

Health and Safety Essentials

Lecture 16 – Accident Investigation Techniques

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Undergraduate Diploma in
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Recap Question 1

Which of the following BEST defines the difference between a hazard and a risk?

- A. A hazard is the likelihood of harm, while risk is the severity of harm
- B. A hazard has the potential to cause harm, while risk is the likelihood that harm will occur 
- C. A hazard only applies to chemicals, while risk applies to physical hazards
- D. Risk eliminates the need to identify hazards

Recap Question 2

A factory identifies a solvent exposure risk. Initial rating using a 5×5 matrix: Likelihood = 4 (Likely) Impact = 4 (Major injury)

After implementing local exhaust ventilation and training: Likelihood reduces to 2 (Unlikely) Impact remains 4 (Major injury)

Which statement BEST reflects the correct interpretation?

- A. The hazard has been eliminated
- B. The risk is now acceptable because impact did not change
- C. The risk has been reduced, but residual risk remains and must continue to be managed and reviewed 
- D. Further controls are unnecessary because likelihood decreased

Recap Question 3

An organisation is designing a new continuous chemical mixing process involving temperature control, pressure regulation, and automated feed systems.

The objective is to systematically analyse potential process deviations (e.g., “More pressure”, “No flow”, “Less temperature”) that could lead to catastrophic consequences. Which methodology is **MOST** appropriate?

- A. Job Safety Analysis (JSA)
- B. Qualitative risk matrix only
- C. Failure Modes and Effects Analysis (FMEA)
- D. Hazard and Operability Study (HAZOP) 

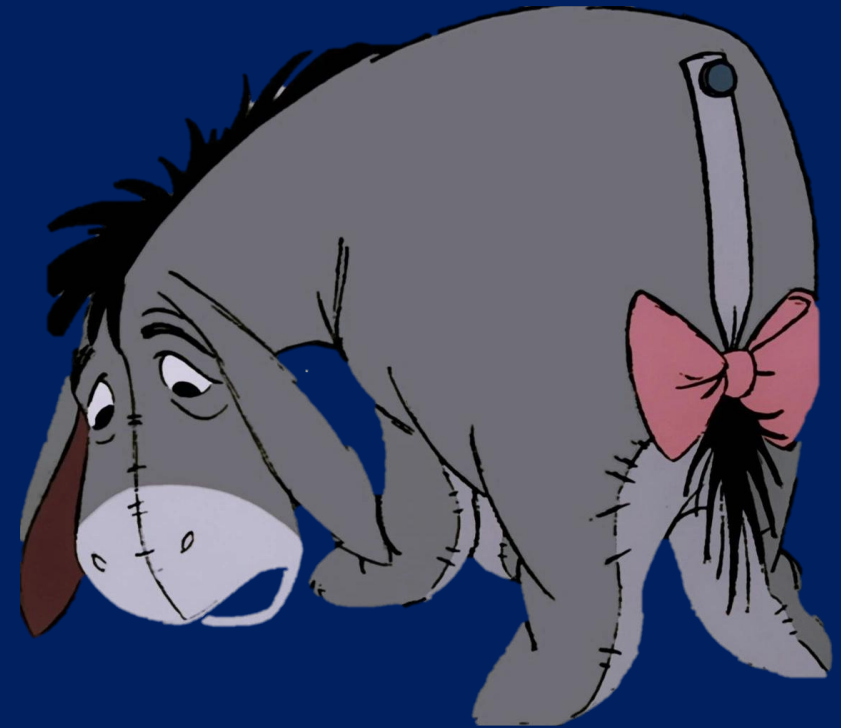
Objectives of the Lecture

- ✓ Define accident investigation principles and their role in preventing future incidents.
- ✓ Explore causation theories and their real-world applications.
- ✓ Examine regulatory requirements for accident reporting and investigations.
- ✓ Learn structured accident investigation techniques (evidence collection, witness interviews, root cause analysis).
- ✓ Develop professional accident investigation reports using best practices.



"They're funny things,
Accidents. You never have
them till you're having
them"

Eeyore (from A. A. Milne's
Winnie The Pooh)



What the Law says?

Do any of these mandate employer led accident investigation?

- Cap. 646 – Health and Safety at Work Act
- **No** - Instead, it gives OHSA the power and function to investigate accidents
- S.L. 646.11 – LN 36 of 2003 General Provisions
- **No** - However:
 - Employers must ensure health and safety at all times
 - Employers must evaluate risks and review assessments
 - If an accident occurs and the employer fails to investigate it, they may struggle to demonstrate:
 - Proper risk evaluation Monitoring and review
 - Preventive control

So investigation becomes legally implied — but not expressly written



What the Law says?....continued

- S.L. 646.12 – Control of Major Accident Hazards (Seveso)
- **Yes** — for major accidents.
 - The operator must review and update the safety report following a major accident document (6) You cannot review and update a safety report without analysing what happened.
- S.L. 646.08 – Workplace (Minimum H&S Requirements)
- **Yes** — but only explicitly in relation to fire.
 - It states: The employer shall investigate the occurrence with a view to taking any action which is deemed fit to prevent any similar recurrence

Why Investigate Accidents?

