# VEHICLE HEALTH MONITORING 19

Mine Overview

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# Taking a pulse

The evolution of real-time health monitoring has reached new highs as in-depth diagnostic analysis, long-term trending and predictive capabilities become standard features on haul trucks, reports Murray Harcus

Requipment is one of the primary targets that mining companies are focusing on to increase efficiency and maintain profitability. In order to secure haul-truck availability, it is necessary to detect any symptoms of machine trouble early on, and have maintenance personnel take suitable measures without delay.

Machine health-monitoring systems can provide in-depth diagnostic analysis, longterm trending and predictive capabilities in real-time to the operator and a central control station. This gives maintenance managers and technicians the information necessary to maximise component life, reduce catastrophic failures, minimise unscheduled downtime and improve the management of a mine's assets.

Original equipment manufacturers (OEMs) install health-monitoring systems that collect vital component data and operational parameters. This includes everything from the engine and transmission though to tyre temperature and exhaust emissions.

Equipment-monitoring systems interface with the electronic control modules (ECMs) responsible for data gathering, which they organise and process prior to sending it to the control centre (usually via a wireless network). Real-time data transmission eliminates the need to physically visit trucks and on-board systems, and provides accurate feedback to a central point where the entire fleet can be monitored.

These systems collect vast amounts of data, but are mainly used to keep track





MEM gives real-time truck data to the control room and operator

Below: controllers keep in touch with operating vehicles

T203

7204

T301e

**Hauting Fleet** 

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of key operating parameters, such as temperature and pressure, and alert the operator with a warning message or alarm of an impending or abnormal condition on the machine. Depending on the severity, it will recommend an appropriate course of action. ECMs also alert engineers of problems through diagnostics sent to a PC during maintenance. This permits the preparation of the necessary parts before a prescribed limit is reached.

Some OEMs produce their own vehicle health-monitoring systems, while others specialise in mobile equipment monitoring. Engine manufacturers produce engine monitors capable of interfacing with various OEM systems, while many third-party firms offer component-monitoring systems for individual items such as tyres.

#### **CATERPILLAR**

Caterpillar developed the Vital Information Management System (VIMS), MineStar and the comprehensive MineStar Health system. Introduced in 1994, VIMS is now standard on 785, 789, 793 and 797 haul trucks, the 854 wheel dozer, and the 991, 992, 993 and 994 wheel loaders.

MineStar Health links with on-board monitoring systems, like VIMS, to provide wireless machine health and operating event data for processing and analysis. Installed at a mine site, with or without MineStar FleetCommander, it can gather real-time data over a radio network through download by a semi-automatic system at a fuel bay, or manually with a laptop. The benefits of MineStar Health are claimed to include:

- Extended component life;Reduced phantom breakdowns;
- Saved component failures;
- Full fleet health monitoring;
- Efficient data analysis; and
- Improved maintenance practices.



monitored via satellite radio using

availability and asset life.

Loading Fleet

Global Mining, tells *MM*: "By integrating numerous machine sensors into each machine design, VIMS monitors over 250 machine functions and health statistics. Essential machine functions are displayed for the operator via the message centre.

MineStar Health can help to identify

including problems within the mine site.

system it can generate reports showing

haul roads, which affect machine health,

where the alerts occur, such as suboptimal

In addition, Caterpillar trucks can be

Product Link, a web-based application,

issues beyond the haul truck itself.

When coupled with an optional GPS

"If a parameter falls outside of the specification, VIMS sends a warning message to the operator and, depending on the severity of the event, recommends appropriate action. VIMS can help lower

#### "VIMS monitors over 250 machine functions and health statistics"

Cat 793F truck interior with VIMS screen on the right and WAVS camera system on the left



Komatsu's KOMTRAX machine operating costs, improve equipment utilisation, and, ultimately, help customers achieve the lowest cost per tonne."

VIMS includes an on-board data recorder, Snap Shot, similar to a flight data recorder, which stores machine and sensor information. This aids troubleshooting by getting to the root cause of a problem. A chronological list of the last 500 machine and system events is retained, providing the date, time and service meter reading when the event began; event duration; operator ID; parameter name; limit value; worst case value; warning category; and number of times the operator acknowledged the event.

