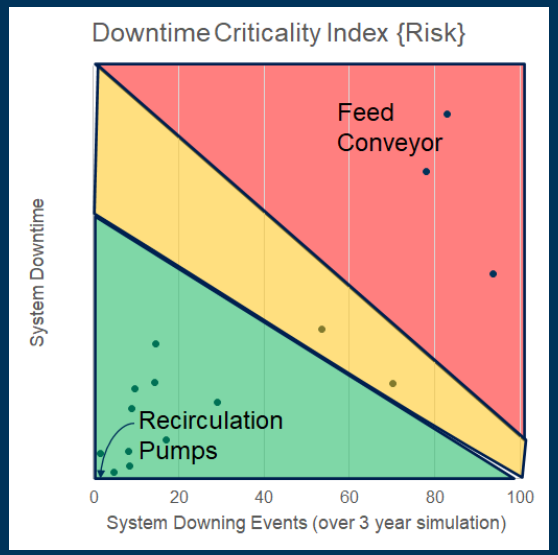
HBM Prenscia Technology Day

Virtual Seminar Series



Data-driven Reliability for Mining and Process Industries

Presented by Mr. Adi Dhora
Reliability Solutions Consultant
Prenscia Engineering Solutions

Session #6: Mathematical Modelling for Data Analytics, Durability, and Reliability #2

Data-driven Reliability for Mining and Process Industries

Abstract

This presentation describes practical approaches for mining and process industries to overcome data quality issues and pursue more data-driven reliability practices. Like most industries, mining and process industries are constantly looking to improve equipment reliability and institute new, best work practices. However, a clear understanding of the requirements regarding data, systems, and work processes is often not widely known and accessible. It describes the use of proven techniques, including life data analysis, ‘reliability-twins’, and new predictive analysis methods, and how they build upon foundations like ‘reliability-centered maintenance’ for more data-driven reliability.

About the presenter, Mr. Adi Dhora

As a Reliability Solutions Consultant, Adi specializes in implementing data-driven methodologies to improve the reliability of critical assets at mines and fixed plants. He has a background in mechanical engineering and has assisted many leading industrial companies in implementing reliability programs.

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Data-driven Reliability for Mining and Process Industries

Session #6: HBM Prenscia Technology Day

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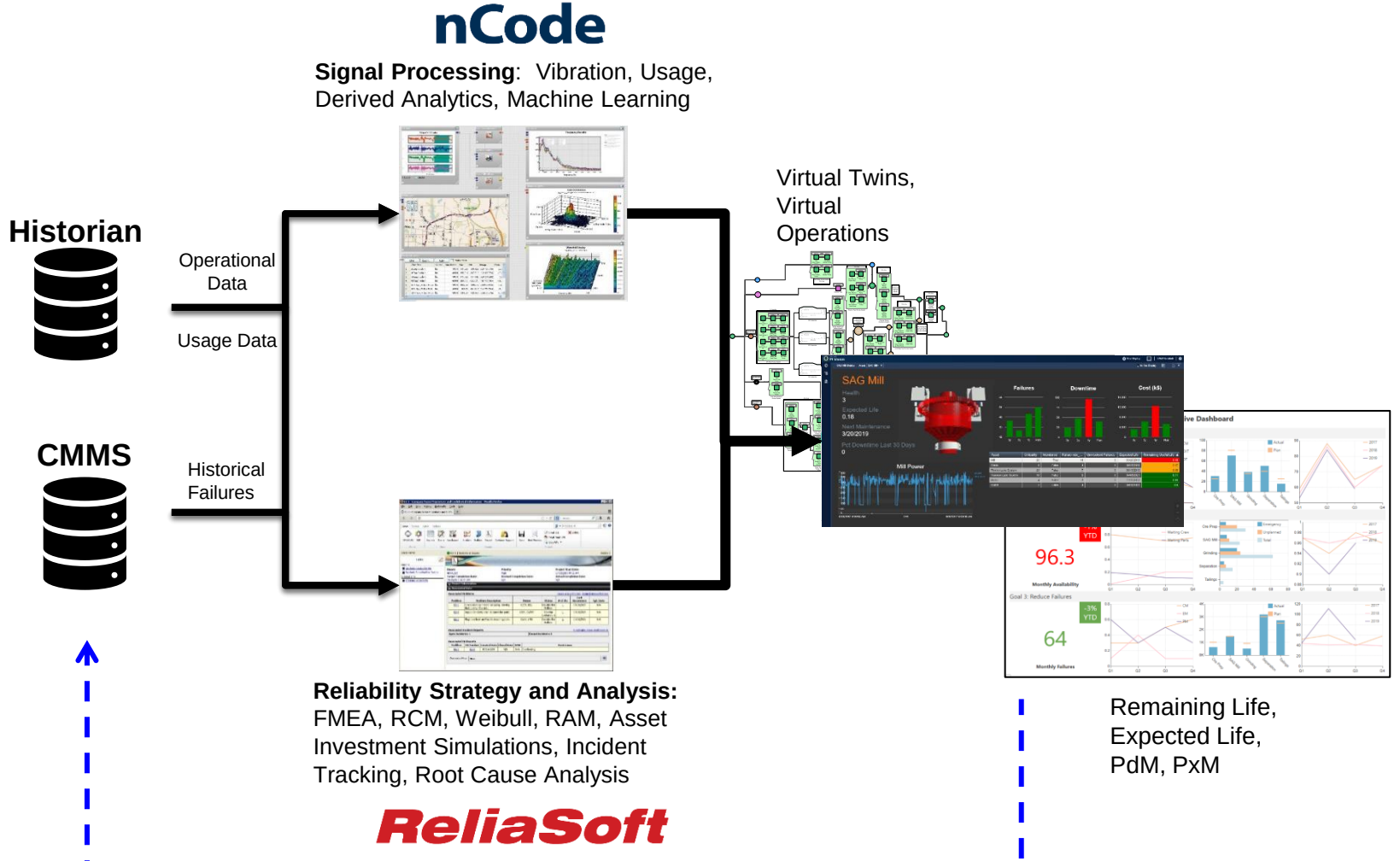
Combine Operational Data with Historical Data for Superior Insights…



