From RAM Modelling to Predictive Maintenance

Optimizing Mine Performance Through Digital Innovation Seminar, October 18, 2017

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Agenda

- Asset Management
- Asset Management System
- Project & Operations Decision Making
- RAM Modelling
- Enabling Predictive Analytics

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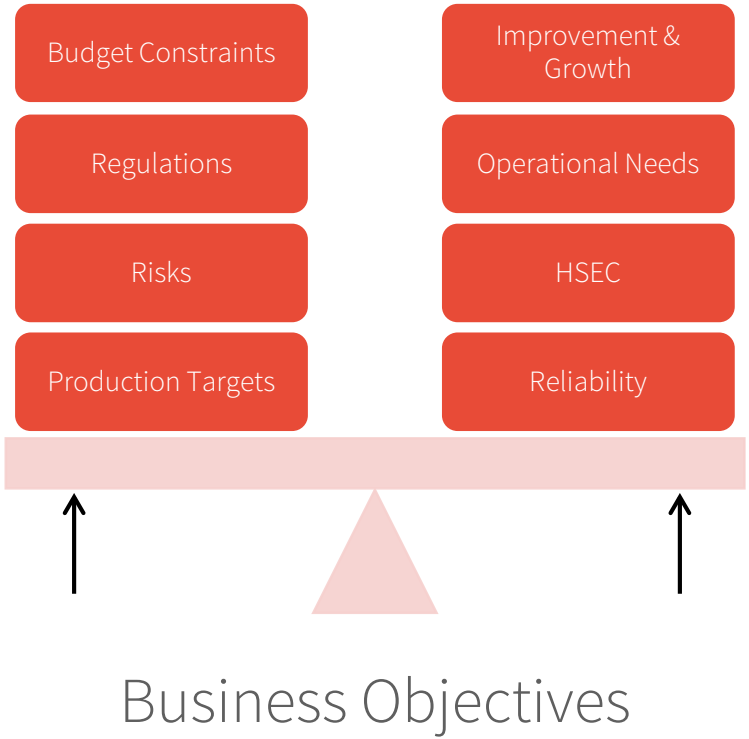
Asset Management

- Co-ordinated set of activities to realize the full potential from assets
- From design to construction and beyond – a lifecycle approach
- Balancing business objectives to ensure success



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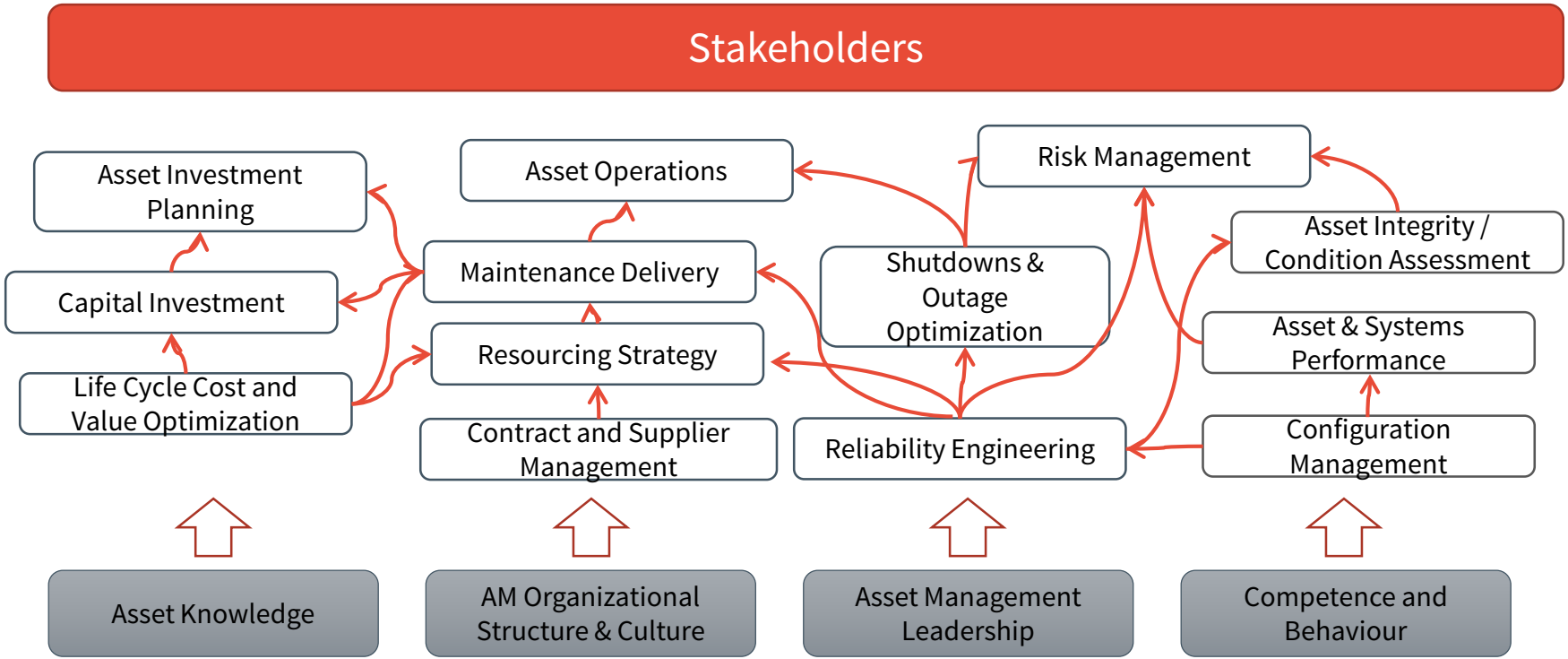
Asset Management System



