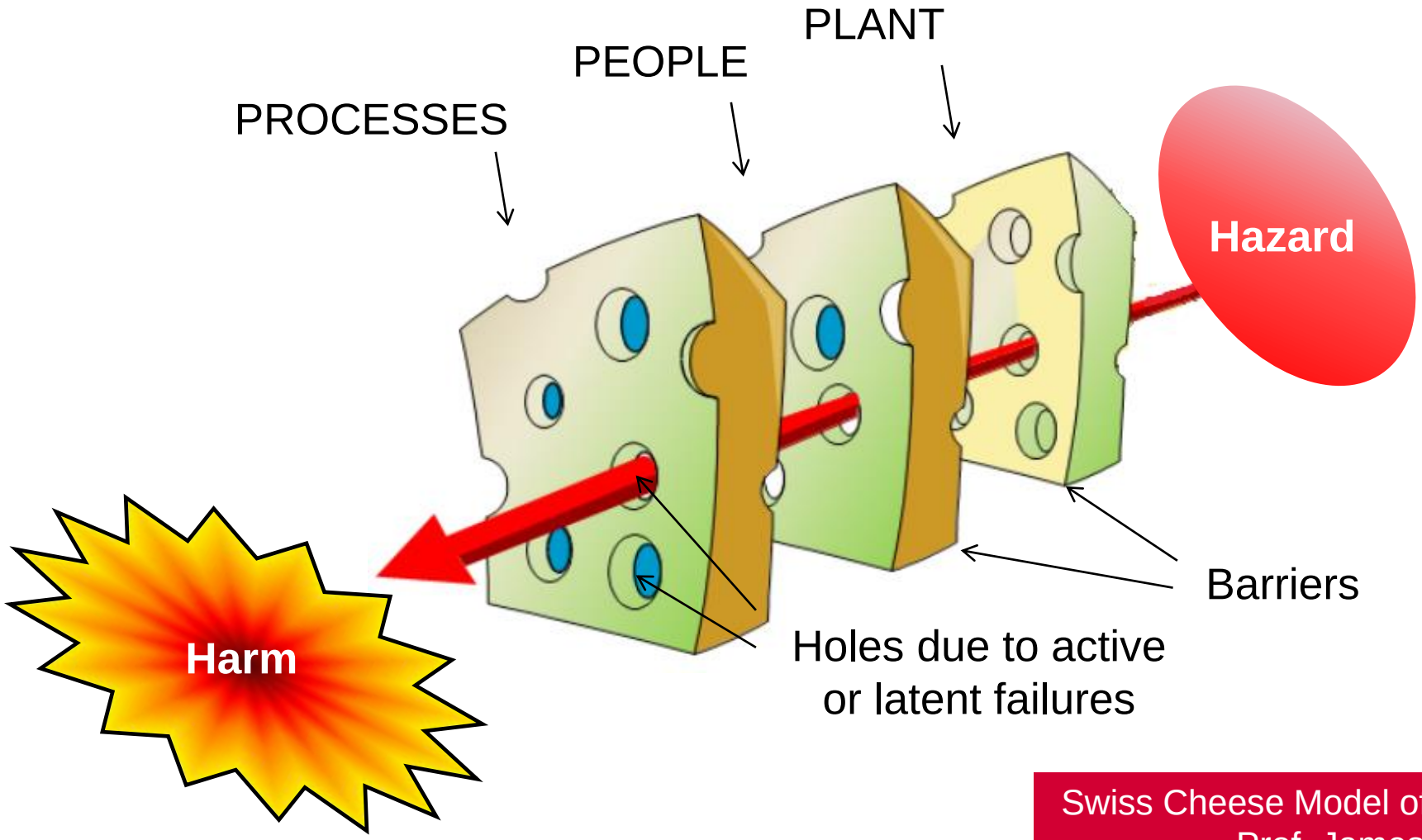
General Guidance

- Threats must be capable of releasing the hazard
  - Failed barriers aren't threats
- Barriers should be:
  - Prevention - can, by themselves, of preventing the threat causing the top event
  - Mitigation - mitigate the consequences of a top event once it has occurred
  - Relevant to the threat or consequence
- Active barriers should include elements of:
  - detection, problem solving and action
- All barriers should be:
  - clearly defined and consistent
  - independent
  - measurable
  - relatively effective
- Escalation Factors compromise the effectiveness of barriers

How are controls made effective?



