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Mining Equipment Event Synthesis

Early Intervention for Increased Efficiency

Presented by **Kyle Gogolinski**

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Syncrude
Securing Canada's Energy Future

dexcent

Mining Equipment Event Synthesis

Early Intervention for Increased Efficiency

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Background

- Syncrude is a crude oil producer from the Athabasca Oil Sands deposit in northeast Alberta. We operate two large-scale surface mines (known as Mildred Lake and Aurora) 35 km apart.
- Syncrude uses a truck and shovel technique for bench mining of the oil sand deposit.
- Mining equipment uptime is a key factor in operating efficiency, driving both production cost and movement volumes.
- Optimized preventive maintenance programs and just-in-time intervention are key to minimizing major component failures

  requiring days or weeks to repair.
- A vast knowledgebase has been created at Syncrude since our inception of truck and shovel mining in the mid-1990s.

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The Challenge

Effectively leverage our reliability knowledge base by:

Transforming reactive, time-intensive forensic data reviews into automated, near real-time

Event synthesis and creation

to enable the next level of

mining equipment efficiency

in our harsh operating

environment.

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The Challenge

Environmental Factors Impacting Asset Maintenance

- 136 unit heavy hauler fleet, plus shovels, graders, and dozers
- Climate extremes: –30°C (–22°F) to +35°C (95°F)
- Geographic location and haul distances
- Oil sand ore
  - Rock hard when cold
  - Sticky when warm
  - Always abrasive

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The Challenge

Business & Big Data Factors Impacting Asset Maintenance

- Effort-intensive manual analysis – truck sensor dataset too cumbersome for timely analysis and intervention – used for forensic analysis only.
- Limited subject matter expertise – attrition and loss of knowledge a risk.
- Data stream and connectivity challenges result in dropped, skipped, and prematurely terminated calculations.
- Ability to integrate into existing workflows in an actionable manner.

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The Team

Syncrude Canada Ltd.

- Process Control & Automation
- Equipment & Reliability Engineering
- Research & Development

Dexcent

- Architect
- Senior Developers

OSIsoft

- Sales
- Centre of Excellence
- San Leandro Engineers

The Plan

Overall Objective

- Create a Mobile Equipment Event Synthesis (MEES) solution to offer support to the tracking, analysis, and reporting of mechanical events that occur on Syncrude's mobile equipment.

Pilot / Test Platform Phase Objective

- Implement extremely complex calculations with the intent to overload the system. Demonstrate the ability for PI ACE to handle large volume data calculations, inconstant data acquisition, and a large number of contexts.

Production Phase Objective

- Optimize for production use, streamline calculations, integrate with notification systems, validate, and tune performance.

The Requirements

- Control the execution of calculations to only process when the data is there. Need to ensure that no gaps in event computation are created as a result of trucks moving in and out of coverage area.
- Process large volumes of data as it comes into the system. The average processing volume during the pilot was 1716 values/second. Surge volumes were much higher – a single unit offline for an hour results in a 79K data value surge when it comes back online.
- Create standalone components for each use case to support independent evaluation, schedule tuning, and overall solution maintenance.
- Produce actionable output.

The Approach - Key Concerns

- Handling of incoming data would be needed to ensure that no gaps in event computation were created as a result of trucks moving in and out of coverage areas.

- The ability to process large volumes of data as it came into the system would be required for quick event identification and timely intervention.

- The delivery of trustworthy, actionable results would be needed for acceptance.

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The Approach

- Analyze what has worked and what has not.
- Work closely with E&RE to create extremely difficult test use case patterns.
- Syncrude and Dexcent would work closely with the OSIsoft Centre of Excellence team, as well as the San Leandro Engineering team, to solve the data gap challenge.
- Implement the use cases, test the pilot, evaluate the results.
- Revisit the use cases and modify the calculations for efficiency in the production environment.
- Validate the production solution.
- Transition to the PC&A support team.