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Project & Operations Decision Making

How can we answer questions important to project and operations stakeholders?

- How to achieve reliable production targets?
- How to reduce CapEx while keeping OpEx low?
- What is the right maintenance strategy?
- What is the right amount of people required to operate?
- What is the right amount of data to analyze?
- What vendor do I choose?
- Do I need to debottleneck the system?
- How can I improve safety?

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RAM Modelling

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What is RAM Modelling?

- RAM Modelling is an analytical methodology to:
  - Identify causes of significant losses of operational availability
  - Identify issues that may limit production throughput
  - Uncover improvements to design or maintenance strategy to meet project objectives

Reliability

Availability

Maintainability

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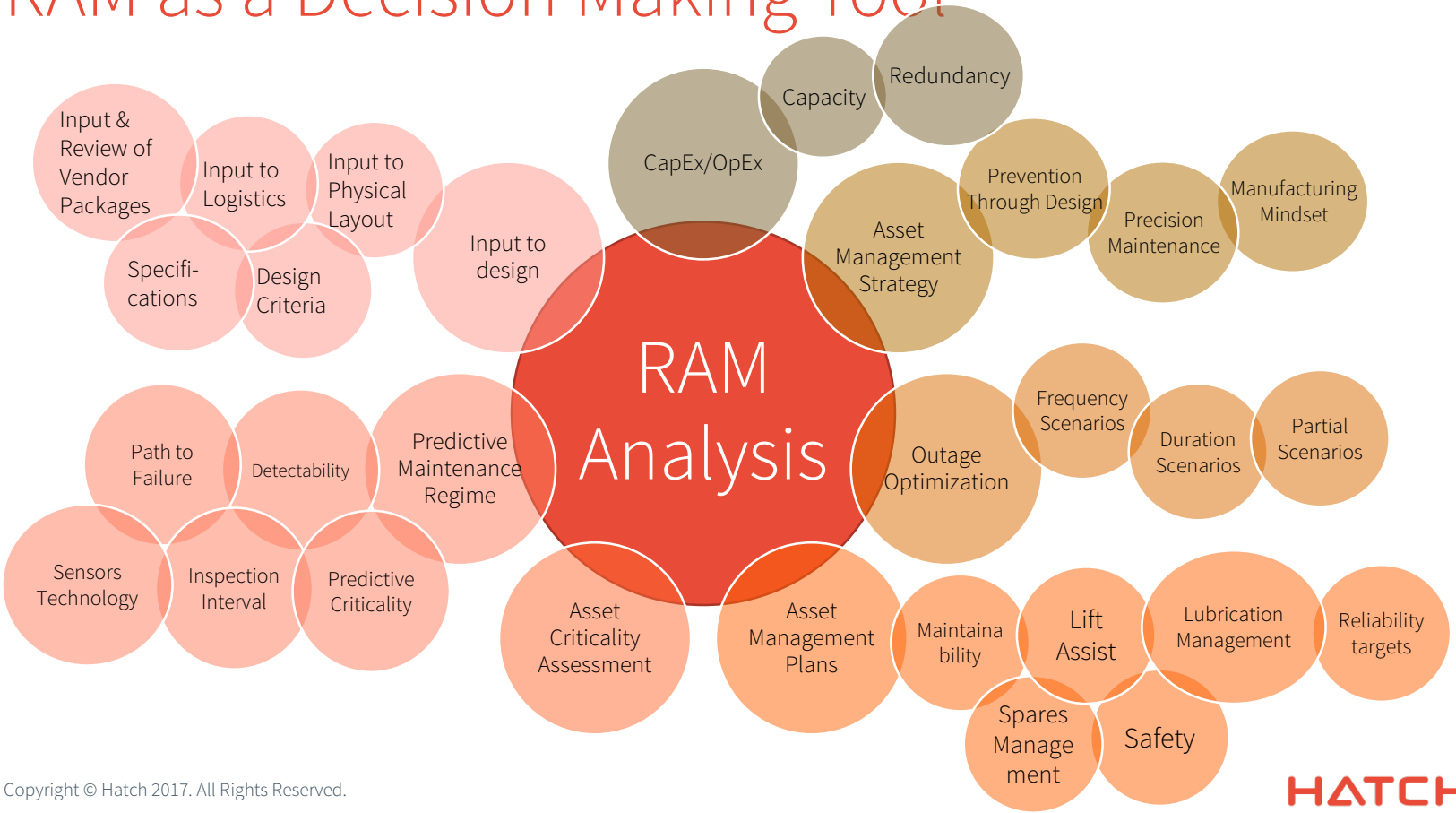
RAM as a Decision Making Tool



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RAM Model Input & Outputs

Failure Modes

- Unplanned MTTR
- Planned MTTR
- MTBF
- Corrective Tasks
- Failure pattern

Inspection Strategy

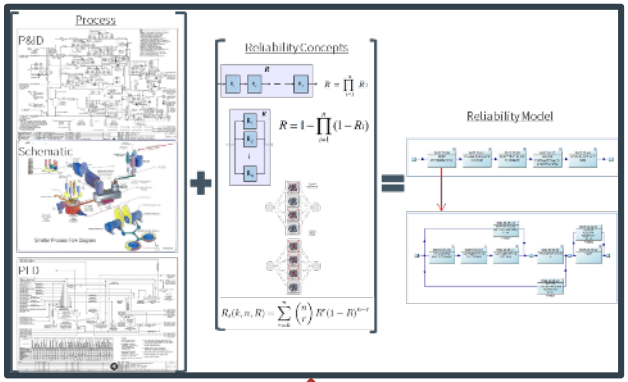
- Inspection Interval
- PF
- Detectability
- CM method
- Plant Shutdowns

Logic

- Operational Modes
- Bypasses
- Redundancy
- Minimum capacity

Logics

- Basis of Assumptions, Functionality, Benchmark Information, Rules, Logics, Voting Rules, Bypasses, Operational modes



Governance

- RACI, Approval Matrix, Interfaces for data transfer, Team workflow, QA/QC, Simulation parameters

Reliability

- System, Area and Equipment MTTR
- System, Area and Equipment MTTR
- System, Area and Equipment MTBF
- System, Area and Equipment Availability

Indicators

- Total Downtime Importance
- Total Capacity Importance
- Single point of failures