Swiss Cheese Model of accident causation
Prof. James Reason

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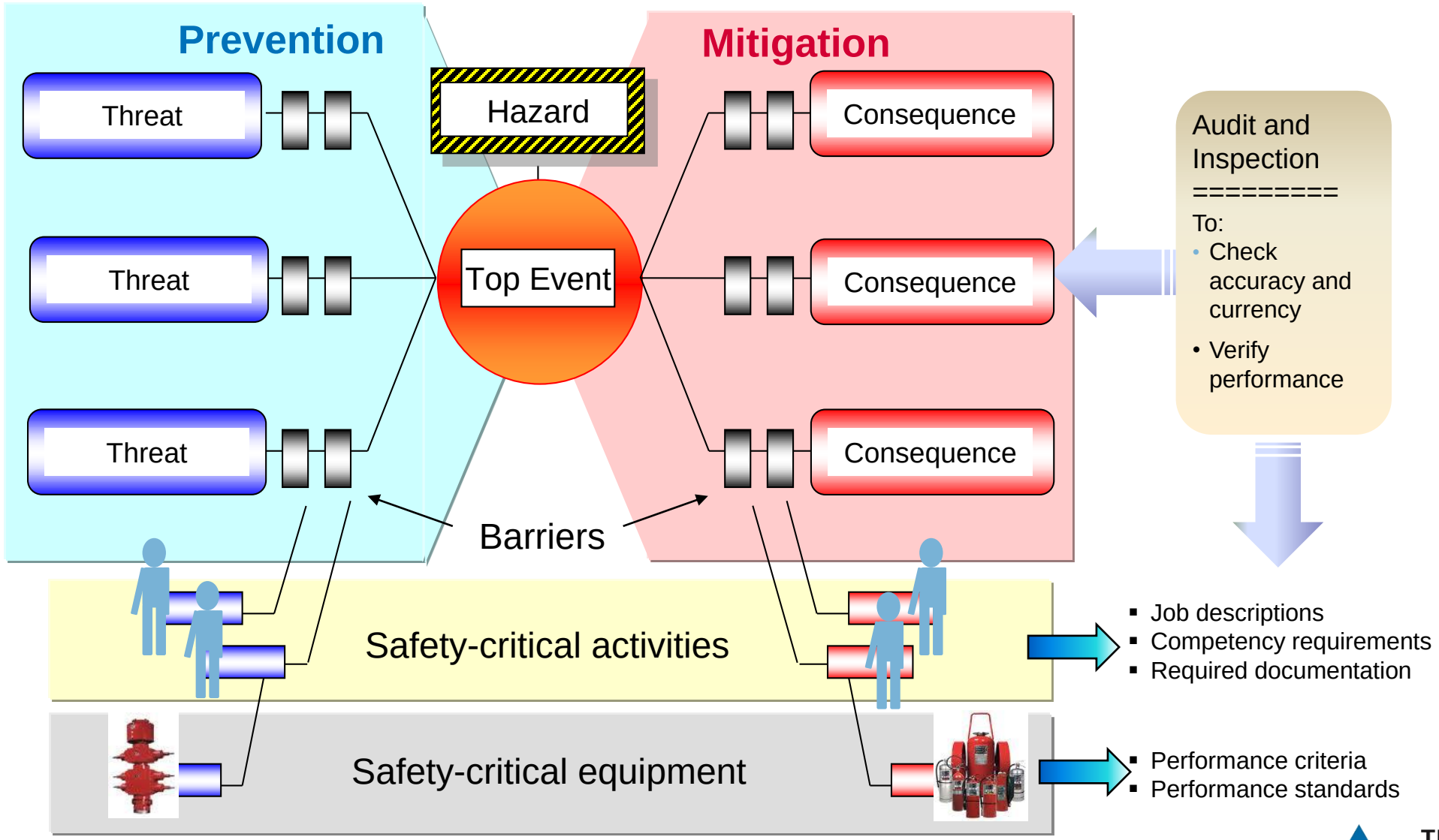
How controls are made effective in bowties