Sample of Insights

- Verified Failure History
- Update Maintenance Interval
- Re-design Component
- Next Inspection Date

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For most operations, reducing the amount of maintenance performed will continue to become a higher priority

Constant Motivators

- Enhanced safety
- Operational excellence
- Cost efficiencies

“New” trends – already in motion

- Aging assets
- Tighter capital expenditure
- Changing workforce
- New operational needs
- Changing technology

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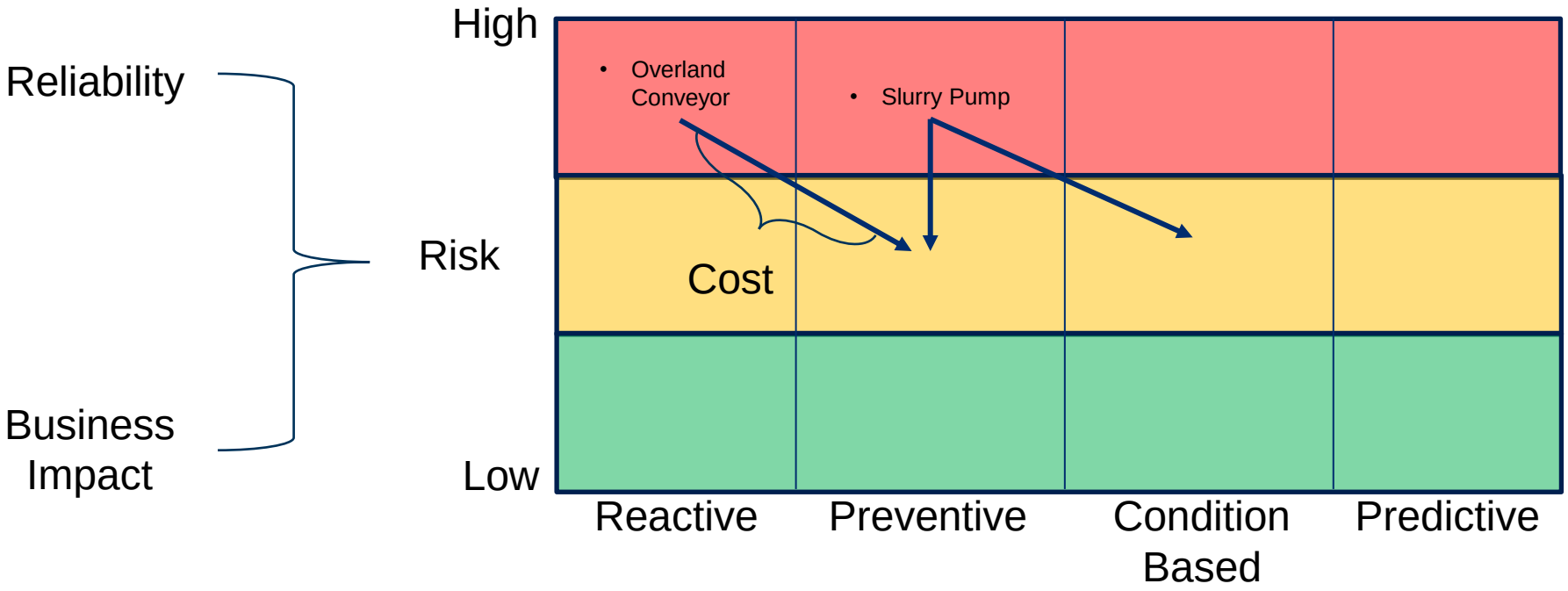
Challenge #1 – Where to start

“For many events, roughly 80% of the effects come from 20% of the causes”
— Vilfredo Pareto

Framework for Reliability-based Asset Management



Combine different tactics to achieve the desired reliability while balancing the costs and resources required to do so

