Applying the AcciMap Methodology to Investigate a Major Accident in Offshore Drilling: Implications for a 'Total Asset Management' Paradigm

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Outline

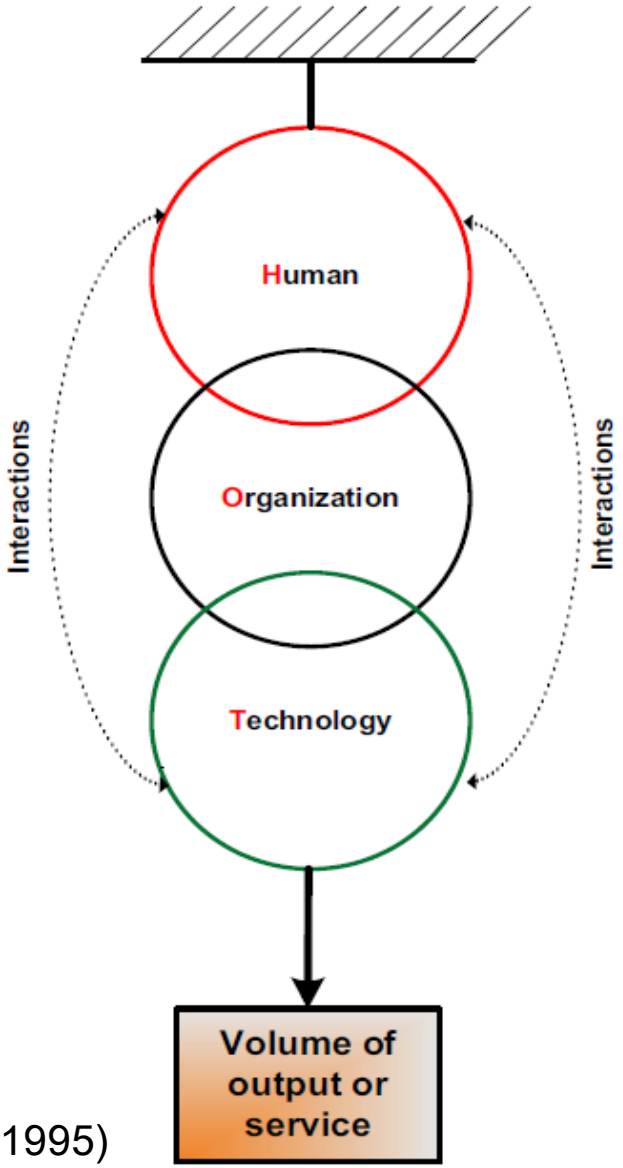
- Introduction to Asset Management
- Importance of Incident Investigation in Asset Management
- Oil and Gas as a High-Risk Industry
- Case Study of BP Deepwater Horizon (DWH) Blowout
- Rasmussen's Risk Management Framework and AcciMap Methodology
- Proposed AcciMap Framework for the Analysis of the BP DWH Accident
- Observations from the Model Analysis
- Recommendations based on the Model Analysis
- Generalized Findings
- A "Total Asset Management" Paradigm

Introduction to Asset Management

- Asset management is "Coordinated activity of an organization to realize value from assets." (ISO 55000, 2014, p.14)

- "Realization of value will normally involve a balancing of costs, risks, opportunities and performance benefits." (ISO 55000, 2014, p.14, emphasis added)

HOT Framework



(Meshkati, 1995)

HOT (Human, Organization, Technology)

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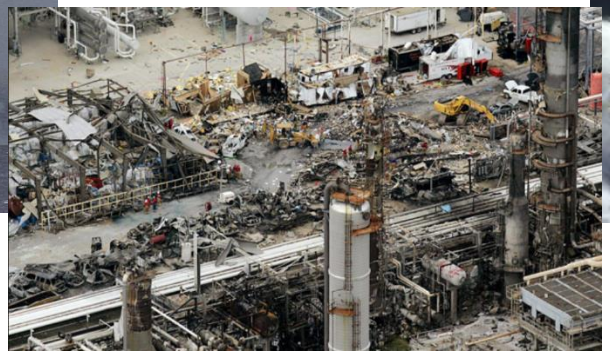
Incident Investigation & Asset Mgmt.