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Performance standards

A Performance Standard describes how a SCE must perform in terms of its functionality, availability, reliability and survivability, and also any interdependence with other SCEs

- Provide assurance that SCEs are, and remain suitable for, their intended purpose (FARSI)
- Focus on engineering statements that define a specific inspection, testing or maintenance requirement
- Provide sufficient detail to enable realistic monitoring and analysis of actual performance based on Computerised Maintenance Management System (CMMS) records

Critical activities: typical information

- WHO does the activities?
  - aim to set activities that may be verified at supervisor level
- WHAT do they do?
  - brief description of activity
  - how does the person know what to do?
- WHY is the activity done?
  - what prompts the activity?
  - how does the person know when to do it?
- HOW do we know it's been done?
  - what assures us that the activity was performed correctly?

Create ownership of the barriers

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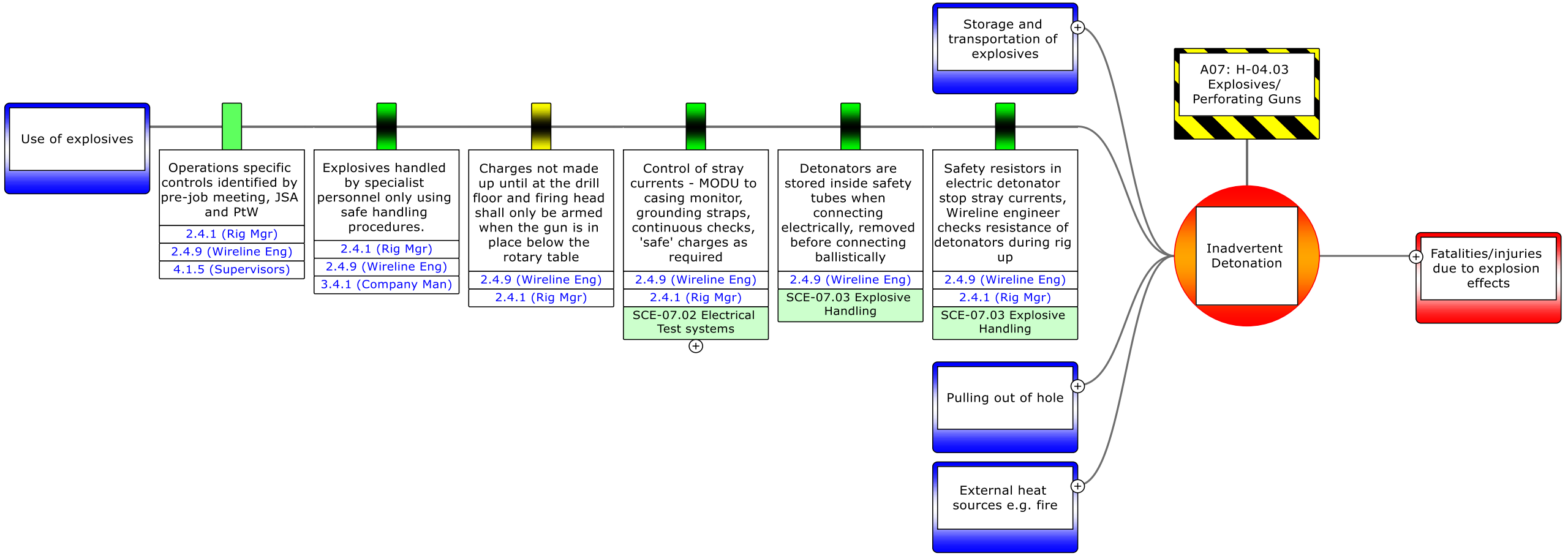
Example Bowtie