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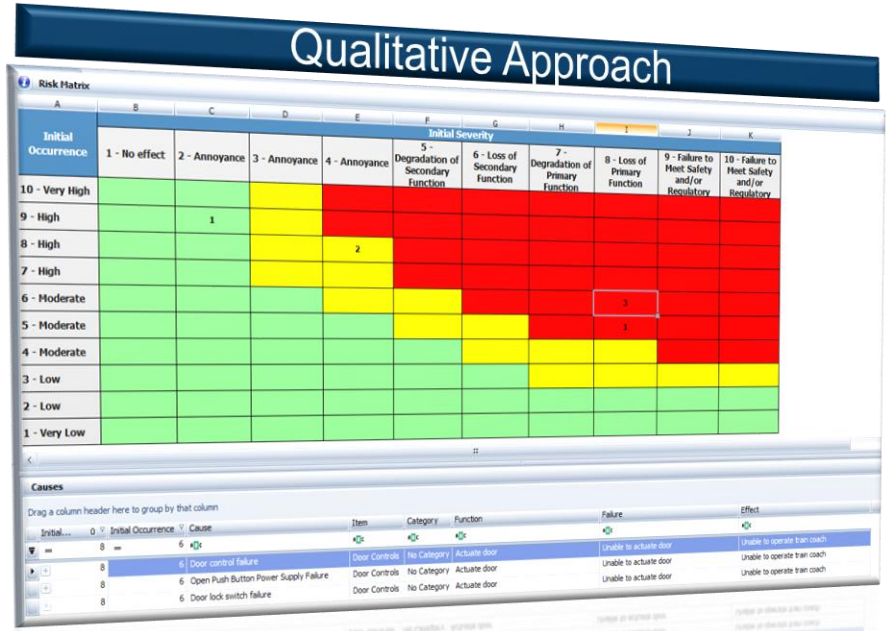
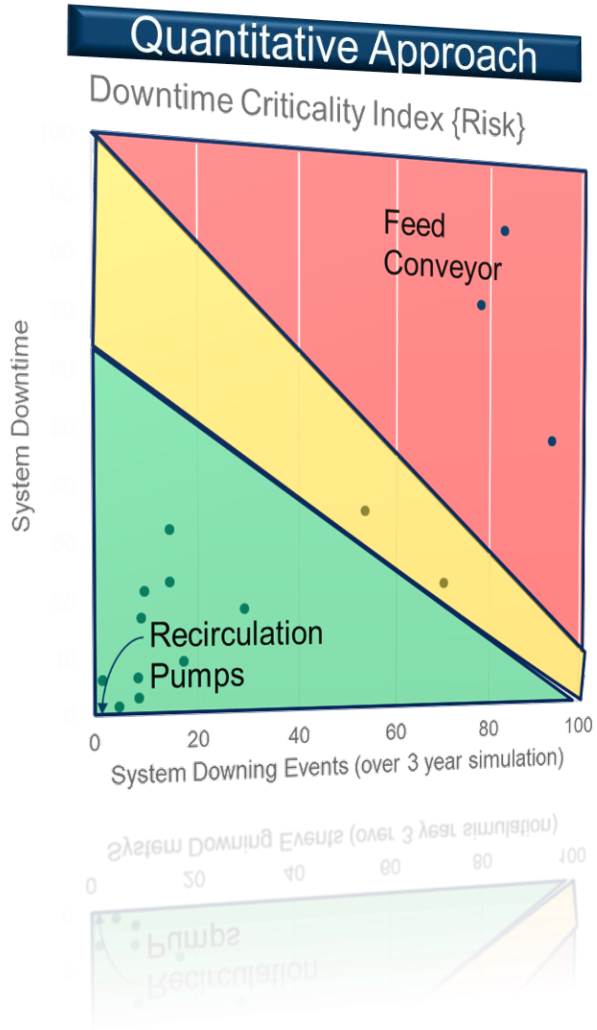
Framework for Reliability-based Asset Management





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Example – Data-driven approach for a Mill

Data Utilized

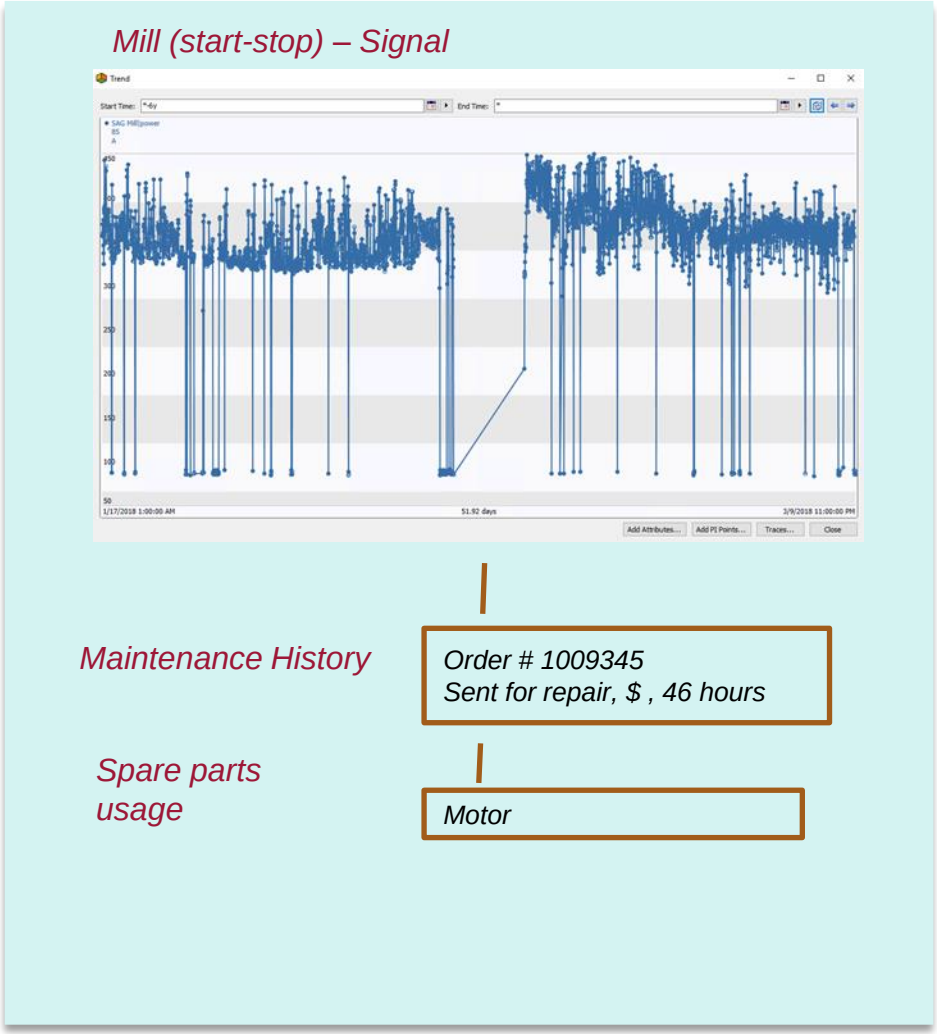
- Historian: Signals (continuous, time series data) (e.g. motor amps)
- CMMS: Maintenance data