- Risk and reliability analysis (management) plays a critical role in improving asset management.
- "Of particular importance are asset-related incidents or emergency situations…. All such incidents, including unanticipated events, should be investigated and reviewed to see if any improvements are needed to the asset management system, to prevent their recurrence and to mitigate their effects." (ISO 55000, 2014, p.9)
- Development of robust, systematic incident investigation methodologies to analyze the main contributing and root causes of incidents

Oil and Gas: High-Risk Industry

Piper Alpha, North Sea, 1988

Fatalities: 167
Cost: $3.4 billion



BP Texas City Refinery, Texas, 2005

Fatalities and Injuries: 15 & 180
Cost: $60-70 Million

BP DWH, GOM, 2010

Fatalities and Injuries: 11 & 17
Cost: $40 billion

Oil and gas is one of the high-risk industries with "tightly coupled" and "interactively complex" operations.

Two Recent Unfortunate Incidents in Iran

Tehran Refinery
Tehran
October 27, 2017

Fatalities and Injuries: 6 & 2

Rag-e-Sefid, Rig No.95
Ghachsaran
October 29, 2017

Fatalities: 4 so far

Texas Refinery accident, 2005 Chemical Safety Board (CSB) Report

(CSB Report, 2007)

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

REFINERY EXPLOSION AND FIRE

(15 Killed, 180 Injured)

KEY ISSUES:

