The need to monitor and manage fatigue affects all mines, large and small, in every location. Fatigue due to a lack of sleep can affect anyone in the mining community, including operators and executives, independent of the size of the company or where they operate in the world. Fatigue monitoring is extremely important in mining due to the potential for accident and serious injury. “All mines will suffer from varying degrees of fatigue irrespective of demographics – it is inherent within the industry,” says Ian Thomas, managing director of Fatigue Management International (FMI). “For example, if you look at haul-truck driving, there are very large trucks driving around in circles, repeatedly, very slowly, for long periods of time devoid of scenery variation or distraction – driver fatigue is inevitable.”

Of course, the operators of vehicles such as haul trucks present the highest risk, so this is where many companies

Feeling tired?

Fatigue is implicated in approximately 69% of mining accidents involving haul trucks. As a result, fatigue management is being recognised by mining companies as a critical part of ensuring safe operations. Ailbhe Goodbody looks at the variety of techniques/equipment available

Causes and consequences

Operator fatigue is largely caused by a lack of sleep; workers who sleep less than 7–9 hours in a 24-hour period are at a high risk of a fatigue-related accident. This risk affects the worker, co-workers, the company and the community. In addition, sleeping less than 7–9 hours in a day is highly associated with increases in obesity, diabetes, heart attacks, depression and sleep disorders.

Monotonous activities, such as long-distance hauls, and the repetitive nature of tasks that provide little or no variance in mental stimulation leave operators especially susceptible to fatigue.

One of the consequences of running 24h shift rotations, as happens on many mine sites, is that it can disrupt normal sleeping patterns and lead to a build-up of sleep debt that will inevitably cause tiredness-induced errors of judgement and thus accidents.

Operators may be at risk of fatigue or drowsiness at any time during their shift. However, there is a tendency for the majority of fatigue events to occur during the times of circadian rhythm (biological clock) lows, in the early hours of the morning and in the middle of the afternoon. Thomas says: “As a consequence of shift work, the early hours of the morning are the most vulnerable time of the day, closely followed by the mid-afternoon. It is no coincidence that these are the times of low alertness in our own body clock.”

Pat Byrne, founder of Fatigue Science, says: “If workers are fatigued, then the root causes should be identified so that the worker can either receive medical attention, training or a review of their work schedules. Fatigued workers should not be allowed to conduct safety-sensitive work.”

Richard Robillard, president of Six Safety Systems, adds: “Beyond operator injury or fatality, loss of productivity, asset damage, environmental and financial impact, and even a company’s social licence to operate could be jeopardised if a mining company doesn’t effectively mitigate worker fit-for-duty risk.”

William Nassauer, product manager, machine guidance and safety systems at Modular Mining Systems, cautions: “Losing control of a 363t haul truck is disastrous and can result in severe consequences such as loss of life and tremendous financial expense from equipment damage, major maintenance...”
target fatigue solutions. The risk may also be higher in certain geographical areas.

“Fatigue is a condition that affects all humans around the world,” says John Capehart, vice-president for business development at Guardvant. “However, there are some situations that do appear to further increase the fatigue accident risk. These include operations at high altitude as found in mountainous regions such as the Andes or New Guinea. In addition, operations found in parts of the world in which the work force is unaccustomed to long or rotating shifts have special social conditions that may further contribute to a greater fatigue risk.”

All mines must work to comply with legislation, address social responsibilities to workers’ safety, satisfy corporate mandates and, most importantly, seek ways to reduce fatigue-related accidents.

CHOOSING A SOLUTION

It is generally accepted that a fatigue risk-management system (FRMS) should be supported by established peer-reviewed science and data-driven, with decisions based on the collection and objective analysis of the facts. There are a few key attributes that mining companies should consider when choosing a fatigue-monitoring solution.

For example, the technology should provide the operator and management with fatigue alerts in a way that is compatible with site operations systems and the site fatigue management plan – every site will have a unique set of requirements based on its management culture, labour situation and operational considerations, so it is important to match the technology to these factors.