Data Fusion

- Distinguish process stops and downtime due to repairs/maintenance events
- Generate downtime records at lowest replaceable unit (LRU) level

Data Storage

- Imported into an failure and maintenance incident management system



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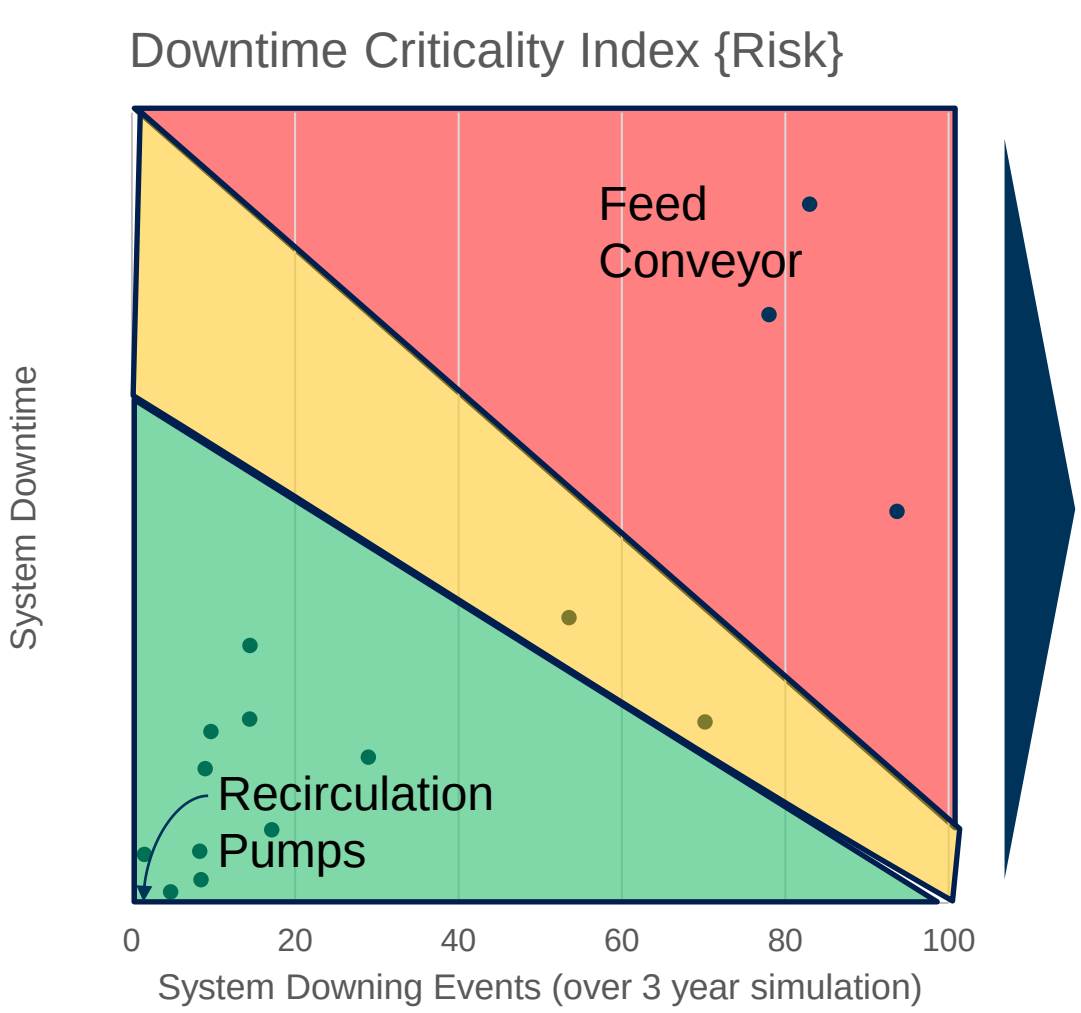
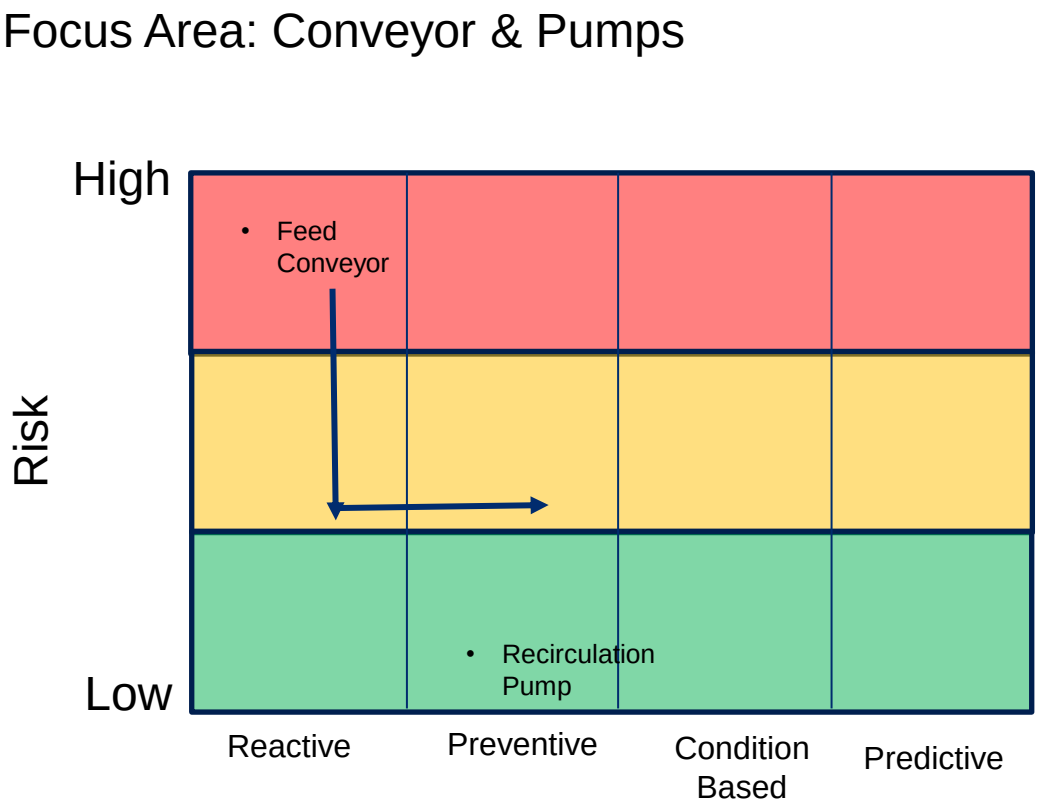
Example – Data-driven approach for a Mill