Event Synthesis – Pilot Use Cases

Sub-system	Use Cases	Condition/Action
General Monitoring	Out of Wireless Range	Truck out of range and/or wireless system disconnected
	Acquisition Offline	Validate data and ensure system readiness
Engine	Throttle Position Condition	Throttle position minimum threshold under load
	Turbo Failure	Turbo boost pressures under load
	Injector Failure	Engine injector failure
	Engine Oil Dilution	Ensure fuel or coolant is not diluting engine oil
	Coolant Temperature Delta	Variations in coolant temperature between the engines
Power Train	Torque Convertor Overheat	Torque converter temperature limits and location
Braking	Service Brake Applied at Speed	Service brake applied while in motion
	Brake Overheat	Brake temperature
	Braking Pumps Cycle	Brake accumulator pressure cycle faults
Frame	Improper Strut Charge	Strut is properly charged
	Strut Deflation	Strut has lost all pressure
	Airborne	Front or back of the unit is airborne
	Side Load	Payload was loaded off to one side
	Front Load	Payload was loaded too far forward
	Structural Force	Structural force (pitch, rack, roll) exterted on the frame
	Abusive Dumping	Dumping procedures were followed
	Abusive Loading	Loading procedures were followed
Steering	Steering Pumps Cycle	Steering pump short cycles and pumps constantly on

Event Synthesis – Pilot Results

- All use cases were implemented successfully.
- PI ACE processing load, scaled across two schedulers, was adequate to process regular data flow.
- When load balanced, the average CPU utilization was ~25% for data flow from ~80 trucks.
- When processing backlogs, schedulers used 100% CPU.
- Data from 44 tags per truck was used to calculate the use cases.
- Events raised were inserted into a database table.
- Single instance alarms were produced.
- Delivered condition reminder notifications for long-running events.

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Event Synthesis – Transition

- All risks and concerns were successfully addressed in the pilot phase.

- The creation of the production version would focus on streamlining the calculations; refactoring the code; extensive testing; and performance tuning.

- A shortened use case list would be adopted.

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Event Synthesis – Production Goals

Where the Pilot phase was intended to prove the system capability, the Production phase focused on:

- Efficiency - reduced execution times; increased performance.
- Integrity - business value would only be realized as confidence and trust increases.
- Effectiveness - implementing additional notifications and escalations; adding cumulative event handling; and integrating with the Maintenance systems and processes.

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Event Synthesis – Standards

The core guidelines and standards for the production release required that:

- Business validation would be performed on all use cases for correct logic implementation.
- Continuous monitoring and QA checks would be done to raise confidence in the results produced.
- Event data would be integrated into existing visualization platforms and operator care workflow before full adoption would be realized.

Event Synthesis – Production

Use Cases	Condition/Action	Assets Monitored
MDSP Offline	Monitor data buffering, connectivity, and data age to automate wireless system health .	150
Lubrication Cycle Time	Monitor lube injection frequency to ensure proper lubrication injection rates.	85
Engine Injector Failure	Monitor the asset for possible engine injector failures	93
Engine Oil Dilution	Monitor engines to ensure fuilds are not leaking into the engine lubrication system and diluting the engine oil.	132
Steering Pump Cycle	Steering pump pressure cycle analysis to determine the health of the steering pump.	79
Service Brake Pump Cycle	Brake accumulator pressure cycle analysis to determine health of brake charge.	79
Suspension Charge Monitoring	Monitor an assets suspension to ensure the struts are properly charged.	119
Dumping Procedure	Monitor that the operator dumping procedure is followed, preventing injury from jarring or loafing.	52

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The Results - Quantification

The effectiveness of change in maintenance and reliability programs can be a challenge to capture and validate.

- Rather than focusing on the savings realized per use case or event, thanks to years of data collection, we were able to look at overall operating cost reductions.
- There had been no other significant change in maintenance cost reduction programs in the past year, therefore any major cost reductions could be attributed to the MEES project.

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The Results – Production

- Over 6600 data points collected and analyzed from 131 heavy haul trucks and 5 shovels.
- Critical event escalations implemented.
- Cumulative events monitored and reported.
- Notifications, Alerts, and Alarms displayed in monitoring platform.
- Daily summary report on wireless status automatically delivered.
- Dumping compliance reports emailed.
- Calculated fleet operating expense savings of $16.75/hr/unit equating to a $20 million annual operating cost avoidance.
- Reduced non-procedural dumping incidents by 85% in the first month in production.