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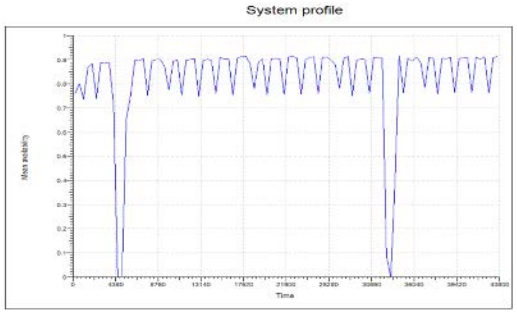
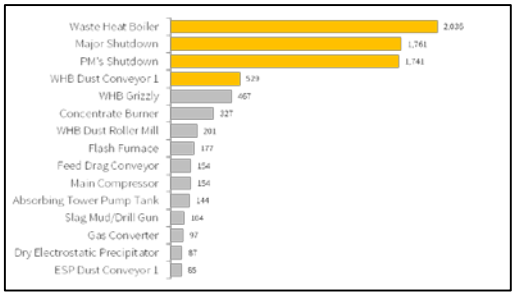
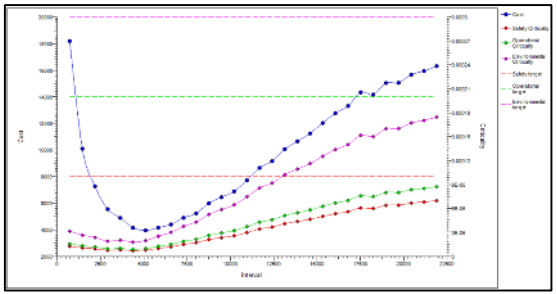
Results Analysis & Interpretations



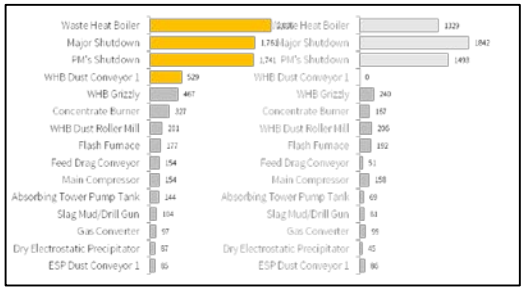
Availability Predictions



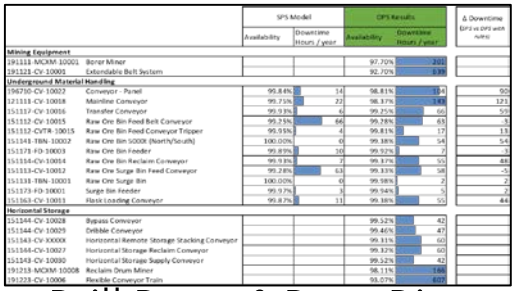
TCI & TDI



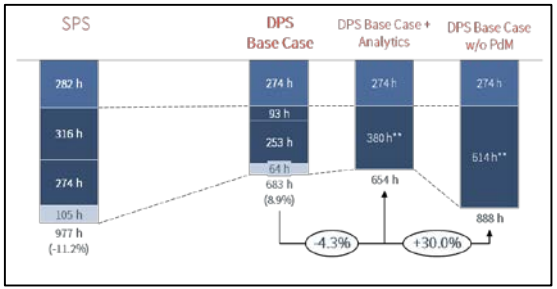
PM & Outage Optimization



Scenario Comparison



Drill Down & Deep Dive Analysis



Waterfall along Design Progress

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Enabling Predictive Analytics

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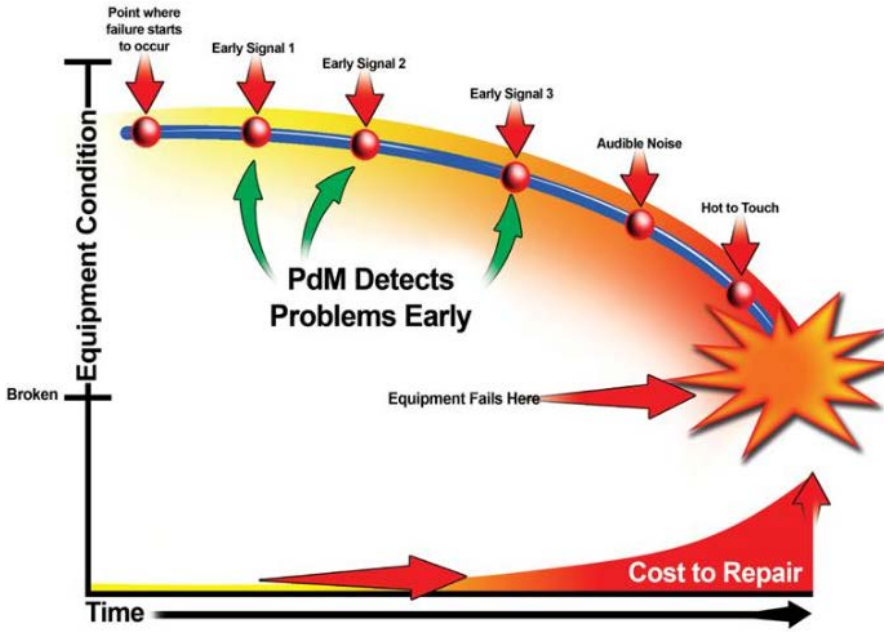
Value of Predictive Maintenance