Key Investigation Drivers

1. Legal Compliance – Ensuring adherence to

 L.N. 52 of 1986 Workplaces (Health Safety and Welfare) Regulations - Part V *mentions Notification rather than Investigation*; Cap. 646 focuses on OHSA investigations.

 EU (89/391/EEC) and

 UK (RIDDOR 2013, HSWA 1974).

 Subsidiary Regulations: Exposure To Carcinogens, Physical Agents...

1. Preventing Recurrence – Understanding what went wrong to avoid repeat incidents.

2. Building a Safety Culture – Learning from incidents without attributing blame.

3. Financial & Reputational Risks – Avoiding fines, compensation claims, and of business trust.

Employer's Role in Accident Investigations

-  Key Points:
 1. Employers must report workplace injuries as per Cap. 646 S.L. 646.03 - L.N. 52 of 1986
 2. Formal investigations are not explicitly required but may be necessary to determine causes.
 3. Employers must document corrective measures, implying a fact-finding process is expected.
 4. OHSA Malta can intervene and investigate serious cases.

Discussion Point



- *Would a legal obligation for full investigations improve safety in Malta?*
- *Should Legislation require detailed employer-led investigations for all major incidents? (Context: Efforts to Report & Investigate Near Miss Incidents)*



Case Study:

- A workplace scaffolding collapse that resulted in multiple injuries but luckily minor; hence not reportable.
- Should the employer only report the incident, or should a full investigation be required?

Who Should Conduct an Investigation?

- Maltese Legislation and EU Directive 89/391/EEC (Framework Directive) does not explicitly require a team-based approach.
- Instead, it places the duty on the employer to take corrective action and communicate with workers/workers' reps.
- In some EU member states (e.g., Germany, France, Sweden), national laws or industry regulations may specify that:
 - A competent person (e.g., a health & safety officer) must lead the investigation.
 - Workers' representatives must be consulted if a serious workplace accident occurs.
 - OHS/Labour inspectors may conduct their own investigations.

The Investigation Team – Selecting the Right People

- Ideal Team Composition:
 - OHS Manager/Officer
 - Safety representatives.
 - Line manager/supervisor.
 - Worksite personnel.
 - Experts with relevant knowledge (e.g., engineers for technical failures).