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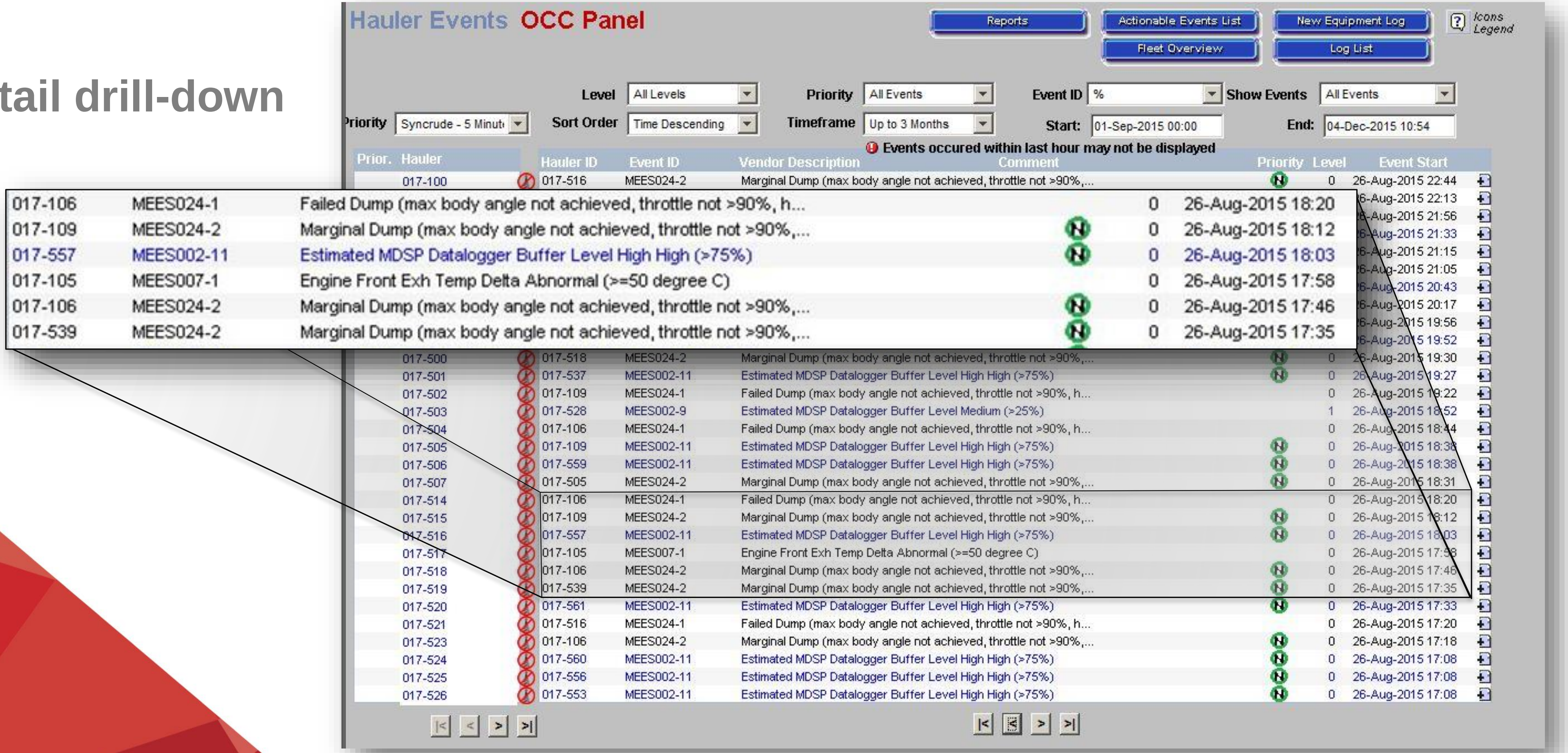
Operator Control Panel