SAFETY CULTURE
REGULATORY OVERSIGHT
PROCESS SAFETY METRICS
HUMAN FACTORS

BP

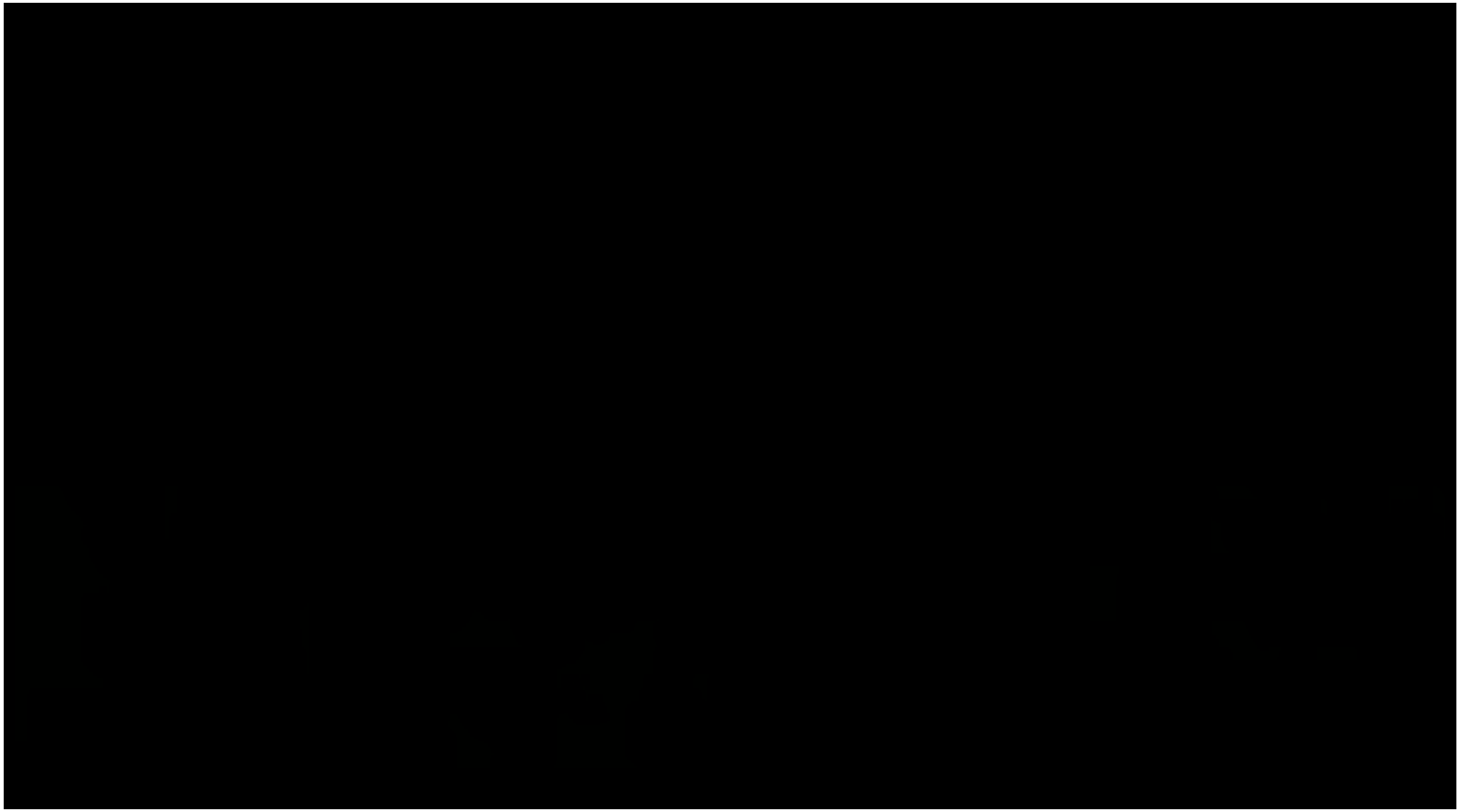
TEXAS CITY, TEXAS
MARCH 23, 2005

REPORT NO. 2005-04-I-TX
MARCH 2007

BP Deepwater Horizon (DWH) Blowout

- April 20, 2010
- 11 people died, 17 injured
- 5 million barrels of spilled oil~682000 tons in 87 days
- Largest environmental disaster in the US
- Influenced small local businesses and tourism
- Billions of dollars of cost

CSB's Animation on DWH Blowout



BP DWH Accident Was Due to a Series of Technical Failures

- Well design:
  - Narrow drilling margin
  - Long string instead of a liner
- Cementing
  - Cement material
  - *Number of centralizers*
- Negative Pressure Test (NPT) misinterpretation
- BOP failure
- Mud-gas separator
- Alarm systems

Critical Role of Management System Failure in BP DWH Accident

- "The most significant failure at Macondo—and the clear root cause of the blowout—was a failure of industry management. Most, if not all, of the failures at Macondo can be traced back to underlying failures of management and communication." (Report to the President, 2011, p.122, emphasis added)
- "What the investigation makes clear, above all else, is that management failures, not mechanical failings, were the ultimate source of the disaster." (Chief Counsel's Report, 2011, p.ix, emphasis added)

Recent Cal OSHA Reformed Regulation
(Released May 2017, Effective Oct. 1, 2017)

Process Safety Management (PSM) for Refineries 5189.1(o):

- OLD - (5) The report shall be reviewed with all operating, maintenance, and other personnel whose work assignments are within the facility where the incident occurred.

- NEW - (5) The Incident Investigation Team shall *implement the employer's Root Cause Analysis method* to determine the initiating causes of the incident. The analysis shall include an assessment of ***management system failures, including organizational and safety culture deficiencies***. [emphasis added]

Department of Industrial Relations
STATE OF CALIFORNIA

NEWS RELEASE

News Release No.: 2017-37 Date: May 18, 2017

Landmark Workplace Safety and Health Regulation Approved to Reduce Risk of Major Incidents at Oil Refineries in California