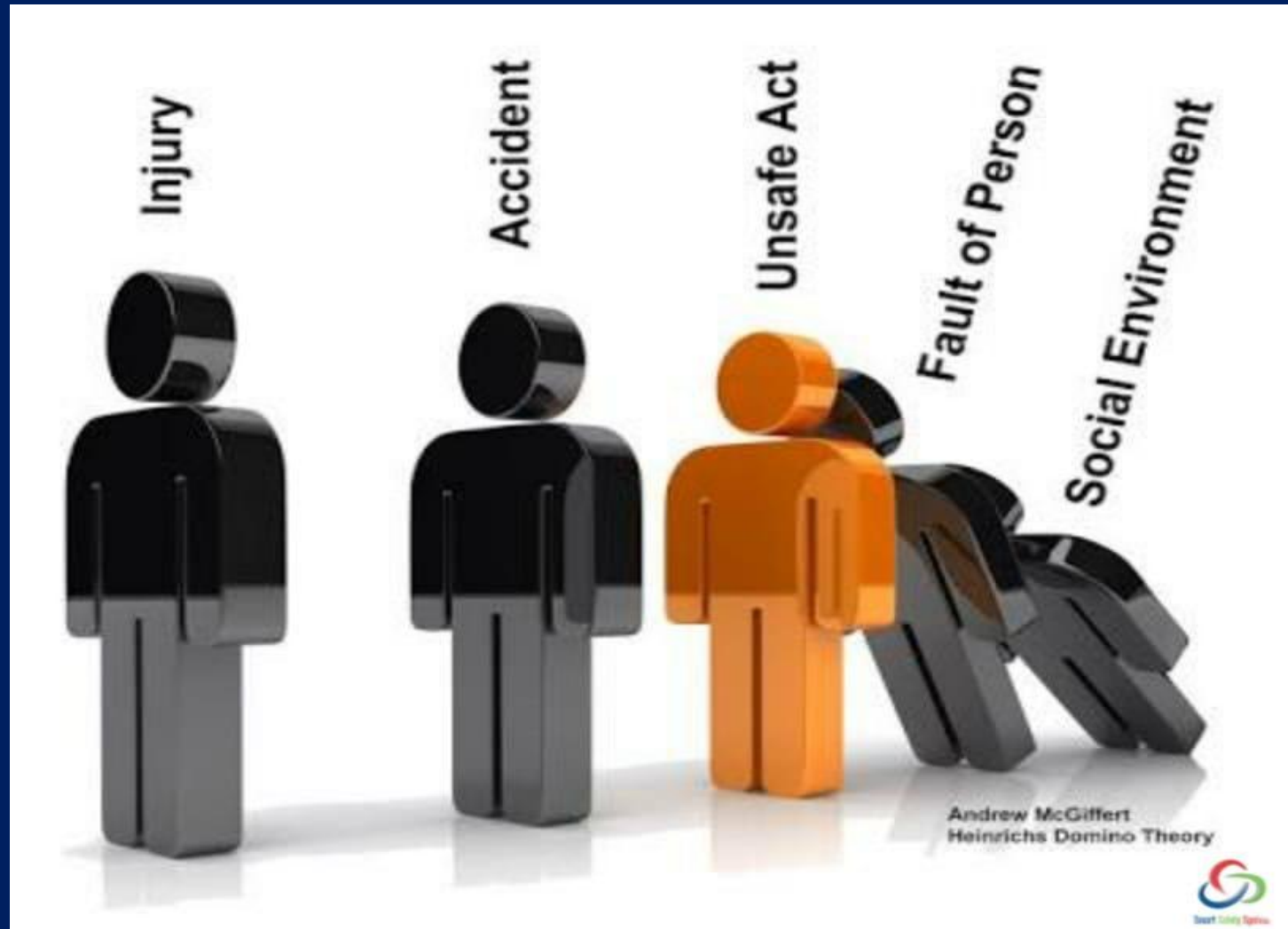


Theories of Accident Causation & Investigation Focus

Causation Models

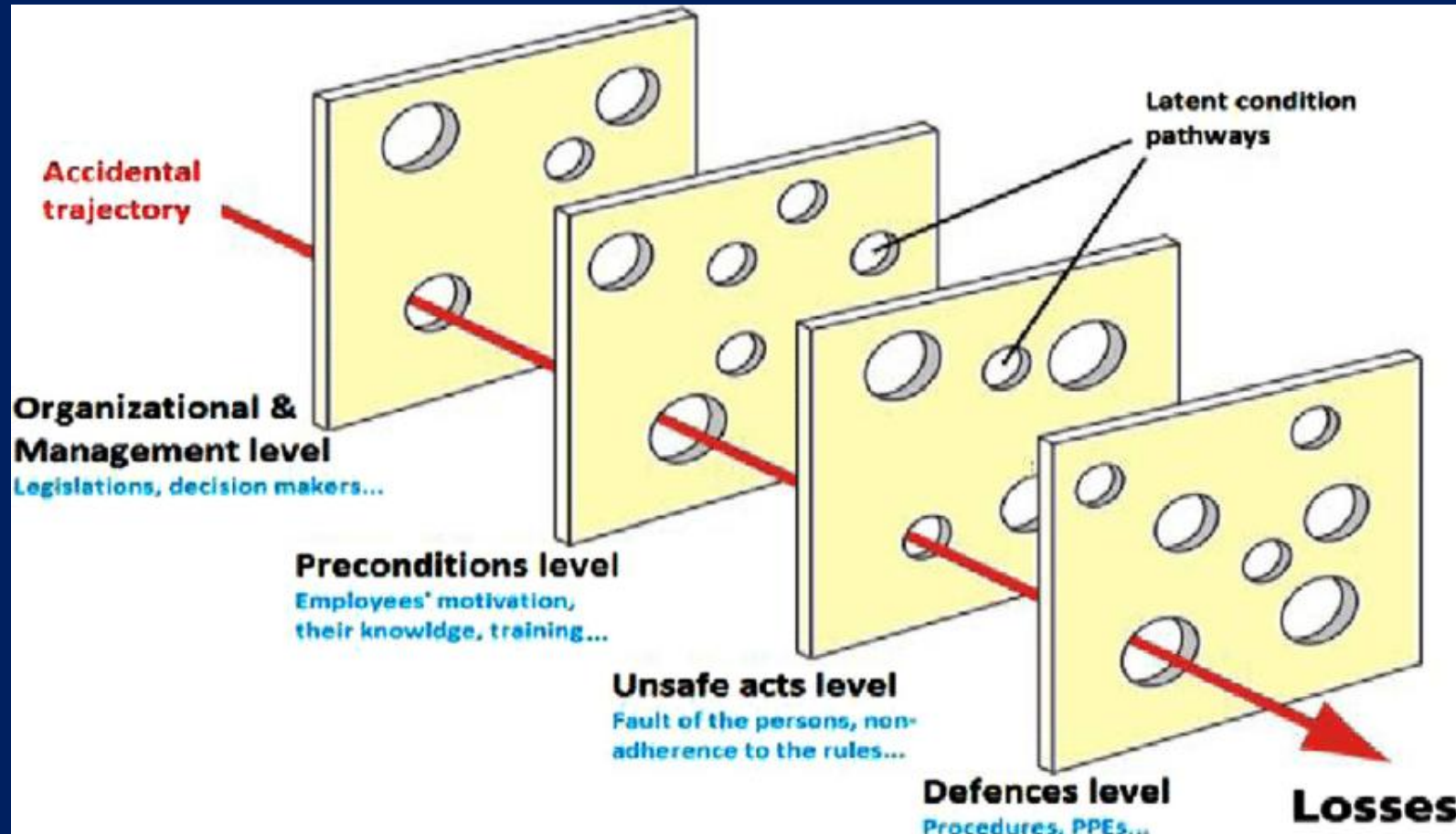
- Heinrich's Domino Theory – Chain of failures.
- Reason's Swiss Cheese Model – Latent system failures.
- Bird's Triangle – Precursor incidents.
- Ferrell's Human Factor Model – human error – caused by overload / incompatibility / improper activities.
- Petersen's Model – Adapts Ferrell's and Heinrich's...
- 5M Model – Man, Machine, Medium, Mission, and Management.