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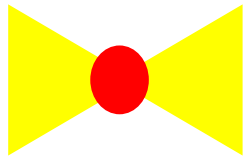
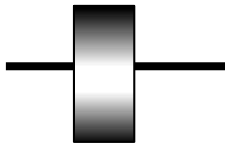
ALARP Process Summary



Develop the Bowtie



Identify and question the barriers

- Plant
- People
- Procedures

Barrier Rating	Used?	Does it work/ is it effective?
Very Good	Always	Always (>99%)
Good	Frequently	Generally (75% - 99%)
Unknown	Unknown/not guaranteed	Unknown/cannot be guaranteed (50% - 75%)
Poor	Occasionally	Possibly (25% - 50%)
Very Poor	Rarely	Currently ineffective (<25%)
Un-assessed	-	Insufficient information

How good are the barriers?

- Are there enough?
- Of the right quality?

Could we do more?

- Improve existing?
- Add more?

Low	Medium	High
Consider	Consider, if risk high	**Do not implement**
Implement	Consider	Consider, if risk high
Implement	**Implement**	Consider

Is it reasonably practicable?

Implement in good time

Document the process

- Monitor/Audit
- Review

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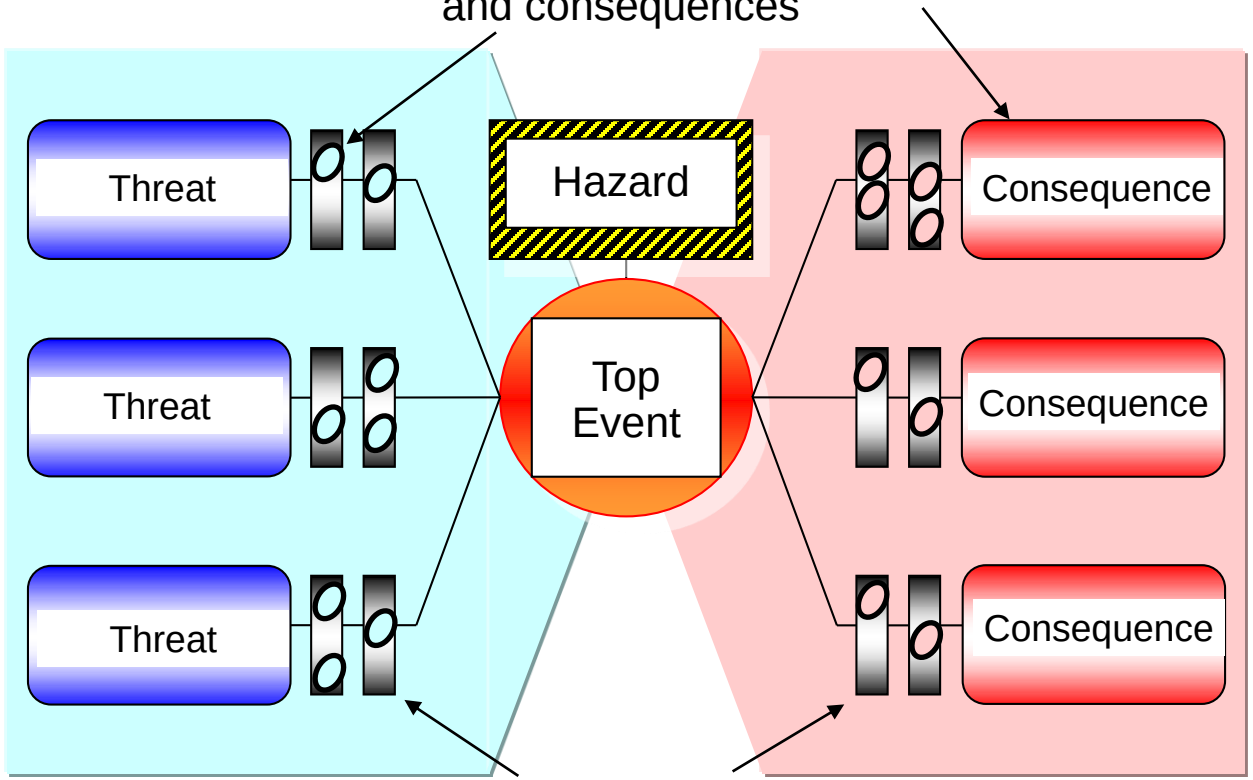
Through Life Assurance