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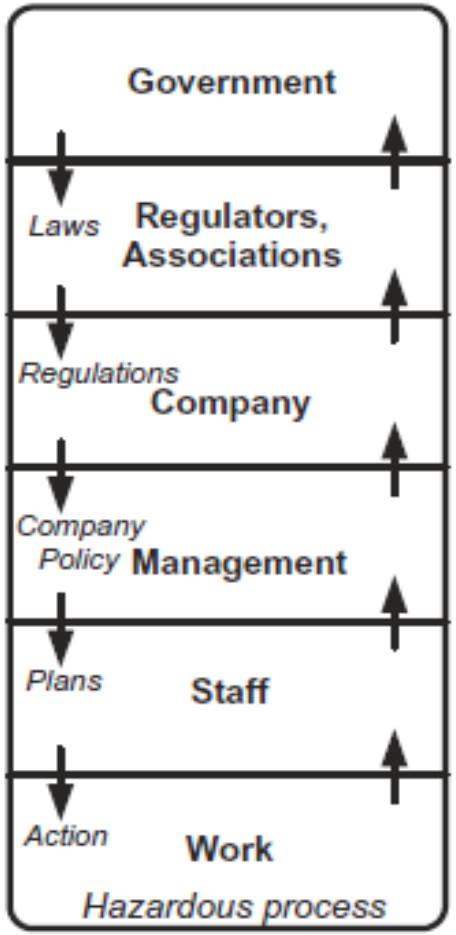
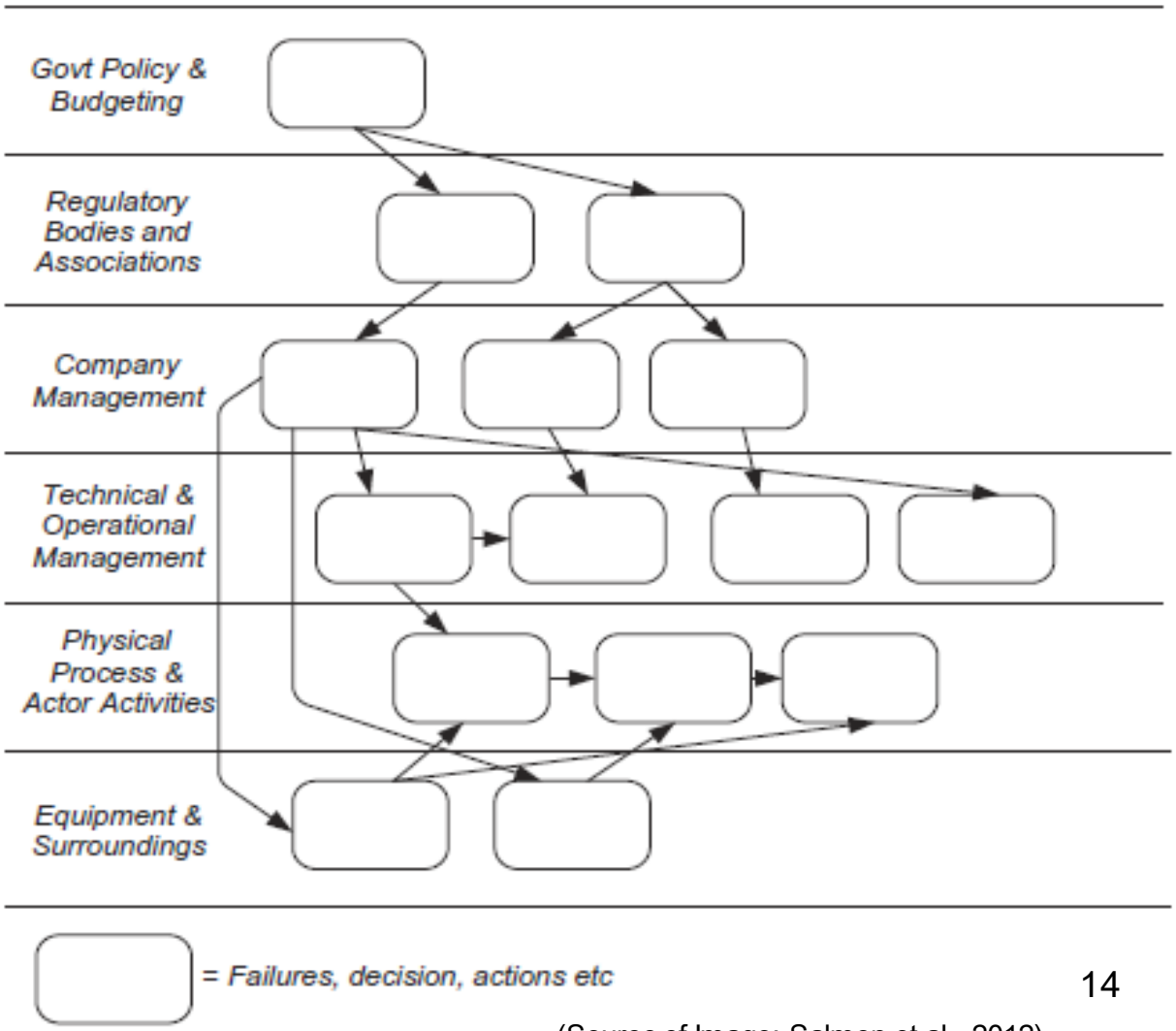