#### **KOMATSU**

Komatsu has developed its own health-monitoring system (which, like the Caterpillar systems, is unavailable to other OEMs). The KOMTRAX system

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caters for utility to CE class machines, while KOMTRAX Plus (formerly VHMS -- Vehicle Health Monitoring System) caters for production and mining class equipment. Every current utility, CE and Mining class Komatsu machine sold in North America comes with either KOMTRAX or KOMTRAX Plus as standard equipment, including communications and data access.

KOMTRAX Plus enables machine data to be transmitted via the internet for review by Komatsu personnel. In most regions, data is also transmitted



by Orbcomm satellites, enabling remote evaluation of the machine's condition and operations. However, it is not fully real-time data, although machine owners can identify service meter readings, fuel consumption, cautions, operational data, payloads and key component measurements provided in the form of trends on a secured web application.

When asked about the availability of real-time data, Kent Fales, product manager – electric trucks, and Rizwan Mizra, ICT manager for Komatsu America Corp, tell *MM*: "By utilising products from Modular Mining Systems (owned by Komatsu), customers operating Komatsu haul trucks can currently access some real-time feedback data from the system. In the not too distant future, as our experience and technology evolves, more data will be available. The key is to provide usable, important data – not to overwhelm the operator with lights and warnings."

Mr Fales and Mr Mizra add: "The most progressive efforts in the area of failure avoidance are being led by Komatsu Distributors using KOMTRAX Plus to plan major component replacement with customers. This 'before failure activity' not only prevents the catastrophic component failure, but allows the customer to choose when the machines are taken out of service while allowing the distributor to pre-order necessary parts and arrange technician availability."

#### LIEBHERR

Liebherr has developed the Litronic Plus diagnostics system, which includes real-time monitoring, fault warning and detection, and numerous methods for downloading and trending truck component data. Once the data is gathered from the ECMs, it can be transmitted via Wi-Fi or remotely via cellular and low Earth orbit (LEO) satellites. It can also be downloaded on a truck by truck basis with single-point USB access. The T282C 363t truck comes with Litronic Plus diagnostics as standard, and will be available on future models such as the T264 and TI274.

The OEM does not plan to offer Litronic Plus diagnostics to other equipment manufacturers; yet, with the system having a non-proprietary CAN Open protocol, any third-party fleet management or dispatch system can access the real-time information being captured. This allows the system to integrate comfortably with existing mine operator infrastructures.

A spokesperson from Liebherr Mining Equipment tells *MM*: "With the Liebherr Mining Equipment line of mining haul trucks having such a strong emphasis on vertical integration of major components, the ultimate goal of a vehicle health monitoring system is to make the truck as smart as possible. A truck that can run productively and diagnose itself, based on trends seen through condition-based monitoring and real-time data acquisition, is the ultimate goal of the Litronic Plus diagnostics vehicle health-monitoring system."

#### MATRIKON

Matrikon is an independent provider of industrial monitoring solutions and offers Mobile Equipment Monitor (MEM) as the answer to health monitoring on haul trucks. MEM bridges the gap between truck ECM data and equipment servicing by monitoring operational parameters in real time, providing indications of developing failures and signifying when immediate corrective action may be required to prevent serious failure.

MEM is a fully open system that works by interfacing with the various



ECMs on OEM trucks. Once data is gathered and buffered on the on-board DataLogger, it is transmitted over the mine's wireless network to the central server.

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In addition, MEM can be integrated with various third-party on-board systems such as oil, lube, fuel and tyre monitors. Equally important is the ability to integrate with enterprise systems, such as maintenance management (Ellipse, SAP, JDE, Maximo), dispatch systems, GIS and mine-mapping systems, and financial

systems such as SAP. MEM will also merge real-time operating data with maintenance management, dispatch, financial and other systems to give the most complete view of overall equipment effectiveness.

David Fisk, the company's regional manager – mining solutions, tells *MM*: "It is the comprehensive, analytical, trending predictive and alarmmanagement capabilities of the MEM system that provide the true value, rather than just reporting the raw data itself. MEM provides predictive analysis capabilities to identify developing faults on the equipment before it actually causes downtime or collateral damage. For instance, air-filter replacement can be based on real-time measurements rather than time-based intervals that can be far too long or short, depending on changing conditions."