- It is not only about predicting failure
- Detecting for failure elimination before damage is irreversible
- Detecting for life extension until next scheduled shutdown
- Trending for RCA
- For changing operational modes to fulfil operational targets



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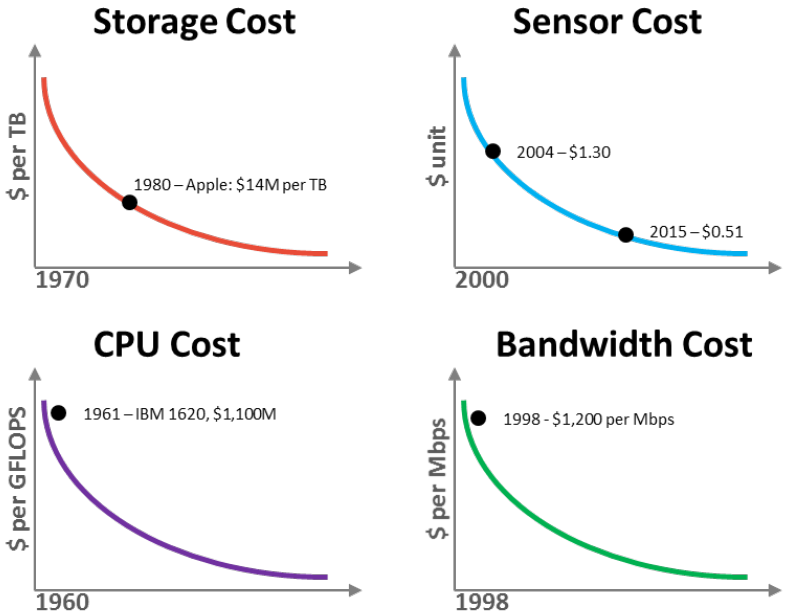
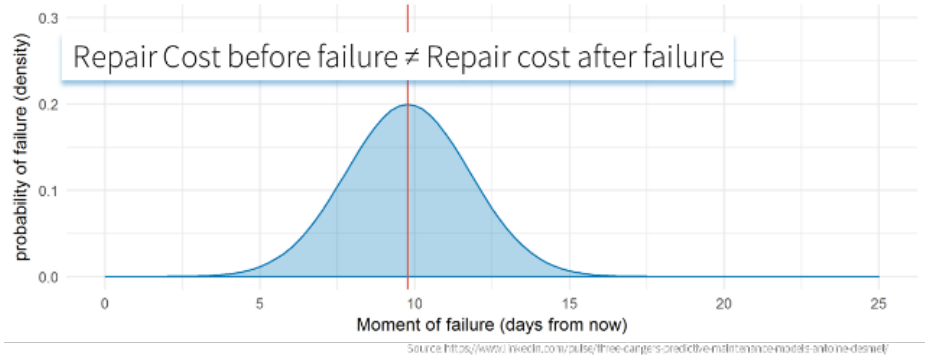
Why is Predictive Maintenance gaining steam now?