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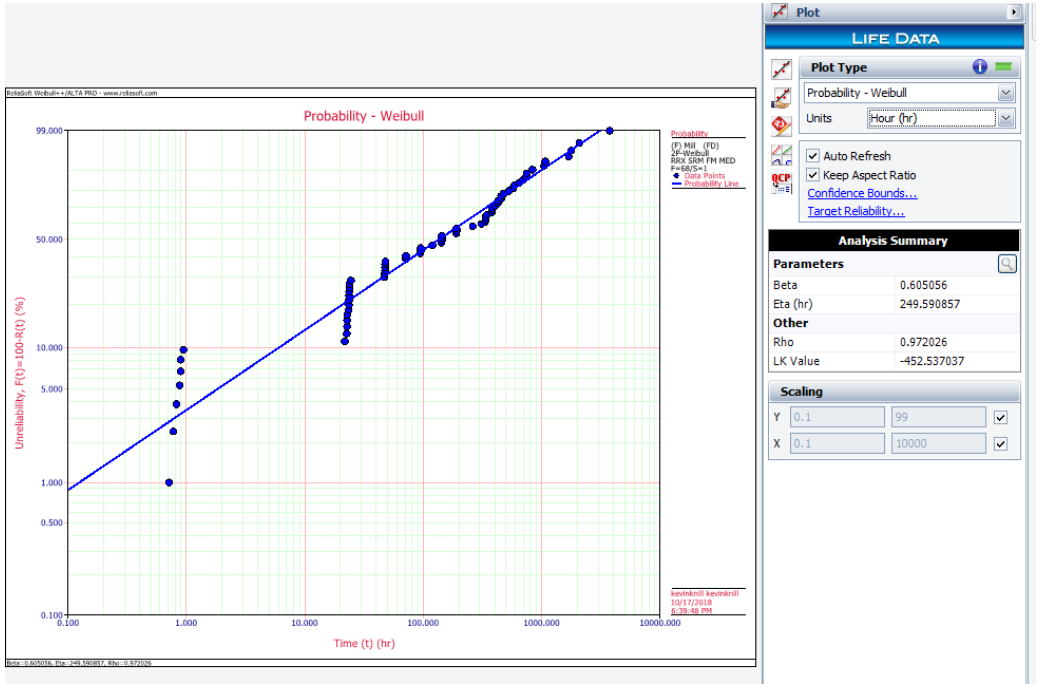
Example – Data-driven approach for a Mill

Data Analysis

- Life data analysis using Weibull++ on unplanned downtime events related to failure (repair)
- Model fitting (Failure intensity, Repairable systems analysis)

Validation

- Good fit
- “Good as new” assumption after failure event appears to be reasonable for most equipment and components