Heinrich's Domino Theory

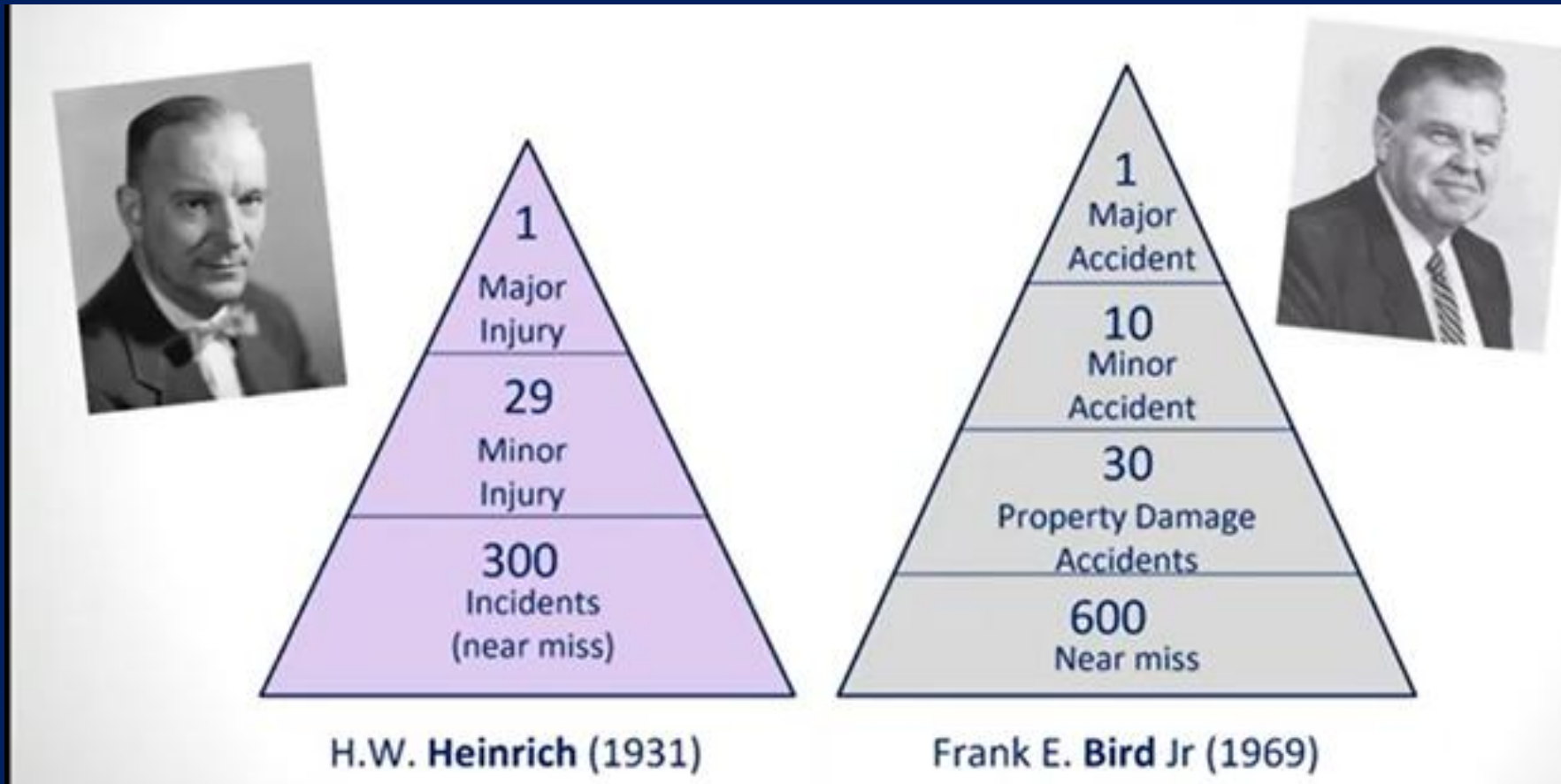


(Heinrich, 1931)