Adapted from: http://radar.oreilly.com/2011/08/building-data-startups.html/



Source: https://www.linkedin.com/pulse/three-targets-predictive-maintenance-models-antoine-desmet/

Source: http://www.movus.com.au

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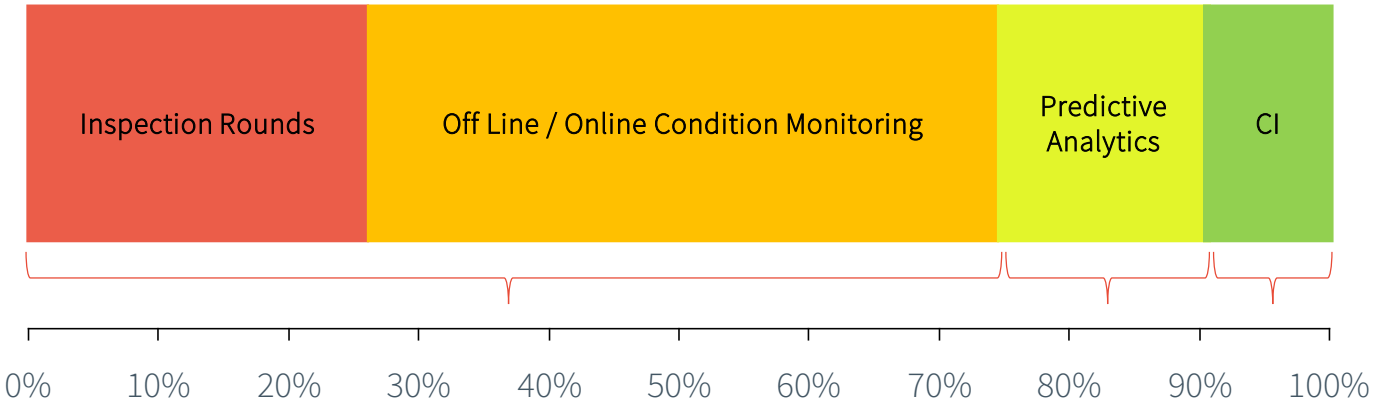
Detectability Opportunity Graph



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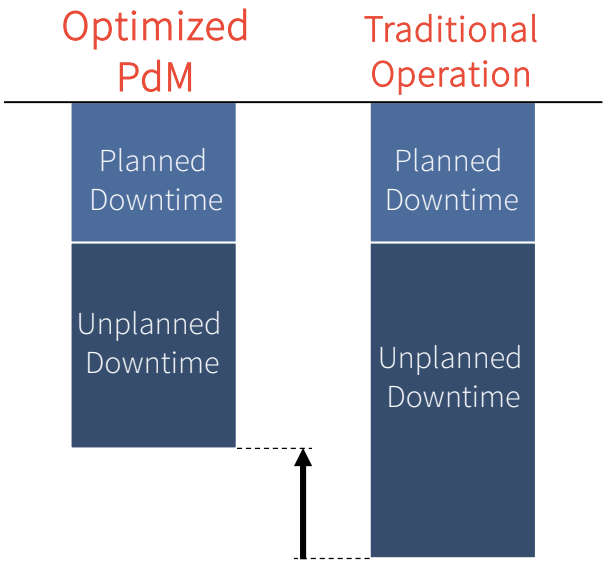
Connecting PdM and RAM

- Optimizing the PdM Regime allows for:
  - Greater detectability of the most critical failure modes in the RAM model
  - Advanced warning of the failures to allow for a planning and scheduling window
  - Decreased unavailability of the plant



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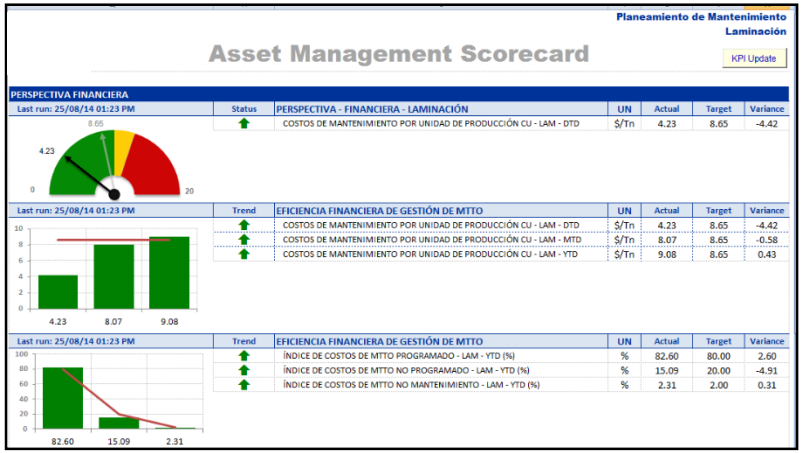
Unlocking Value During Operations