Control Panel

- Asset Health
- Log access
- Event access
- Notifications
- Report access

Operator Control Panel

Detail drill-down



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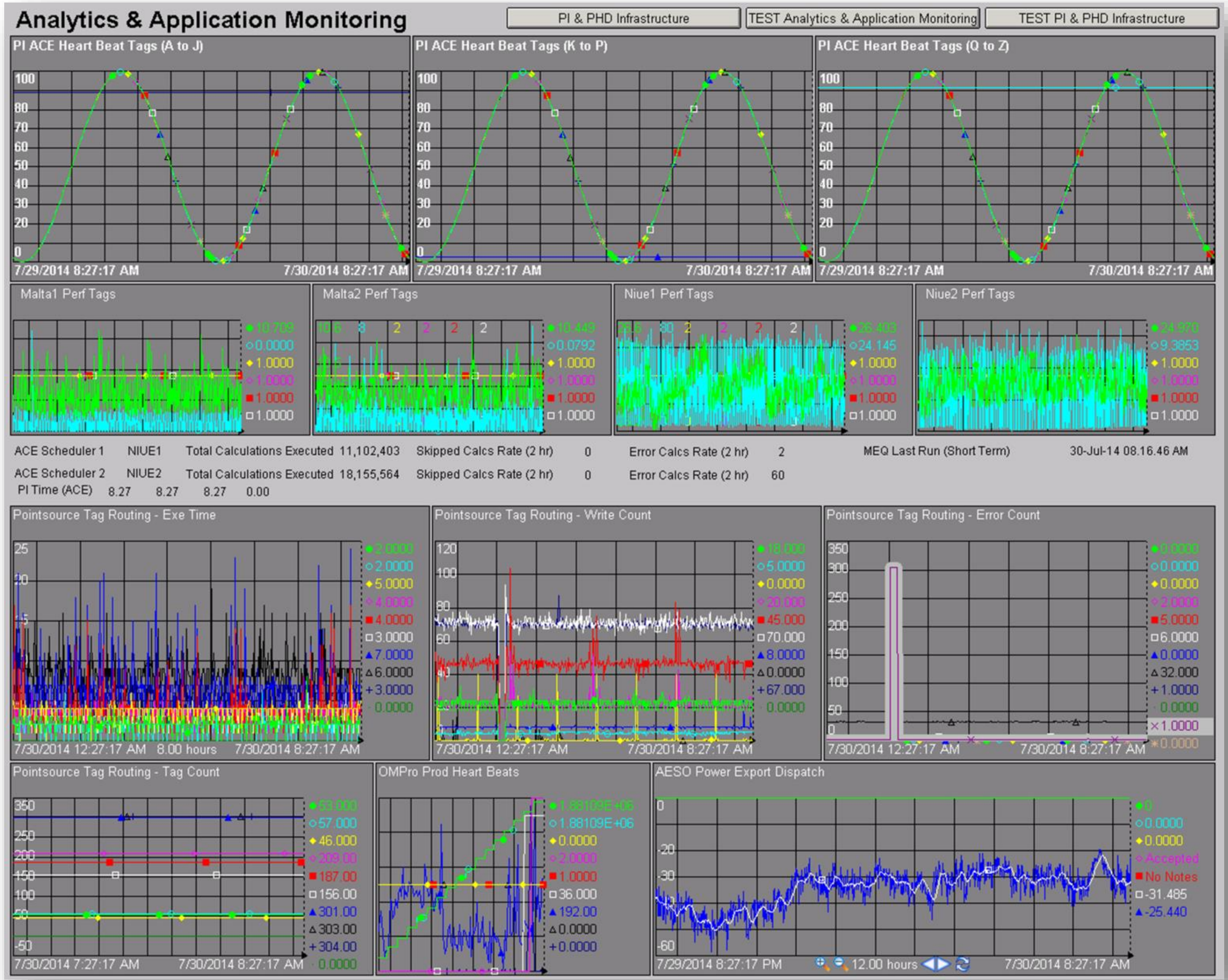
Monitoring the Monitoring

PI ProcessBook

- Calculations
- Performance
- Pointsource
- Statistics



The Results – An Example

Failure: Heavy Hauler Engine Ventilation Event

Post pilot and prior to the production implementation of MEES:

- A unit experienced a catastrophic engine failure where "*the internal parts of the engine disconnected from their normal position and made their way outside, leaving a large "ventilation window" in the side of the engine block*".
- Manual forensic analysis determined a valve had broken, severely damaging a cylinder. The valve then passed through the exhaust port and damaged a turbo charger. The damage to the cylinder led to the ventilation event. The cause of the valve failure: lack of lubrication.

Running MEES calculations over the event timeframe revealed:

- An Engine Injector Failure event would have been triggered well in advance.
- An Engine Oil Dilution alarm would have been raised 2.5 days before the engine failed.