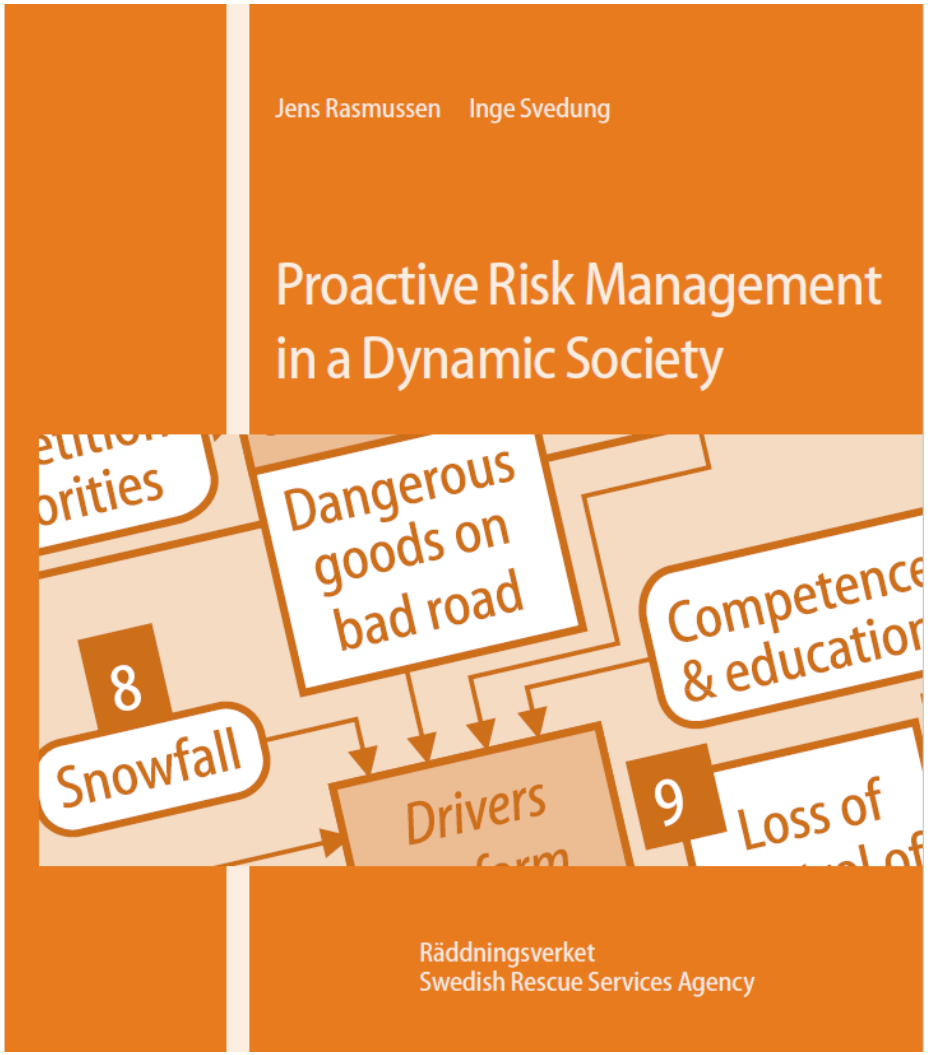
Rasmussen's Risk Management Framework & AcciMap Methodology