Workers who do not sleep well generally fall into three categories: those that have a medical sleep disorder; those that work schedules or rosters or who have a poor sleep environment that do not allow for proper sleep opportunities; and those that are generally good sleepers but make certain lifestyle choices and do not get the sleep that they need.

All of these risks are controllable through a proper fatigue risk-management system (FRMS), and can be managed in the same manner as all other mining health-and-safety risks. For example, individuals making poor lifestyle choices normally require sleep hygiene and fatigue training to demonstrate to them the health-and-safety risks of low sleep hours.

A good fatigue monitoring or management solution will benefit both the company and the individual workers. “The benefits of fatigue monitoring not only include operators going home safe, but reduced accidents and costs for damage repairs,” says Erich Smidt, vice-president, sales and marketing at Guardvant. “In addition, fewer equipment-related incidents equates to increased operational efficiencies due to improved equipment availability and reduced shut-down time attributed to accident investigations.”

“Losing control of a 363t haul truck is disastrous and can result in severe consequences such as loss of life and tremendous financial expense from equipment damage, major maintenance and unplanned downtime.”

Meet us at June 17-21 | Antofagasta, Chile
GEOCOM S.A.
RIEGL LMS GmbH, Austria | RIEGL USA Inc. | RIEGL Japan Ltd.
“At a minimum, mining companies need to understand the difference between reactive and predictive technologies,” says Nassauer.

“Systems that utilise reactive technology detect fatigue very late – often when the operator is actually falling asleep. Systems using predictive technology detect fatigue when the operator is just starting to exhibit signs, which allows mines to proactively manage operator risk.”

“Those more advanced systems work in conjunction with a complete fatigue-management programme, which promotes a shift in the overall culture regarding fatigue. Low-level, reactive systems that are put in place with no supporting training or change management may satisfy a legislative mandate, but they cannot and should not be expected to perform well.”

Byrne agrees: “The difference is significant. ‘Alerting fatigue’ technologies are considered secondary or tertiary control mechanisms. It is really the difference between having a preventative maintenance programme for an important piece of equipment or waiting until the oil light flashes or the equipment breaks down before doing maintenance.”

The acceptance of the solution by the mine’s labour force should also be considered – for example, will the system be unobtrusive, is it compatible with the work environment, and is it an active or a passive monitoring system?

“From our experience, operators don’t like to wear monitoring devices or be filmed by camera-based technology as they are all deemed to be too intrusive and tend to monitor the latter stages of the fatigue process,” says Thomas.

“When considering technology, companies should look for an unobtrusive, early warning system that tracks the early stages of tiredness so that you can dynamically manage and reassign operators for maximum effect. To achieve this, the system needs to deliver information in real-time with the ability to customise and configure the solution for individual site requirements.”

Some systems require the operator to wear a monitoring sensor, so it is important that this does not interfere with any required personal protective equipment (PPE).

Other things for companies to consider include the on-going maintenance and administrative requirements of the solution, and whether the system is reliable from a hardware and software availability perspective; whether the supplier can provide the level of support required to maintain the system availability; if the methodology of detecting fatigue is accurate, or if it produces a high level of false positives; whether the cause of fatigue can be confirmed independently; and if the technology can be integrated into other site-based systems such as fleet management, production monitoring or health monitoring.

“Many mine operators have conducted extensive studies in these areas and made changes to mine camp facilities that include segregating day-shift workers from night-shift workers to minimise sleep-period noise and other disruptions,” says Capehart of Guardvant. “Shift rosters have been re-scheduled to provide for better-quality rest periods. In some situations, mine operators have provided bus transportation from towns to allow operators the chance to nap on the commute to and from site rather than driving individually. Some sites have instituted mandatory rest periods after night shifts prior to commuting home from drive-in camps.”

A successful solution to mitigate worker fatigue risk requires a comprehensive approach and may take months of assessment and strategy development prior to the installation of any monitoring technology. “Understanding a company’s leadership and objectives, as well as its risk exposure and risk threshold, is the starting point to develop an effective strategy,” says Robillard. “Once a strategy that aligns to the company is formed, a broad education and training strategy is key to success.”

He adds: “The overarching element is change management, and this must align to the mining company’s internal processes. A fatigue solution must be fully integrated within the business.”