Performance Monitoring

LAGGING INDICATORS

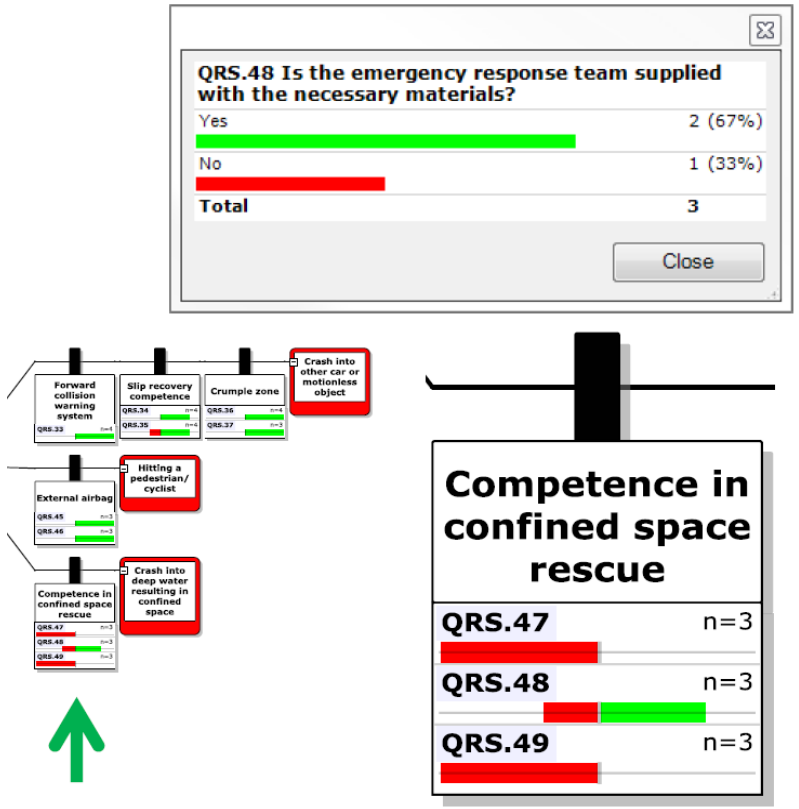
Measure barrier defects (holes), events and consequences



LEADING INDICATORS

Measure barrier strength (activities which maintain risk control systems)

Audit



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Bowtie Method

Advantages

- Graphical format encourages
  - Participation
  - Ownership
  - Use
  - Understanding
- Clear identification of roles and responsibilities
- Can vary level of detail specific to the analysis

Pitfalls

- Can be difficult to do well
- Need to ensure:
  - Consistency of approach
  - Pitching at the right level
  - Involving the right people
  - Avoiding wish fulfilment
- Control dependencies
- Doesn’t replace QRA

Summary

- The better we understand, the better we manage
  - Reactively, for what we have
  - Proactively, for audit and review
- What is really there, rather than what we wish is there
- Bowties are a user-friendly, graphical illustration of how hazards are controlled, supporting a complete and comprehensive approach to risk management
  - Linkage to HSE Management Systems;
  - Assigning Critical Tasks, Procedures, Competencies
  - Identifying Safety Critical Equipment, Processes
- Not only what controls are in place today, but why they will still be there tomorrow.

Thank you

Any questions?

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