Reason's Swiss Cheese Model



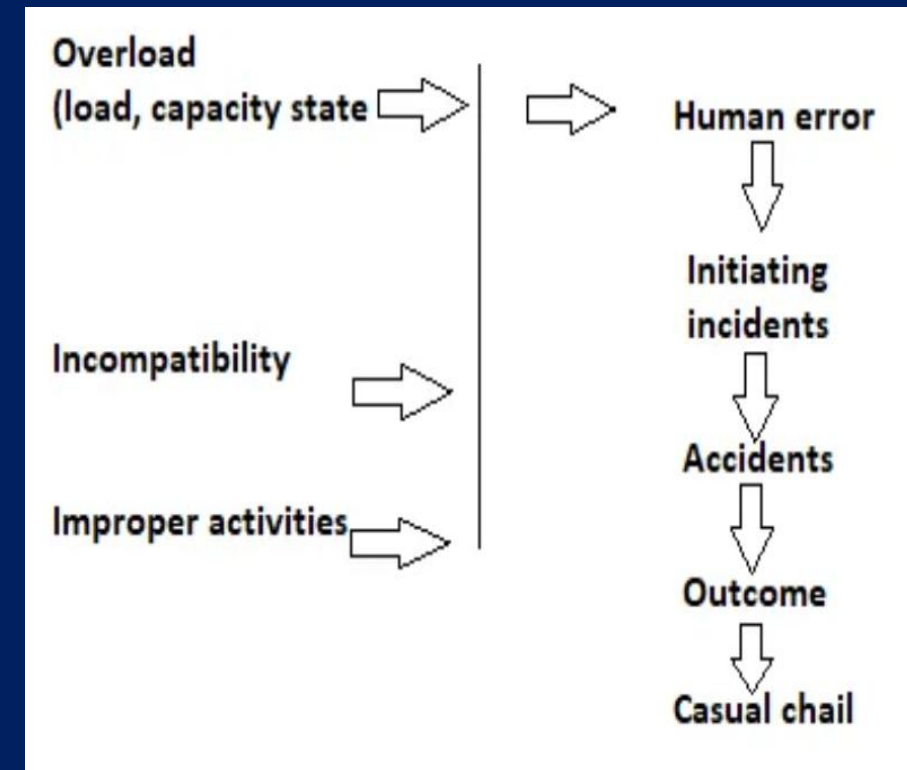
Heinrich's & Bird's Triangles



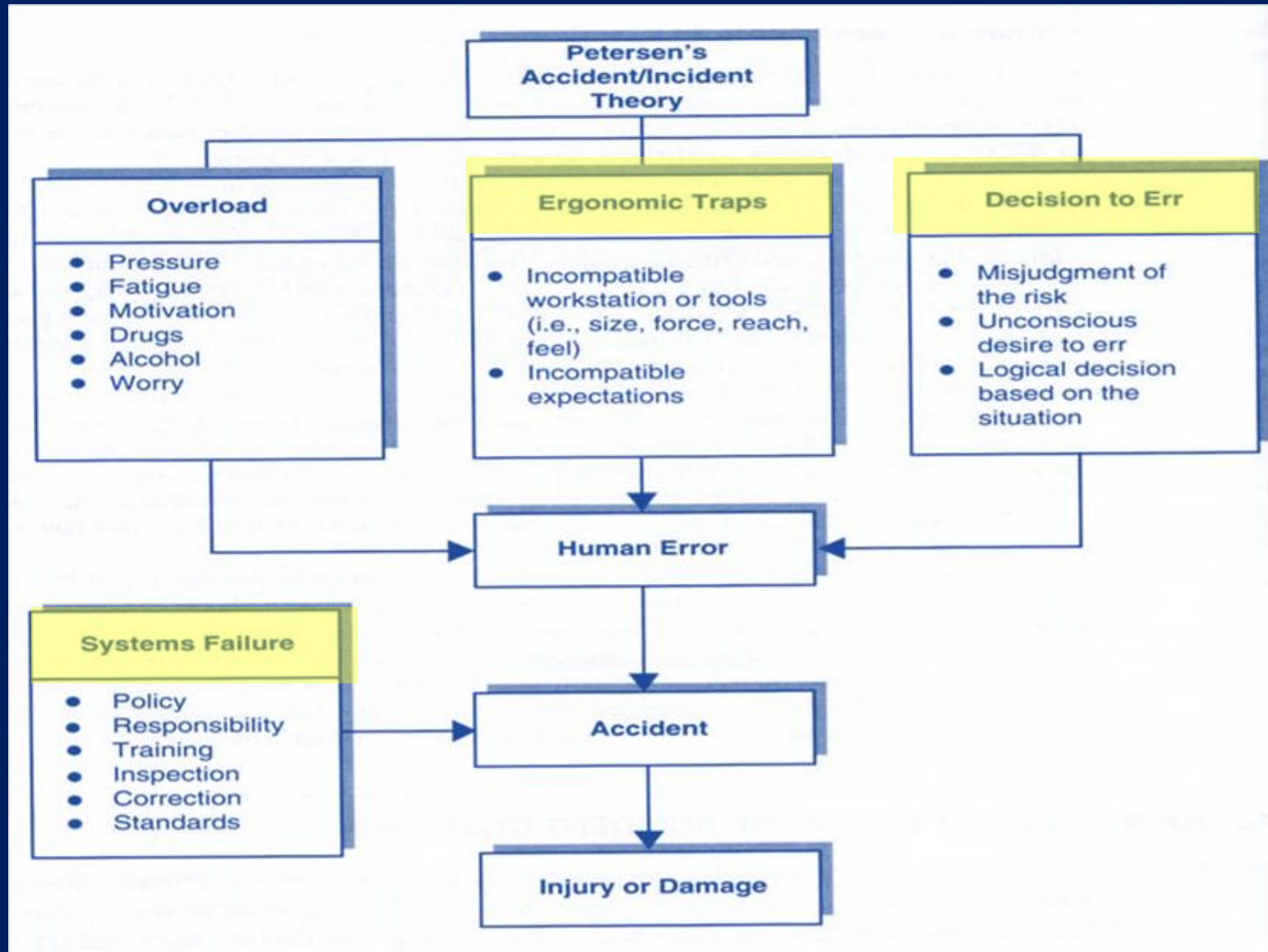
Ferrell's Human Factors Theory

This theory identifies three primary causes of accidents:

- **Overload** – When the demands on a worker exceed their capacity to respond effectively.
- **Incompatibility** – A mismatch between human abilities and work conditions.
- **Improper Activities** – Errors made due to lack of knowledge or deliberate risk-taking.



Petersen's Accident–Incident Causation Theory



Break



5-M Model Approach to Accident Investigation

- What is the 5-M Model?
 - A systematic method for analysing accident causes.
 - Primarily used in aviation, but also applied in maritime, transport, industrial safety, and healthcare.
- The Five Key Areas:
 - Man – Human factors such as training, qualifications, and mental/physical state.
 - Machine – Equipment design, maintenance, and reliability.
 - Medium – Environmental conditions, including weather and infrastructure.
 - Mission – The complexity and nature of the operation.
 - Management – Organisational policies, safety culture, and decision-making



6M Model

- ◆ The 6M Model builds on 5M by adding one more category:
+ Measurement (Metrics/Data/Control Systems) – Issues related to incorrect data, miscalculations, or faulty sensors.

Why Add "Measurement"?

- Many errors in modern workplaces come from data errors (e.g., incorrect risk assessments, equipment calibration errors).
- Common in industries relying on data-driven decisions (e.g., aviation, pharmaceuticals, finance, IT).