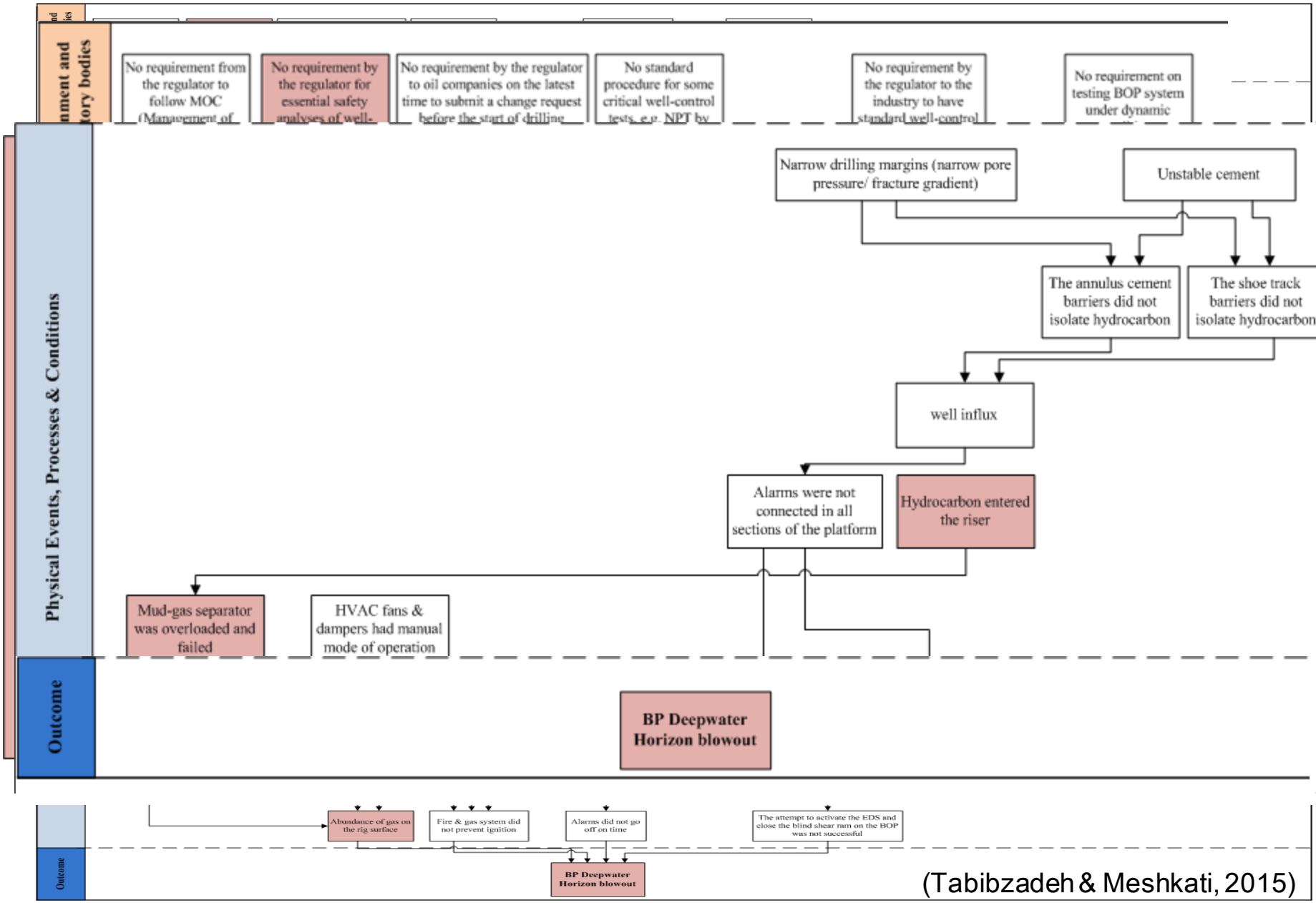


(Source of Image: Salmon et al., 2012)



(Rasmussen and Svedung, 2000)

AcciMap of the BP Deepwater Horizon Blowout



(Tabibzadeh & Meshkati, 2015)

Observations from the Model Analysis-1

1) **External factors levels:**

- **Government and regulatory bodies:** no requirements by the regulator for essential safety analyses of well-drilling operations is a possible contributing cause of the BP DWH accident.
- **Oil and gas industry:** no standard in industry codes regarding the skill-level of personnel for well-drilling operations as well as the existence of no standard procedure for some critical well-control tests, such as NPT, are two important contributing factors to the BP DWH blowout.

Observations from the Model Analysis-2

2) Internal factors levels:

- Aside from influencing external components, **organizational factors**, among internal elements, were the root contributing causes of the BP DWH blowout.
- Three most influential organizational factors:
  - Economic pressure
  - Personnel management issues
  - Issues in communication

Recommendations Based on Model Analysis- External Factors

Recommendations to regulatory bodies:

- Develop system-based risk management programs to holistically assess the safety of well-drilling operations conducted by different oil companies.
- Improve regulatory effectiveness through incorporating explicit reviews and approvals of safety-critical points into that risk management program.
- Require oil companies and contractors to implement safety analyses of their well-drilling operations.

Recommendations Based on Model Analysis- External Factors

Recommendations to the oil and gas industry:

- Develop standard protocols for critical well-control procedures, such as negative pressure test.
- Develop recommended requirements for the minimum skill-level of personnel in well-drilling operations.

