

# INDUSTRIAL SAFETY CULTURE – LEADING INDICATORS AND APPLICATION

Paul Amyotte<sup>a</sup>, Faisal Khan<sup>b</sup>,  
Micaela Demichela<sup>c</sup> & Norberto Piccinini<sup>c</sup>

<sup>a</sup>Dalhousie University, Halifax, Canada

<sup>b</sup>Memorial University, St. John's, Canada

<sup>c</sup>Politecnico di Torino, Torino, Italy



# OUTLINE

- Introduction
  - Safety Culture
  - Hierarchy of Controls/Inherent Safety
  - Safety Management Systems/Incident Investigation
- Conceptual Framework for Safety Culture Assessment
  - Safety Culture Indicators
  - Lagging vs Leading Indicators
- Case Study: Westray Coal Mine Explosion
  - Incident Description and Causation
  - Application of Proposed Safety Culture Indicators
- Concluding Remarks

# INTRODUCTION

## ■ Scope

- Enhancement of industrial safety through recognition of the importance of safety culture and corporate leadership as expressed within a safety management system

## ■ Motivation

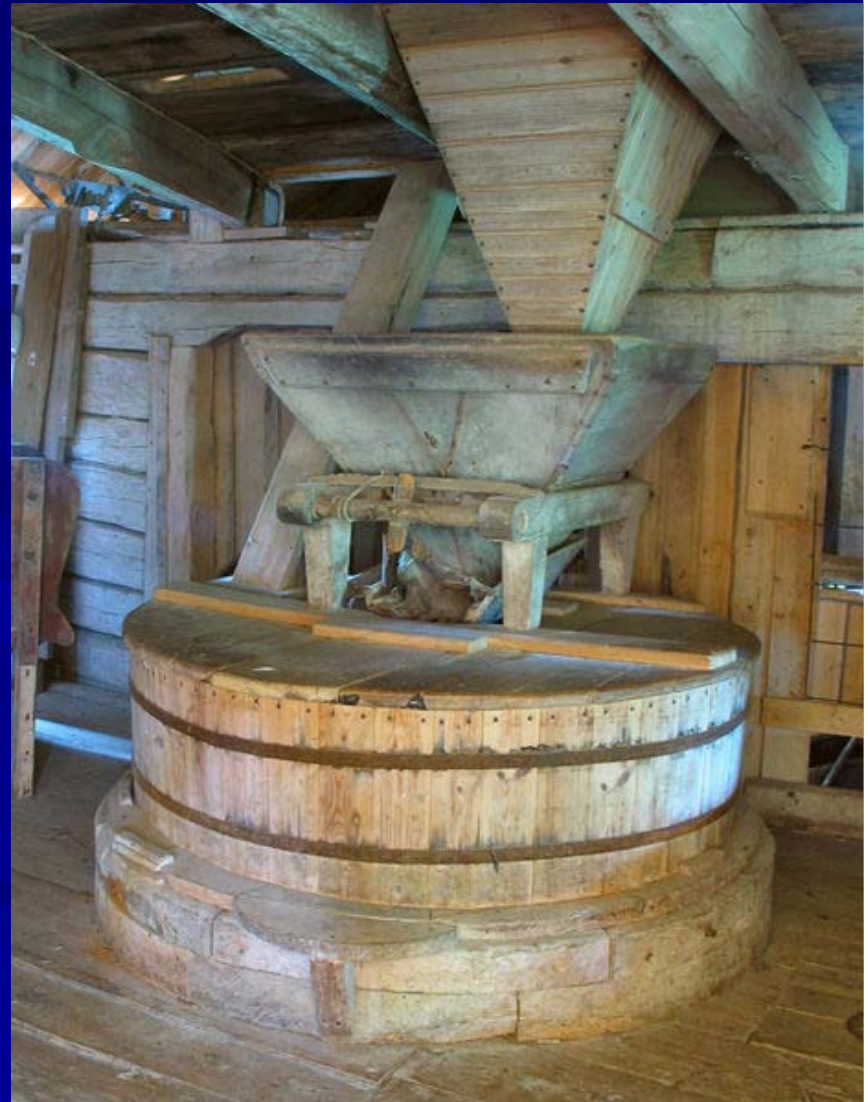
- Protection of people, environment, assets and production
- Provision of an assessment framework and case study highlighting safety culture as an integral component of safety management systems

# Safety Culture

With thanks to co-author Prof. Norberto Piccinini of the Politecnico di Torino

Account of a violent explosion which happened in the flour-warehouse, at Turin, December the 14<sup>th</sup>, 1785...

