Investigation Report on a Mining Disaster in USA: "When mine operators resort to tricks and deceit to keep government officials in the dark, our mine safety system unravels and miners are put in harm's way."
The Basic Life Cycle Management Model

Essentially the same across all industries
THE COMPLEXITY AND CHALLENGES OF ASSET MANAGEMENT IN MINING
The Devil Lies in The Degree of Complexity / Uncertainty

Normal Accidents: Living With High Risk Technologies - which explains his theory of normal accidents; catastrophic accidents that are inevitable in tightly coupled and complex systems. His theory predicts that failures will occur in multiple and unforeseen ways that are virtually impossible to predict.

Mining is both complex and loose – a new workplace everyday!
A complex system is simply a system in which many independent elements or agents interact, leading to emergent outcomes that are often difficult (or impossible) to predict simply by looking at the individual interactions.

- A good example from economics is
  - Micro and Macro Economics.

The “complex” part of CAS refers to the vast interconnectedness of these systems.

They can be better understood through the application of models, rather than a disparate collection of facts.

Some of the more complex industries:
- Nuclear
- Military
- **Underground Mining**
- Space
- Aircraft
- Chemical Plants
Mining as a Complex Adaptive System

- Unidentified or out-of-range disturbance
- Process input missing or wrong
  - Government, regulators, company, management, workers
  - Inappropriate, ineffective or missing control action
    - Flawed controls
    - Conflicting control actions

- Weak safety culture
  - Personal accountability
  - Problem identification & resolution
  - Environment for raising concerns

- Vision, beliefs, & values

- Mission Goals Policies
  - Latent organizational weaknesses

- Error precursors
  - Inadequate or missing feedback (operating experience)
    - Measurement inaccuracies
    - Feedback delays

- Process model inconsistent, incomplete, or incorrect
  - Control input or external information wrong or missing
  - Delayed operation
  - Process output contributes to system hazard
The Consequence of Complexity and Over-regulation
LEARNING FROM HISTORY
CASE STUDIES OF MINING DISASTERS
Mining Disasters Present: Lessons

• Honkeiko Colliery, China: April 26, 1942  1,549 Fatalities

Worst mining disaster in History

Gas Explosion
Monongah Colliery, West Virginia, USA, Dec. 6, 1907

361 Fatalities

Worst mining disaster in American History

Gas Explosion as Ventilation System Disabled

On the 6th of Dec., 1907, 361 coal miners, many of them from countries far across the sea, perished under these hills in the worst mining disaster of our nation. The four who escaped died of injuries.
Mining Disasters Recent: Lessons

- Buckhannon Colliery, West Virginia, USA, Jan 2nd, 2006  
  12 Fatalities

Led to closure of the mine 2 years later

Lightning strike ignited
Accumulated gas at
Mouth of Mine Entry

Act of GOD or Preventable!
Mining Disasters Recent: Lessons

- Upper Big Branch Mine, W.V., USA, Apr 5th, 2010  
  29 Fatalities

Largest Coal Mine Disaster in USA in 40 years

- Mine eventually closed by new owners
- CEO Convicted and jailed
- Corporate criminal liability $ 209 Million

■ Poor Ventilation
■ Inadequate environment monitoring
■ Lack of maintenance – malfunctioning sensors
■ Inadequate water spray system
■ Poor house keeping / whistle blower disclosures suppressed

Opening Sentence of Investigation Report: Safety precautions in mines are “a hard-earned right paid for with the blood of coal miners,” read the report's introduction. "People who run coal mines have a fundamental obligation to be honest with mine regulators"
Mining Disasters Recent: Lessons

- Pike River, New Zealand, Nov. 19th, 2010
  - Designed as a world class mine for low environment impact, high safety with modern machines  
  - 29 Fatalities
  - Mine closed. Company bankrupt

- Preventive maintenance in adhoc manner: gas sensors unserviceable / defeated
- Deficiencies in engineering implementation of ventilation hardware
- Response to emerging hazards deficient
- Systems engg. analysis revealed planning for prevention (not recovery) + organizational shortcomings → poor implementation
- Basic mining engineering for gassy mines neglected – CH4 drainage compromised
- Inadequate Organizational response to emerging hazards

Existing Act pre-empted the conviction of key officials despite multiple failures. Led to new Mines Act in 2015 and stress on systems engineering approach. Efficacy of self governance questioned: Only works where mine management is honest & socially responsible.
Learnings from the Case Studies

• Mining disasters continue to take place due to explosions
• Number of fatalities are less due to less persons engaged
• Excellence in asset management / infrastructure integrity is compromised
  • Shortcuts to achieve quick gains
• Unscrupulous operators not conscious of the dangers of mining
• The dangers of mining by non specialist / inexperienced mining organizations
  • Dependence on one or two operations magnifies the adverse impact of poor geo mining conditions on the bottom line
  • Organizational shortcomings due to lack of depth and expertise
  • Shortcuts to achieve production targets
Some Practical Tips for Mine Operators

• Disruptive events and uncertainty defeat traditional approaches

• Create matrix organizations which provide for centralization but also the flexibility of decentralization that crises demand

• Life Asset performance should be aligned with Corporate Objectives

• Supporting strategies to be well defined and enshrined with top management demonstrating commitment

• Plan and implement

• KPI’s based on asset management should form an important element of performance appraisal from top to bottom
ASSET MANAGEMENT
BEST PRACTICES IN UNDERGROUND MINING
What Has Been Achieved in India – Joy Global Best Practices

- Flawless Start Up
- Operational Excellence (Opex)
- Life Cycle Management
- Remote Condition Monitoring Capability
- 24 Hour Service Backup

Rigorous and intensive training – each project fully equipped

Application of the principles of Opex to the UG mining workplace

Machine Overhauls and Rebuilds

Machine condition analysis

Component Exchange System based on
- Mean Tonnage Before Failure (MTBF), &
- Condition Monitoring

- The first Continuous Miner in India (2002) is still in operation = 16 years
- To the same performance standards with no machine / maintenance related serious injury
Yet to Come ............

- Smart Service Centres
- Remote Fleet Monitoring
- Prognostics
- Asset Performance Software
- On Line Technical Information Portal Service

**Technical Information Portal Service (TIPS)**

**Safety Notices**
- Centralized online access
- Increased safety awareness

**Technical Service Bulletins**
- Quick up-to-date distribution
- Increased workforce skills

**Parts Catalogs**
- Ability to customize and annotate
- Increased workforce efficiency

**Training Materials**
- Easy to access and re-use
- Increased machine productivity
- More skilled and educated workforce

**Multimedia Library**
- Enhance internal presentations
- Utilize as an excellent visual and educational resource

**Technical Manuals**
- Widespread use and availability
- Reduced downtime
Thank You