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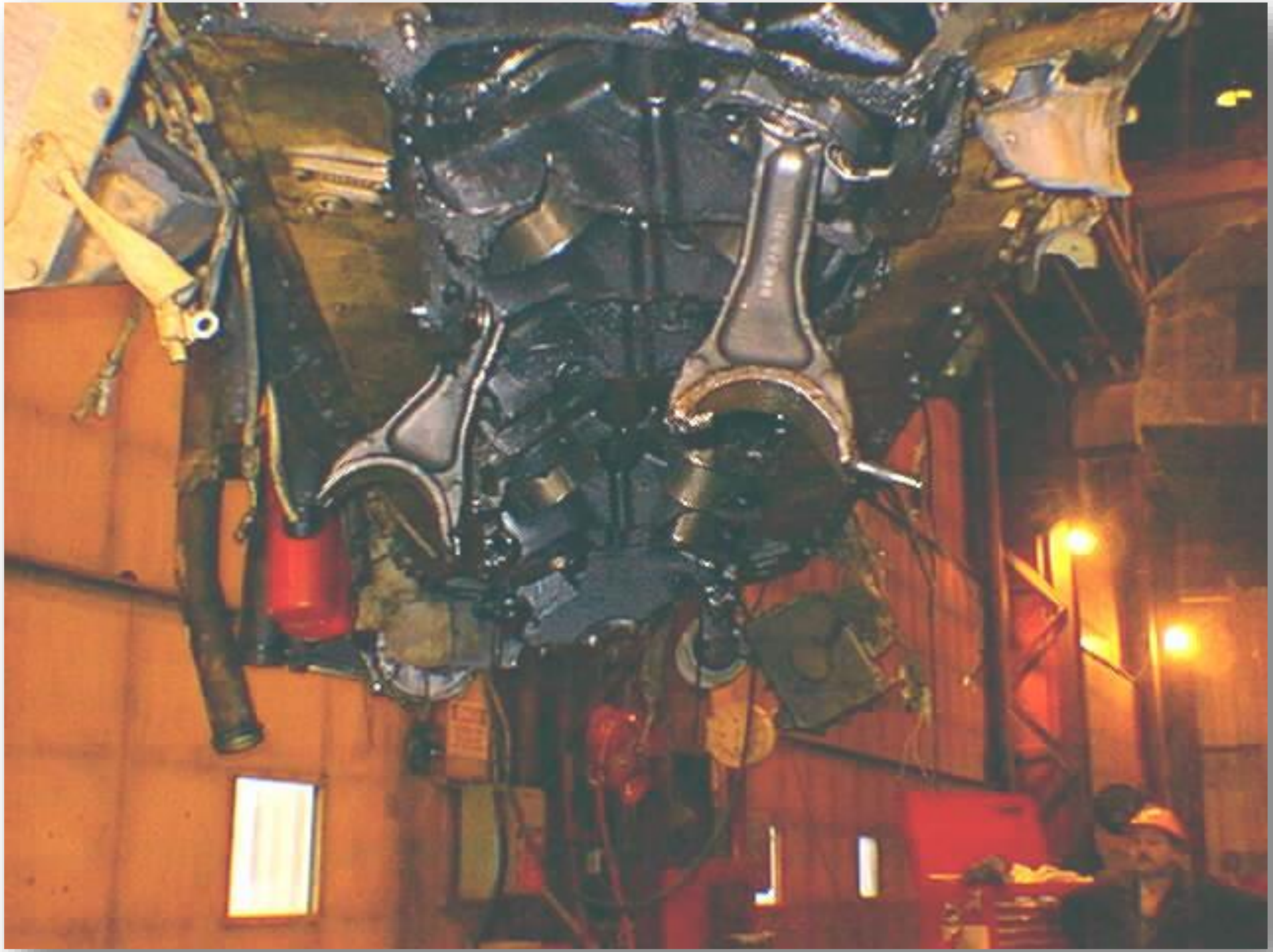
Ventilated Engine Example



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Mission Accomplished

Syncrude was able to effectively leverage our reliability knowledgebase by transforming reactive, time-intensive forensic data reviews into automated, near-real-time event synthesis and creation.

This enabled the organization to move the next level of mining equipment efficiency in our harsh operating environment.

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Questions

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谢谢

Danke

Merci

Gracias

Thank You

ありがとう

Спасибо

Obrigado

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