Matrikon's continuous data-logging capability supports detailed analysis of any sensor information for any range of time. For example, MEM makes it easy to compare fuel-burn rates across a fleet over a six-month period. Longer-term data analysis is critical to addressing repetitive issues to improve the reliability and availability of the equipment, rather than simply identifying a fault that has already tripped an alarm.

It is this long-term prognostic ability that is the future for vehicle health monitoring, as many abusive behaviours can be eliminated, thus prolonging the life of the major components of the truck.

Mr Fisk summarises MEM, stating: "The power is in identifying and addressing developing faults and optimising maintenance rather than waiting for an alarm to go off."

Matrikon announced in April 2010 that a multinational, publicly-traded mining company had deployed MEM to a third site among its North American mines, with implementation at its remaining sites planned for 2011. MEM is also in the process of active marketing and distribution in South America, Australia and South Africa.

#### **MODULAR MINING SYSTEMS**

Modular Mining Systems (MMSI), owned by Komatsu, offers MineCare, a maintenance software tool designed to minimise maintenance response time, increase planning efficiency, provide critical failure analysis information and report key performance indicators (KPIs) to maintenance personnel in real-time. Features include real-time remote diagnostics, asset time tracking and management, alarm event notifications, configurable alarm criticality and variable OEM interfaces.

MMSI's first OEM interface was developed in 1989, while MineCare has been on the market for over seven years, including five major software releases and numerous updates. Many of the product features are a direct result of feedback from industry leaders such as Rio Tinto.

Gregory Lanz, manager, sales and marketing services at MMSI, tells *MM*: "Modular integrates closely with the full Komatsu suite of monitoring systems, although it is an industry leader in providing OEM interfaces, including connections to Caterpillar, Hitachi, Liebherr, Bucyrus, P&H, Terex, O&K, Sandvik, Atlas Copco, LeTourneau and Scania equipment health-monitoring systems.

"These systems are designed to monitor engines, hydraulics, power train, drive train, electric drives, brakes, cooling systems, air systems and electrical systems. For tyre monitoring specifically, there are ModularReady interfaces to Bridgestone, Michelin, Goodyear, PressurePro, TireSmart and Rimex. All told, Modular offers over 100 interfaces to OEM systems, including



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MMSI's MineCare displaying data trends on brake temperatures and engine loading many specialty interfaces such as our radiation scanner and fatigue risk-management interface with ASTiD."

MMSI works with each manufacturer to identify their communication protocols and custom-build the interface to their OEM specifications. This enables MMSI to provide the maximum amount of data to operators. The MineCare system includes the Trending Module, which is focused on predicting equipment degradation based on trends in specific OEM parameters. Trend data is captured, based on configurable operating conditions, while a truck is loaded or passes a specific location in the mine.

Mr Lanz says: "The key is to alert the user only when necessary, minimising data overload and desensitisation. Once trends

are configured, they require no additional modification and will automatically notify that action is necessary when threshold conditions are met.

"Multiple, discrete trends can be activated simultaneously on a single piece of equipment using completely different parameter configurations. For long-term analysis, different trends can be used for break-in or wear stages, and trend performance data can be analysed over the entire component life."

Mr Lanz adds: "Modular products are inherently designed to increase efficiency and decrease costs. Typically, our MineCare customers realise a ROI of months, rather than years. At one customer site, we recently identified an average, annualised saving of over US\$40,000 per truck. Early last year we introduced a new MineCare licensing model to make it more affordable for smaller operations, partly in response to the global financial crisis.

"The MineCare system supports operational data integration with the DISPATCH mine-management system. It can also be deployed with other mine management systems or at sites without a mine-management system."

Modular's MineCare is installed at sites in North and South America, Australia, Africa, Asia and Russia.

#### **WENCO**

Wenco International Mining Systems is similar to MMSI in being majority-owned by Hitachi Construction Machinery, offering several systems that combine to monitor vehicle health.

The company's Maintenance Monitor system manages repairs assigned to an individual piece of equipment, allowing evaluation of the time, labour and components spent on each maintenance activity.