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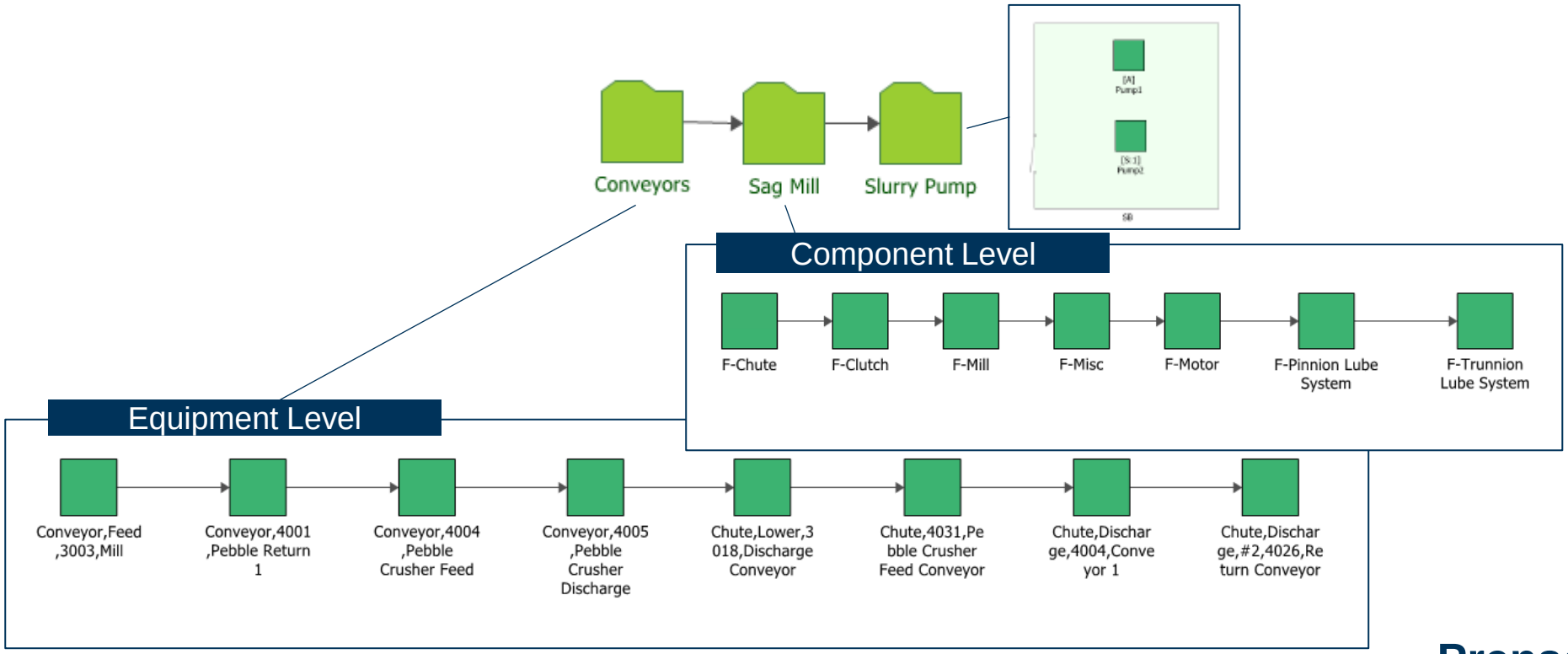
Example – Data-driven approach for a Mill

Reliability, Availability and Maintainability Simulator

- Create reliability block model of process
- Run 3 year simulation at 10 minute intervals



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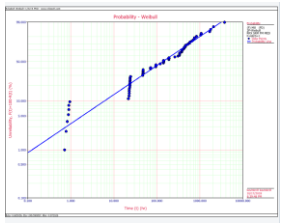
Reliability, Availability and Maintainability Simulator

Input



Output

Expected performance plan agreed across the business

- **System availability and reliability**
  - Failure rates
  - Expected number of stoppages
- Production output
- Costs
- **Asset Criticality**
  - Contribution to system downtime
- Spares requirements

…..+ more

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Recirculation Pumps: Preventive → Optimized Preventive

Analysis

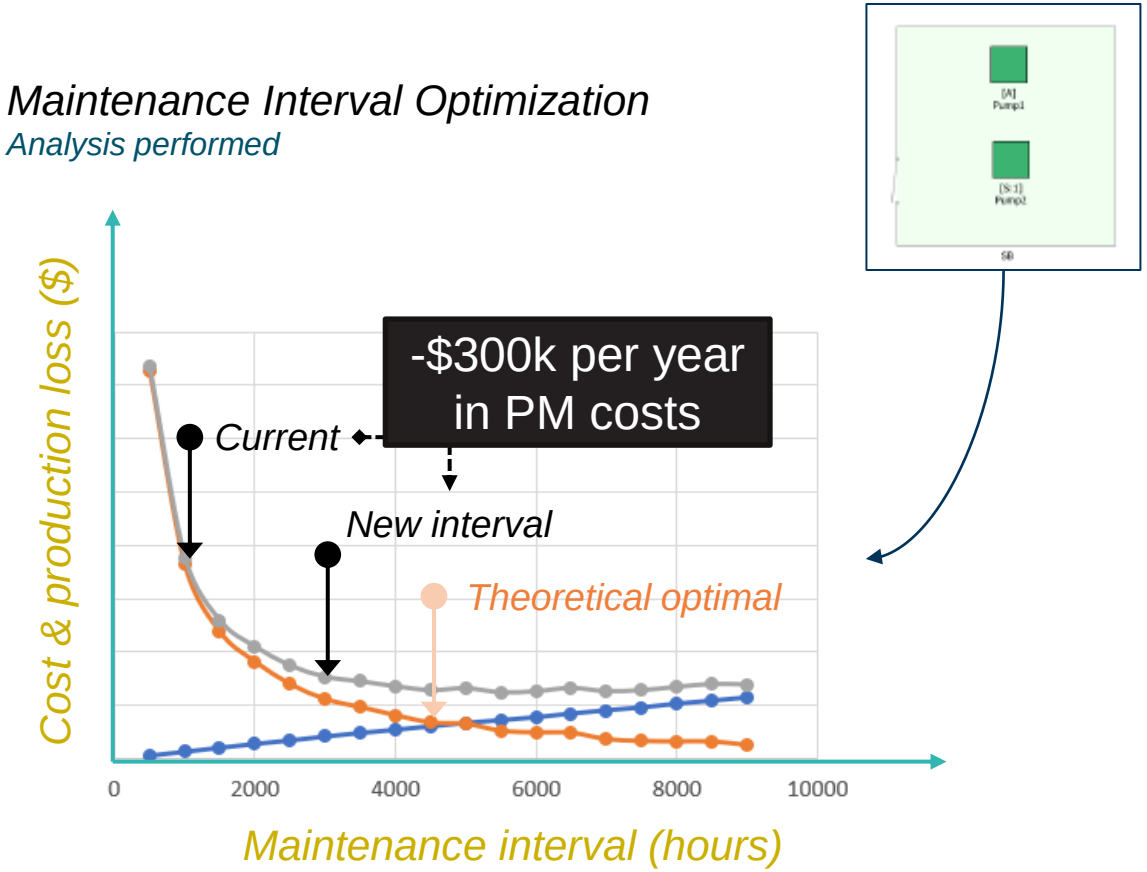
- What-if we rebuild the pump every 3000 hours instead of 1000 run hours?
- Use ‘reliability block model’ of the system (duty + standby pump)
- Simulation and what-if scenarios run with different rebuild intervals (every 500 hours to every 9000 hours)