- Digital Twin's Asset Health Index with Specification
- Weighted formula based on PdM Recipe
- Augmented with Predictive Analytics for Estimated Days to Failure
- Online reliability trending



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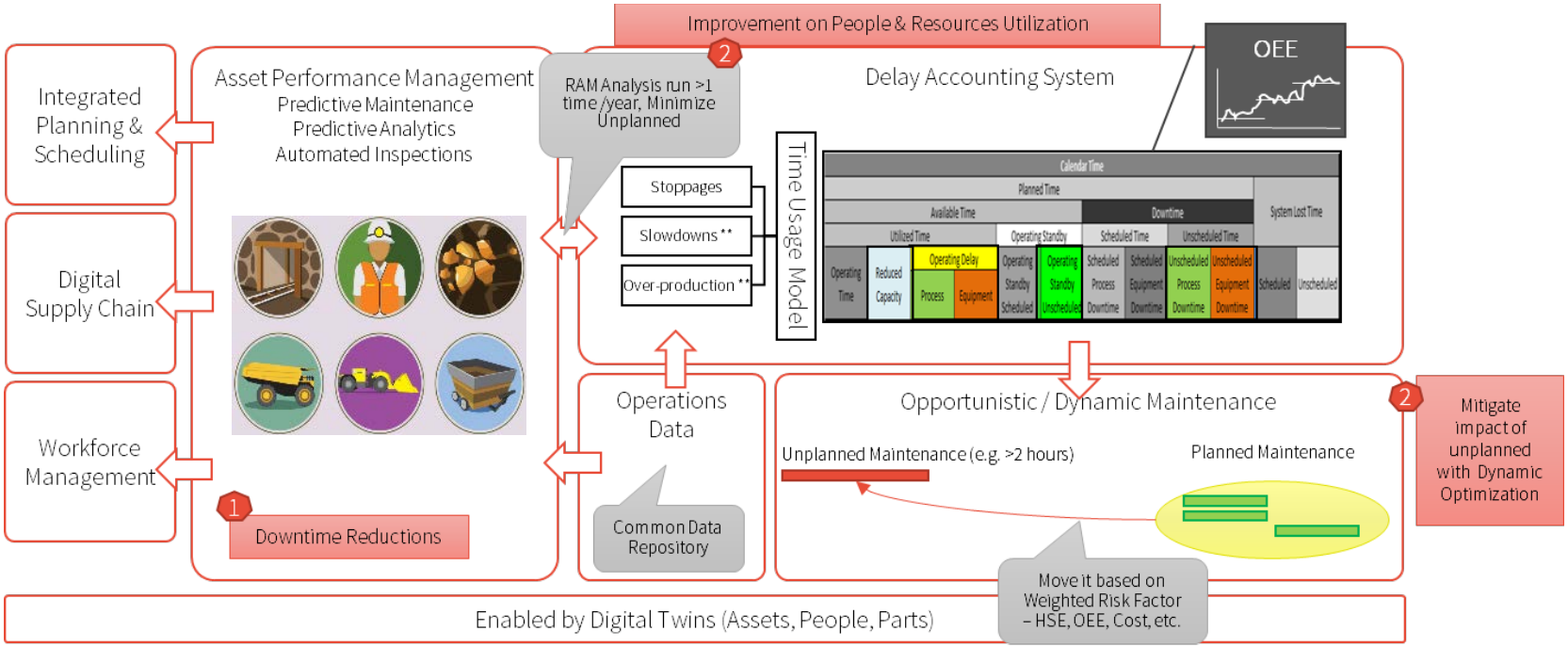
Asset Management becomes Digital Asset Management



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Thank you.

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