Recommendations Based on Model Analysis-Internal Factors

Oil and gas companies need to improve safety culture and its root contributing organizational factors by:

- Improving responses to economic pressure:
  - Establish a balance between production and safety; e.g. incorporate equivalent number of performance measures for safety achievements comparing to production and cost saving accomplishments
  - Define rewarding systems for safe operations
- Improving personnel management issues:
  - Provide specific training to personnel who deal with complex operations such as NPT
  - Audit trained personnel by experienced experts
  - Integrate trainings on safety culture and non-technical skills into workplace procedures

Recommendations Based on Model Analysis-Internal Factors

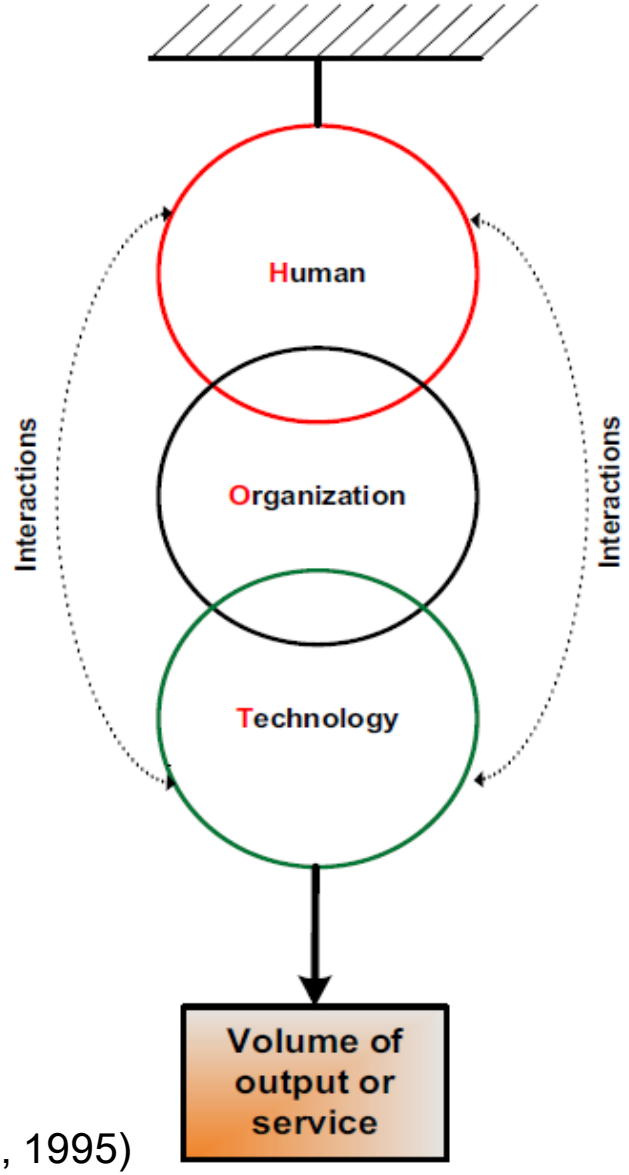
Oil and gas companies need to improve safety culture and its root contributing organizational factors by:

- Improving communicational issues:
  - Communicate the importance of specific operations such as NPT and their associated risks to personnel
  - Define clear lines of communication
  - Design standard and well-understood reporting infrastructures
  - Rearrange or redesign monitoring and control rooms

Generalized Findings

- The analysis of past accidents indicates that they were not caused by the "coincidence of independent failures and human errors", but through the interactions of multiple involved contributing factors.
- There is a need to see the actions of workers or the errors that triggered an accident in a broader socio-technical context.
- Management system failures, including organizational deficiencies, are a main group of accidents root causes.
- The AcciMap Methodology is a powerful tool to analyze the main contributing causes of an accident as well as the interactions of key involved decision-makers and stakeholders.

HOT Framework



(Meshkati, 1995)

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A "Total Asset Management" Paradigm

- Asset management is not only about considering and improving technology and equipment.
- A holistic, systemtic perspective to the three sub-systems of **Human**, **Organization** and **Technology** and strengthen and improve these sub-systems in a balanced manner
- Not only developing an integrated asset management system, but also integrating it with other management systems such as:
  - Quality (ISO 9001),
  - Environment (ISO 14001),
  - Health and safety (OHSAS/ISO 18001) and
  - Risk management

A "Total Asset Management" Paradigm-Cont'd

- It includes an assessment of management system failures, including organizational and safety culture deficiencies while conducting incident investigation.
- Related elements to management systems:
  - Safety culture
  - Management of change
  - Communication and interoperability
  - Personnel management
  - Procedures, standards and protocols

Thank you

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