- by Count Morozzo
- from the Memoirs of the Academy of Sciences of Turin



# Safety Culture, Case Studies, and Lessons Learned

“Ignorance of the fore-mentioned circumstances, and a culpable negligence of those precautions which ought to be taken, have often caused more misfortunes and loss than the most contriving malice: it is therefore of great importance that these facts should be universally known, that public utility may reap from them every profitable advantage.”

# BP Texas City, TX, USA

March 23, 2005: [www.csb.gov](http://www.csb.gov)



# Process Safety Management

- Process safety: the operation of facilities that handle, use, process or store hazardous materials in a manner free from episodic or catastrophic incidents
- Process safety management: the application of management principles and systems to the identification, understanding and control of process hazards to prevent process-related injuries and incidents (fire, explosion, toxicity, corrosivity)
- *CCPS: Guidelines for Technical Management of Chemical Process Safety*
- *MIACC → CShE: PSM Guide (3<sup>rd</sup> edition)*

# Process Safety Management (PSM)

1. Accountability: objectives and goals
2. Process knowledge and documentation
3. Capital project review and design procedures
4. Process risk management
5. Management of change
6. Process and equipment integrity
7. Human factors
8. Training and performance
9. Incident investigation
10. Company standards, codes and regulations
11. Audits and corrective actions
12. Enhancement of process safety knowledge



# 1. Accountability: Objectives and Goals

- Process safety is a corporate value
- Requires management commitment and leadership
- Hopkins (2005): *Safety, Culture and Risk*
  - Safety culture
  - Collective mindfulness
  - Risk-awareness
- Hierarchy of controls

# Hierarchical Approach

**INHERENT SAFETY**

**PASSIVE ENGINEERED (ADD-ON) SAFETY**

**ACTIVE ENGINEERED (ADD-ON) SAFETY**

**PROCEDURAL (ADMINISTRATIVE) SAFETY**



Royal Australian  
Air Force

F111

Deseal/Reseal  
Program

*The absence of  
any commitment  
to the hierarchy of  
controls is another  
manifestation of  
the priority of  
platforms over  
people (Hopkins,  
2005).*

# Corporate Leadership

- Safety Culture (reporting, just, learning, flexible cultures) → **9. Incident Investigation**
- Collective Mindfulness (preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience)
- Risk Awareness (synonymous with collective mindfulness which is closely related to safety culture)

Hopkins (2005): *Safety, Culture and Risk*

# CONCEPTUAL FRAMEWORK FOR SAFETY CULTURE ASSESSMENT

- Concept # 1: Safety culture and incident investigation are explicitly linked via just, reporting and learning cultures, and implicitly linked via flexible culture and inherent safety
- Concept # 2: Whether process safety indicators are lagging or leading is of secondary importance to whether they measure the effectiveness of the various controls in the risk control system (i.e. elements of PSM system)
- Both concepts directly or indirectly from Hopkins (2005 & 2007)

# Demonstration of a Commitment to...

<b>Indicators</b>	<b>Possible Metrics</b>
■ Just Culture	<ul style="list-style-type: none"><li>➤ Number of incident reports</li><li>➤ Number of near-miss reports</li><li>➤ Employee/management surveys</li></ul>
■ Reporting Culture	<ul style="list-style-type: none"><li>➤ Number of incident reports</li><li>➤ Number of near-miss reports</li><li>➤ Measure of quality of reports</li></ul>
■ Learning Culture	<ul style="list-style-type: none"><li>➤ Measure of outputs of reporting and investigating (e.g. lessons learned)</li></ul>
■ Flexible Culture	<ul style="list-style-type: none"><li>➤ Makeup/qualifications of investigation and remedial action teams</li></ul>
■ Principles of Inherent Safety	<ul style="list-style-type: none"><li>➤ Measure of integration within incident investigation and all PSM elements</li></ul>