On-board Insight allows performance data to be viewed and distributed from the central control room. Wenco claims that real-time observations on oil levels, engine temperature, strut pressure, the performance of newly-repaired vehicles, effects of long ramps on a specific fleet and the evaluation of new components can all be monitored.

The Eventing System manages exception messages generated from Wenco System diagnostics, mine-operating practices and OEM health system alarms. When an alarm is generated, it is colour-coded and displayed according to its severity, thus ensuring the right personnel are made aware and take the necessary action.

TireMax helps to extend the life of tyres by providing real-time monitoring of their work rate. Colour-coded bar charts



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## Cummins' QSK50 Tier 2 engine with electronic control modules

and graphs identify at-risk tyres quickly, so dispatchers can take preventative action.

Messages or alarms generated from OEM health-monitoring systems are received at Wenco's on-board hardware platform via one of numerous interfaces (serial, CANbus, digital, ethernet or USB). This information is then broadcast over the broadband wireless

network to the central system at the mine office. When an event is generated, a message describing it is displayed in Event Monitor with detailed information such as the time, source

and severity. A comment column is included for the dispatcher or

other supervisor to provide additional details on the event.

Glen Trainor, marketing director for North American sales for Wenco, tells *MM*: "Wenco's on-board hardware and software is designed to provide real-time interfaces to major OEM health-monitoring systems such as Caterpillar VIMS and Hitachi.

"Our on-board hardware has multiple inputs to receive the information from the on-board OEM health system, so the Wenco System can operate over any IP-based network. Our primary market is with the mine operators, while our customers include Teck Resources, Coal India, Alrosa, Anglogold Ashanti, Syncrude Canada, BHP Billiton Diamonds, De Beers Group, Rio Tinto Aluminum and Cliffs Natural Resources, and joint ventures with Barrick Gold in Australia, and Newmont Kalgoorlie Consolidated Gold Mines," he adds.

#### **CUMMINS**

Cummins, a leading engine supplier to haul-truck OEMs, offers Advanced Engine Monitoring, which allows the performance of each cylinder to be observed in real time (either through mine-dispatch systems or over the internet). It can also provide trending chart capabilities for informed, preventive maintenance to

maximise operation and reduce downtime. MM spoke to Clint

Schroer, off-highway communications spokesman for Cummins, who states: "Cummins works with the OEMs to ensure its electronic interface connects with truck interfaces, allowing the engine monitoring systems to connect to the OEM system, and prevent the need for independent systems. We install and design our own ECMs through our electronics division, which connect to the OEM or other supplier connections via SAE J1939 vehicle bus standard communications."

#### **MTU DETROIT DIESEL**

Another leading engine supplier, MTU, provides the Exhaust Gas Temperature Monitoring System

(ETMS), which helps operators detect an abnormal fuelling condition. ETMS monitors individual cylinder temperatures and determines whether they are operating within an acceptable range.

> Diagnostic codes are generated in the event that the cylinders are hotter or colder than expected. This allows the technician to address the correct cylinder

effectively the first time.

MTU's Remote Services are another diagnostic tool for preventive maintenance

and to minimise downtime. Key engine data such as hours and diagnostic codes may be transmitted via a cellular telephone network, which can notify maintenance personnel immediately when fault codes are generated. It can give current engine hours to ensure maintenance is completed as scheduled.

MTU Tier 2 engines are equipped with a Service and Automation Module (SAM), which provides easy access for OEM installation and diagnostic codes for technicians who may not be equipped with special diagnostic tools.

Ran Archer, MTU's manager for mining sales, tells *MM*: "MTU installs its own ECMs, but also builds engines to accommodate third-party equipment that has been installed by the truck manufacturers.

"We provide an ECM that is essential for control of all engine functions, designed to communicate with, and control the functionality of, optional equipment using SAE standards, such as J1939, and the ability to operate over a CAN bus system. Such components include starters, cold-start systems and fan control."

He adds: "With the use of ETMS, catastrophic engine failures have been avoided due to early detection of a failing injector and the risk of fuel dilution, which typically leads to loss of lubrication

and a seized piston. When considering the future of engine health monitoring, advances in remote diagnostics and a higher speed cellular network uplink will enhance the speed of troubleshooting and maintenance support for mining operations."

A remote monitoring module from MTU Detroit Diesel



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