Outcome

Showcased rebuild intervals can be extended without sacrificing availability and uptime of the plant

Maintenance Interval Optimization

Analysis performed



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Why adopt a Reliability-based Asset Management framework?

Operating costs can be reduced significantly

Less downtime and interruptions to production can lead to better safety and higher throughput

*On average**

-10.4% unplanned events
-9.4% less PM activities
-10.2% materials used
-10.9% stocked spare parts

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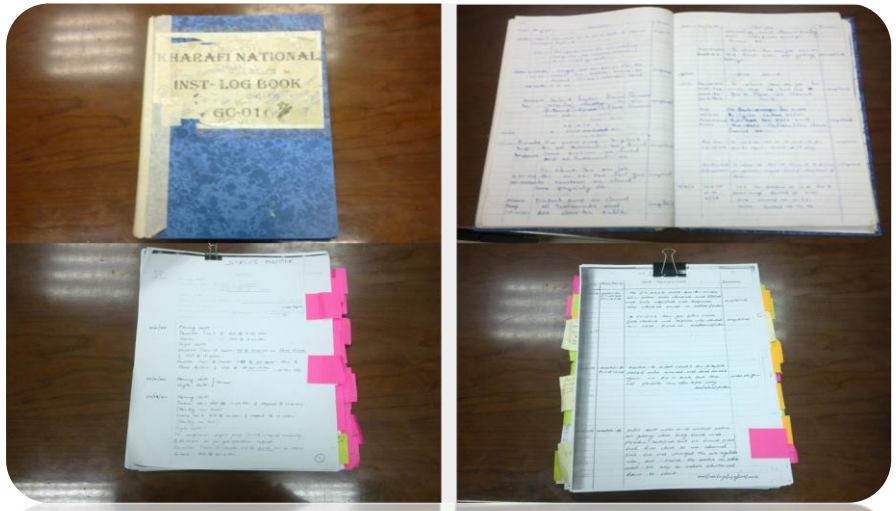
Challenge #2 – Data

20 Years Ago – The challenge was data



Today – The challenge is… still data

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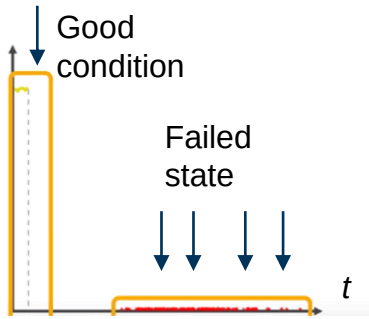
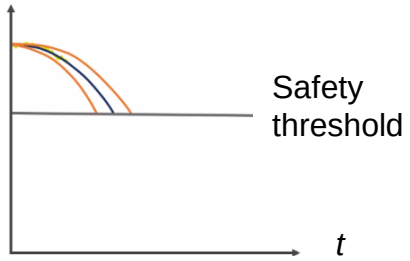
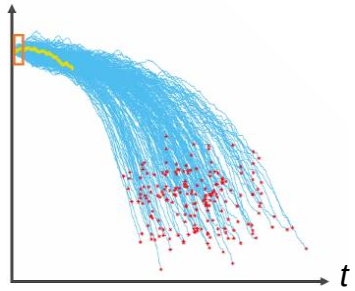
Good maintenance and failure history are keys to all data-driven methods

	Outcome	Input data required
Life Data Analysis 	• Probability of failure under *similar conditions*  Battery life: 12 hours	• **Failure or maintenance history** • **Failure causes and classification (Recommended)**

Degradation Analysis 	• Estimation of current condition of a *specific asset*  Low, High	• Condition indicators
		  • time-based (e.g. engine oil temperature)
		  • test-based (e.g. crack UT)
		  • model based (e.g. fatigue load cycles)
		• Thresholds
		  • Knowledge-based
		  • Validate against ***failure or maintenance history***

Prognostics 	• Prediction of the Remaining useful life of a specific asset *based on current usage and trends*  16%: Approximately 3 hrs left	• **Failure history** • **Failure cause and classification** • Condition indicators (signals, data points) + Accurate asset identification + Sufficient fidelity of data (frequency of data capture)