# CASE STUDY: WESTRAY COAL MINE EXPLOSION

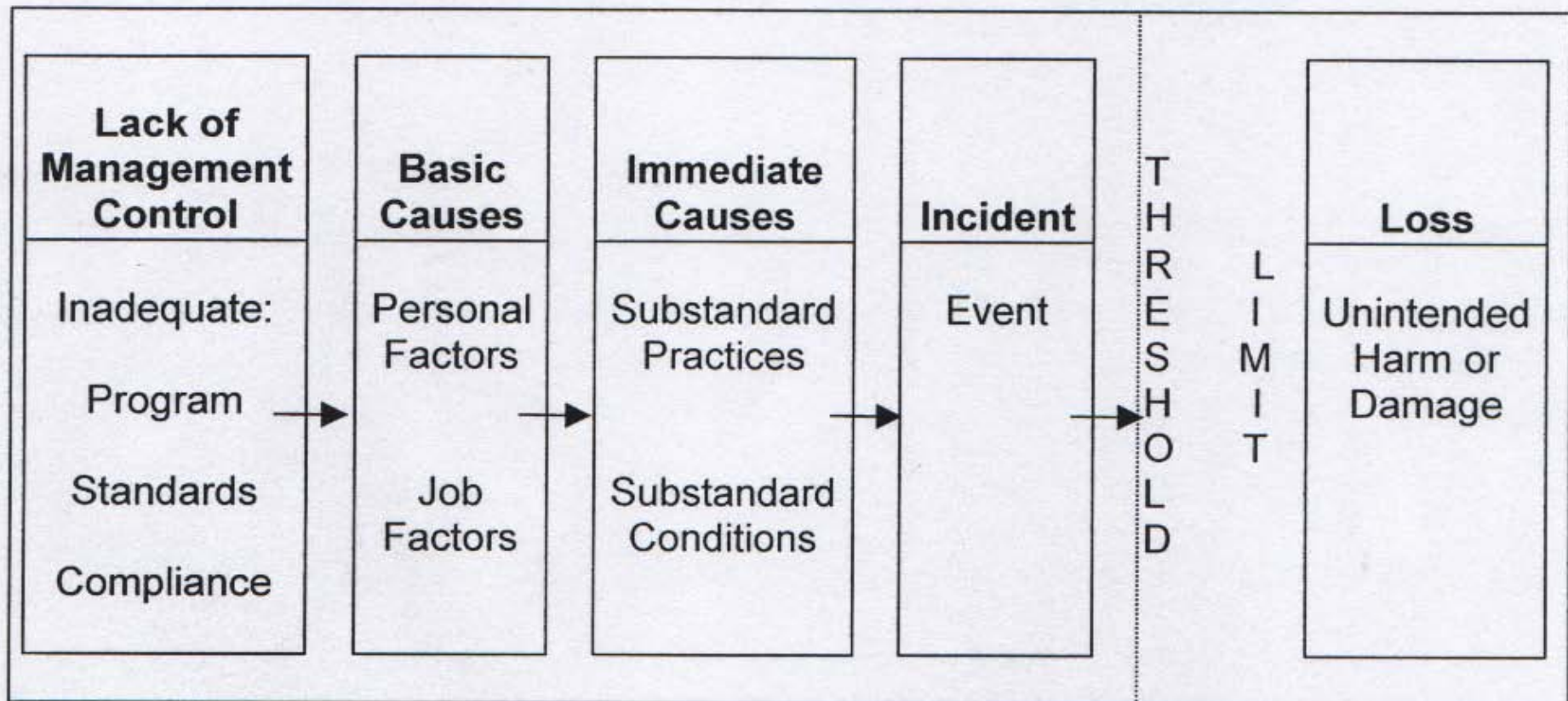


# Plymouth, Nova Scotia, Canada May 9, 1992





# Domino Loss Causation Model



# Safety Culture Indicators

## ■ Commitment to a Just Culture

- Blame-filled, fault-finding culture
- Low worker morale
- Management intimidation of workers who raised safety issues
- Worker fear of reprisal
- Employee dismissal for raising safety concerns

## ■ Commitment to a Reporting Culture

- Four roof falls in two months following mine opening (seriousness downplayed by management)
- Numerous unreported rock fall near-misses
- Rock fall emphasis (due to production concerns) resulting in methane/coal dust hazards being neglected

# Safety Culture Indicators

## ■ Commitment to a Learning Culture

- An ineffective incident investigation program = No lessons learned
- Most basic safety practices non-existent

## ■ Commitment to a Flexible Culture

- Impossible to achieve given management mindset and specific practices
- Workers without experience promoted to supervisory positions due to production demands
- Little training in safe work practices and hazard identification

# Safety Culture Indicators

- Commitment to the Principles of Inherent Safety

<b>Principle</b>	<b>Hazard Avoidance</b>
Minimize	<i>Methane:</i> Degassification
Substitute	<i>Ventilation:</i> Forcing instead of exhaust
Moderate	<i>Coal Dust:</i> Roadway consolidation; rock dust
Simplify	<i>Methane:</i> Reliable, robust monitoring

# CONCLUDING REMARKS

- Presented a concept and some thoughts for assessment of process safety culture
  - Link PSM element of incident investigation with four safety subcultures and four inherent safety principles
- Case study helpful, but a negative proof is not conclusive
- Work on metrics is needed and is underway in our group (emphasis on offshore safety)

# ACKNOWLEDGEMENTS

- Financial support of the Natural Sciences and Engineering Research Council (NSERC) of Canada