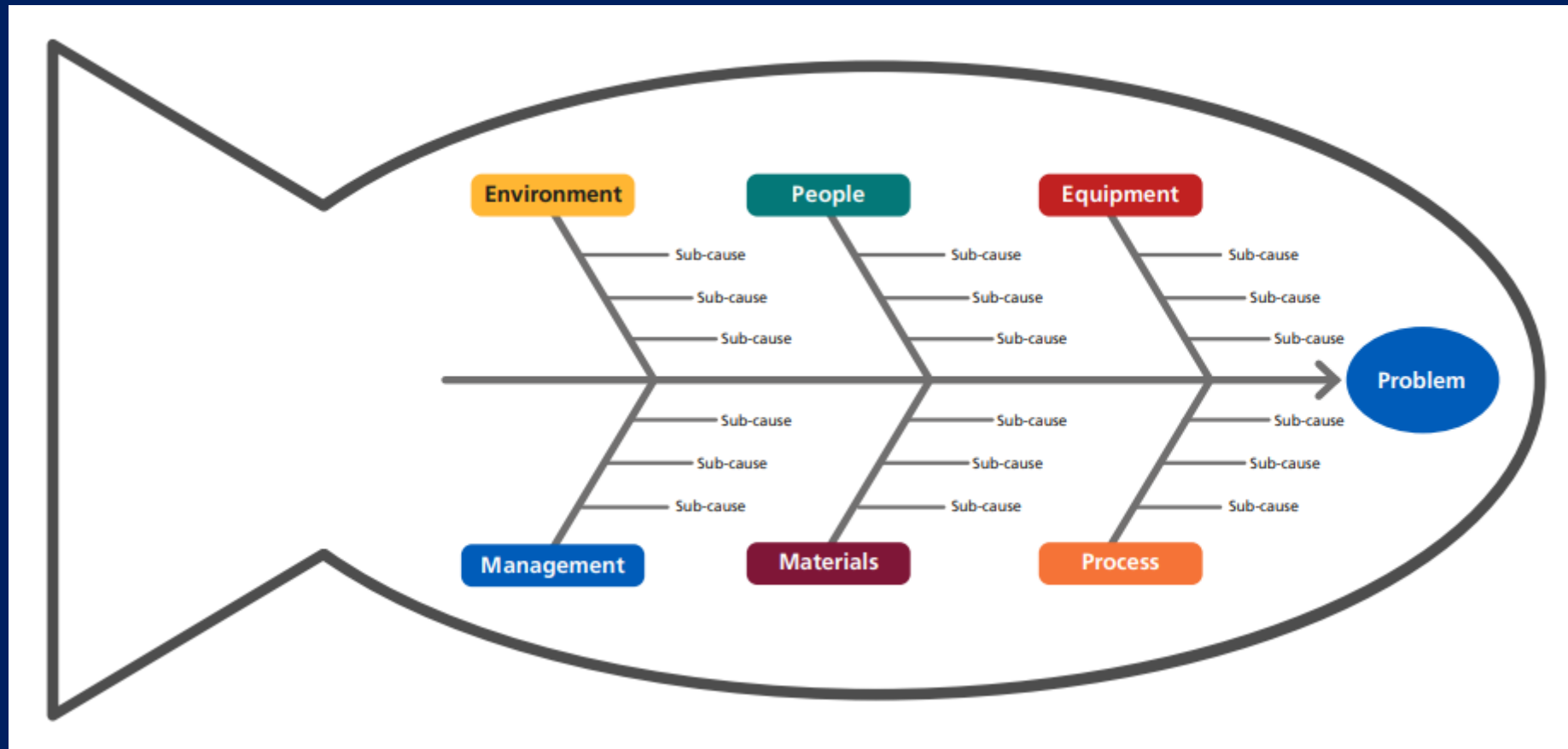
Case Study – Singapore Airlines Flight 006

- <https://www.youtube.com/watch?v=ubjLhBaLD1Y>
- Incident Summary:
 - On 31 October 2000, SQ006 attempted takeoff on a closed runway (05R) at Taipei Airport in poor visibility.
 - The aircraft collided with construction equipment, resulting in 83 fatalities.
- Findings Based on the 5-M Model:
 - Man: Pilots failed to verify the taxi route and use the Para-Visual Display.
 - Machine: No mechanical issues; aircraft was airworthy.
 - Medium: Poor visibility due to Typhoon Xangsane; inadequate airfield lighting and signage.
 - Mission: Urgency to depart before worsening weather may have influenced errors.
 - Management: Lack of proper ground radar; non-compliance with ICAO safety standards.

Fishbone Analysis

- 📌 Developed by Professor Kaoru Ishikawa in the 1960s.
 - Also known as Cause-and-Effect Diagram due to its fishbone-like structure.
 - Combines brainstorming with mind mapping for structured root cause analysis.
- 📌 Uses of Fishbone Analysis
 - ✓ Discover the root cause of a problem.
 - ✓ Uncover bottlenecks in a process.
 - ✓ Identify why a process is not working effectively.
 - ✓ Often adapted and integrated with 6M
- 📌 Team-Based Approach
 - Fishbone Analysis should always be a team effort.
 - A team must consist of individuals with specialist knowledge and open minds.

Fishbone Diagram Example & Application



Key Components of Fishbone

- 1 Problem (Head of the Fish) – Clearly defined issue to investigate.
- 2 Main Causes (Fish Bones) – The major categories influencing the problem.
- 3 Sub-Causes (Small Bones) – Specific factors contributing to each category.

-  Standard 6M Categories for Analysis:
 - ✓  Man (People) – Training, skills, human error, workload.
 - ✓  Machine (Equipment) – Faulty tools, technology issues, maintenance problems.
 - ✓  Method (Process) – Inefficient workflows, unclear instructions, missing procedures.
 - ✓  Material – Poor quality raw materials, incorrect supplies.
 - ✓  Milieu (Environment) – Workplace conditions (noise, lighting, temperature).
 - ✓  Management (Leadership/Policies) – Poor supervision, lack of enforcement.
-  Alternative Categories
- Depending on the problem, categories can be adjusted to include:
 - Information systems
 - Work organisation
 - Competitor influence
-  Key Takeaway:
 - All branches lead to the problem at the head, helping teams see how different elements contribute to failure.

Step-by-Step Accident Investigation Process

-  Systematic Procedures
 1. Immediate Response & Site Preservation
 1. Act quickly before evidence is disturbed.
 2. Photograph and sketch the scene.
 2. Evidence Collection
 1. Secure tools, equipment, chemical samples.
 2. Interview witnesses separately.
 3. Analyse Past Incidents
 1. Check for similar near-misses.
 4. Identify Causes Using Systematic Approaches
 1. Five Whys, Fishbone, Bowtie Analysis.
-  Best Practice: "Look for causes, not blame."
- Systems fail for multiple reasons. Blaming individuals hinders future safety improvements.