Critical requirement for a data-driven approach

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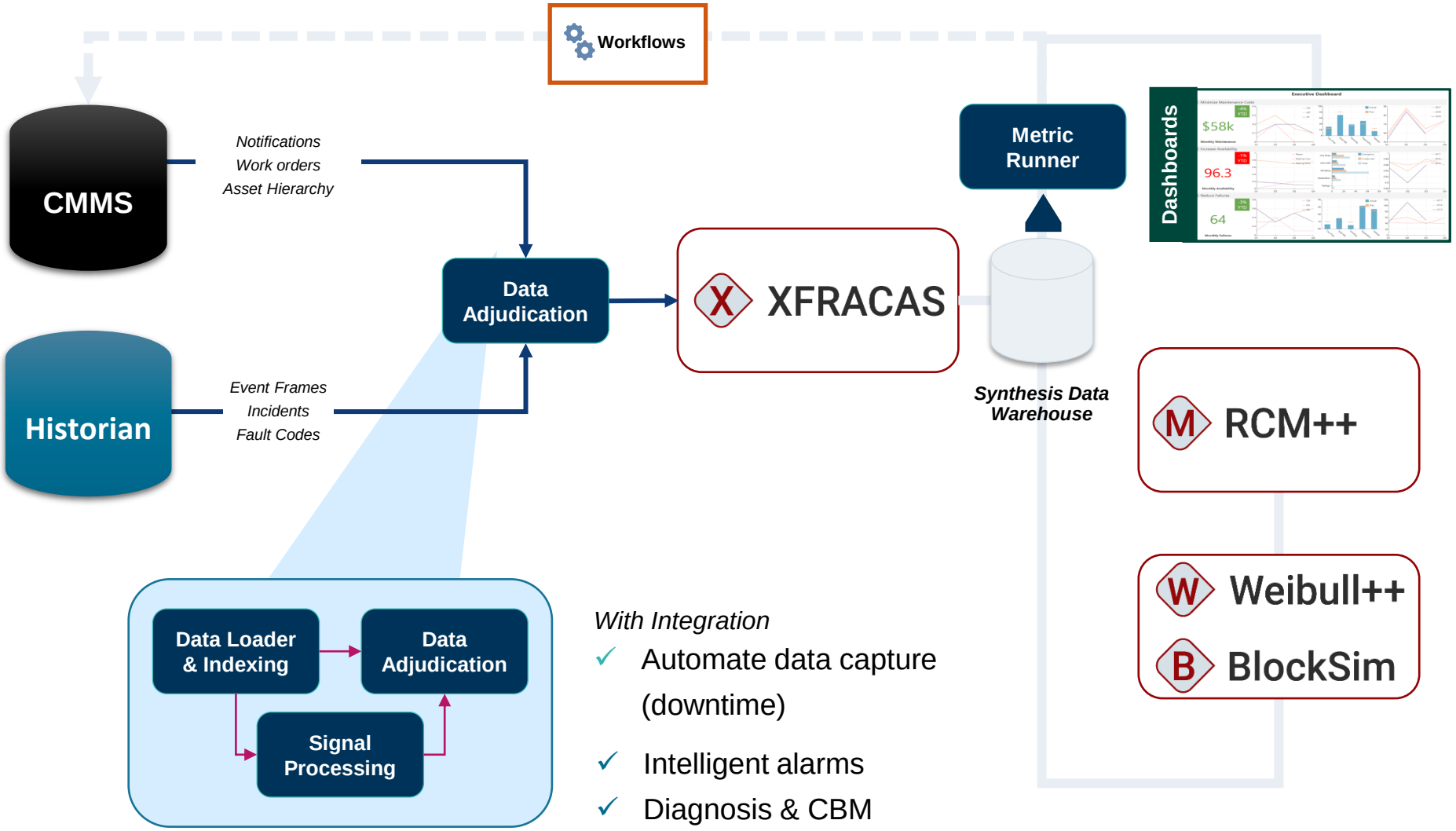
Utilizing FRACAS system to document failure and maintenance history



With Integration

- ✓ Automate data capture (downtime)
- ✓ Intelligent alarms
- ✓ Diagnosis & CBM

With XFRACAS

- ✓ Root Cause Analysis
- ✓ Failure & Maintenance History
- ✓ Bad Actors
- ✓ Triggers for Reliability Analysis

With RCM++

- ✓ Asset Criticality
- ✓ Risk-based Strategies
- ✓ Failure Mode Library

With Weibull++, BlockSim

- ✓ Quantitative Analysis (Reliability Growth, MTBF, Optimum Intervals etc.)
- ✓ System Availability & Reliability Forecast

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Summary

- Reliability will continue to be a top priority to reduce the costs associated with maintenance in today's current economic landscape and the operational reality of the future
- Adopting a systematic framework, even with imperfect data, can help prioritize and identify quick wins
- A FRACAS system with links to other systems (e.g. CMMS) and some level of automation (data adjudication) can help capture highly valuable failure and maintenance history without requiring large manual effort– a critical enabler for more advanced data-driven methodologies

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Thank You

Q&A

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Q&A

- (no questions)

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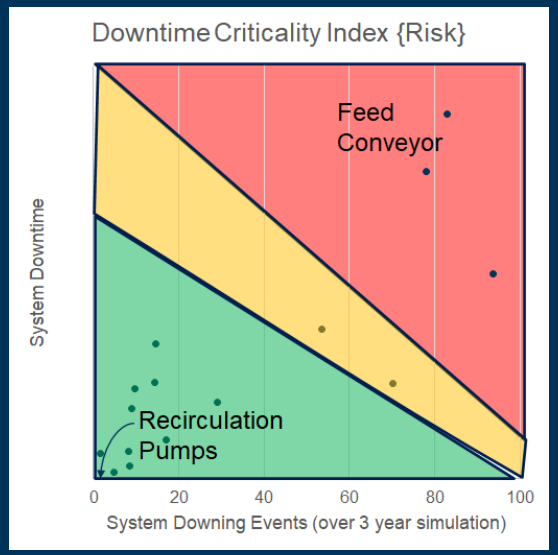

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