Common Investigation Pitfalls

- ⚠ Investigating Too Quickly
 - Jumping to conclusions before evidence is gathered
- ⚠ Blame-Oriented Thinking
 - Focusing on the last person involved
- ⚠ Ignoring System Failures
 - Not examining supervision, workload, or procedures
- ⚠ Poor Evidence Control
 - Scene disturbed before documentation
- ⚠ Weak Root Cause Identification
 - Stopping at “human error”

 Professional Investigations focus on systems, not scapegoats.

Cognitive Bias in Accident Investigation

-  Confirmation Bias
 - Looking only for evidence that supports an initial assumption
-  Hindsight Bias
 - “It was obvious this would happen” (after the event)
-  Outcome Bias
 - Judging decisions based only on the severity of the outcome
-  Authority Bias
 - Accepting senior explanations without challenge

 Good investigators challenge their own assumptions.

Evidence Collection & Interviewing Witnesses

Best Practices:

- Secure evidence immediately.
- Check if anything has been moved.
- Document site conditions (lighting, weather, noise levels).
- Interview separately to prevent influencing statements.

Investigator's Checklist (5 Ws + How):

- ✓ Who was involved? Who saw it? Who supervised the task?
- ✓ What was being done? What tools were used? What went wrong?
- ✓ When did it happen? When was it last checked?
- ✓ Where did it happen?
- ✓ Why (x5) did this occur? Why were safety measures ineffective?...
- ✓ How could this have been avoided?

Root Cause Analysis Techniques

Key Methods for Root Cause Analysis:

1. Swiss Cheese Model (James Reason) – Identifying multiple layers of failure.
2. Peterson's Model of Accident Causation – Focusing on safety management failures.
3. Five Whys – Systematic questioning to uncover root causes.

Linking Investigation to ISO 45001

- ISO 45001 – Clause 10.2
Incident, Nonconformity & Corrective Action
- Requires organisations to:
 - React to incidents
 - Determine causes
 - Implement corrective action
 - Review effectiveness

 Accident investigation forms part of continuous improvement.



Writing an Effective Investigation Report

Report Structure (minimum)

1. Introduction: Overview of incident.
2. Incident Description: Facts only.
3. Findings: Root cause analysis.
4. Recommendations: Preventive measures.

Best Practices:

- Be factual, clear, and neutral.
- Use photographs, logs, witness statements.
- Avoid assumptions – stick to evidence-based conclusions.

Breakout Activity – Team 1 and 2

Legal Debate: Investigation Duty

Objective

- Develop legal reasoning and critical thinking.
- Group A:
 - Argue that Maltese law should explicitly require employer-led investigations.
- Group B:
 - Argue that general duties are sufficient and more legislation is unnecessary.

Breakout Activity – Teams 3 and 4

Fishbone Mini-Workshop

-  Objective
- Apply structured categorisation using 6M.
- Scenario
- A warehouse worker suffers a fractured arm after falling from a mobile ladder while retrieving stock from a high shelf.
- Facts:
 - Ladder had no visible defects
 - Worker had not received ladder safety training
 - Supervisor was covering two departments
 - Previous near miss reported 3 months earlier
 - No documented inspection record for ladders

Continue on next slide.....

Task

Team 3:

- Group 1 → *Man*
- Group 2 → *Machine*
- Group 3 → *Method*

Team 4:

- Group 4 → *Management*
- Group 5 → *Medium*
- Group 6 → *Measurement*

Each group must:

- Identify at least 4 contributing factors
- Avoid repeating “human error”
- Prepare 1 systemic corrective measure

Breakout Activity – Teams 5 & 6

“Bad Investigation Report” Critique

- “Worker failed to follow procedure and caused own injury. Reminded staff to be more careful.”
- Groups must identify:
 - What is missing
 - What assumptions were made
 - What evidence was not considered
 - What would OHSA likely criticise

Expand Your Understanding: Other Recommended Resources

- 1. EU-OSHA – *Accident Investigation Techniques*
A practical overview of a range of investigation methodologies, from simple to systemic approaches.
 <https://oshwiki.osha.europa.eu/en/themes/accident-investigation-techniques>
- 2. ILO – *Guidelines for Accident Investigation*
International Labour Office guidance on conducting effective inspections and investigations.
 https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@ed_dialogue/@ab_admin/documents/publication/wcms_346714.pdf
- 3. Rasmussen, J. (2014) – *Accident Investigation and the Analysis of Causal Factors*
Scholarly article exploring causal factors and systemic thinking in accident analysis.
 <https://www.sciencedirect.com/science/article/abs/pii/S0925753514002379>



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