Thomas agrees: “We believe that any solution needs to follow a holistic approach to managing fatigue. Technology will not stop fatigue, but it will point you in the direction of those operators that may be more vulnerable. The approach also requires multi-level buy-in and commitment from operators, supervisors and management alike.”
Equipment providers

There are a number of different solutions available for fatigue monitoring, both predictive and reactive. MM spoke to several providers, whose solutions are detailed below.

CIRCADIAN
Circadian, in partnership with Qualcomm’s FleetRisk Advisors unit, provides fatigue risk management and predictive modelling solutions for a number of industries, including mining.

Circadian offers comprehensive fatigue-management programmes that will map out the course of action to provide high safety standards while reducing the costs associated with fatigue-related errors and incidents.

The Circadian Alertness Simulator (CAS) Driver Fatigue Model generates a fatigue score for each operator every seven days. This score identifies the drivers who are most likely to have a fatigue-related incident in the next week. Predictive modelling isolates these symptoms and exposes other risk factors so that mining companies can take action before an accident happens. Drivers can be coached before they experience fatigue-related issues, and fleet efficiency can be improved by reducing driver fatigue.

Circadian also offers services such as shift schedule optimisation, along with programmes to assist shiftworkers with managing their personal health.

EDANSAFE
The SmartCap provides real-time measurements of fatigue for vehicle drivers or operators of heavy equipment. The system consists of a baseball cap with sensors concealed in the lining. The sensors use electroencephalography (EEG) to measure an operator’s brainwave information to calculate a measure of drowsiness, which is wirelessly communicated to a display in-cab, or to any Bluetooth-enabled device.

The SmartCap uses small sensors capable of reading EEG through hair, without the need for any scalp preparation. The SmartCap processes brain wave information and determines the wearer’s level of alertness every second. With the look and feel of a typical baseball cap, the SmartCap is intended to overcome any operator acceptance problems associated with camera- or response-based technologies.

Each operator is provided with their own low-cost cap. The core electronics are contained in a card-like package that may be inserted in a connector on the underside of the brim, or docked in the base unit for testing and recharging.

Drivers keep their own cap with them and insert a card into the brim of their cap once inside the cab. The base unit is capable of holding and recharging up to three cards (known as SmartCap Fatigue Processors), and will be mountable either on or under the dashboard area, or in an overhead position similar to some two-way radio consoles. Three cards are kept in the truck to provide double redundancy in the event of system faults, flat batteries, or operators accidently taking the cards out of the truck after shift. Rear connectors allow connection to a back-to-base system, and permit in-cab diagnostics to be conducted.

Connected to this base unit is a remote display, similar in size to a typical GPS display in passenger cars. This display provides real-time information to the operator, and relays visual and audio alarms if specific fatigue criteria are met. The remote display can be used without a base unit as a fatigue monitoring solution in light vehicles or other plant in which redundancy is not required.

The system is also capable of determining when the cap is not being worn on the head, but still connected by Bluetooth to the display (for example, on the seat beside the driver or resting on the driver’s lap). Within 15 seconds, the system status is changed to ‘cap off’.

Both the SmartCap display and the base unit provide standard serial connections to most remote monitoring systems. When used in combination with the SmartCap Fatigue Manager Server, operations can effectively monitor the fatigue information of an entire fleet of SmartCap users in real-time.

The Fatigue Manager supervisor interface delivers audible and visual fatigue alarms based on site-specific criteria. It also allows review of single and multiple shift fatigue histories of individual users and also the remote customisation of various fatigue alert criteria. This system works with the in-cab equipment to provide a comprehensive fatigue monitoring solution, which complements existing fatigue-management strategies.

The technology behind the SmartCap solution was developed within CRCMin- ing, a co-operative research centre established by the Australian government, supported by four universities and 13 industry partners including equipment manufacturers and mining companies.

Anglo American Metallurgical Coal (previously Anglo Coal Australia) and the Australian Coal Association Research Association (ACARP) supported this work for a number of years, which led to two successful field trials at central Queensland surface mining operations, where it was used by operators in haul trucks, excavators, dozers, graders and water trucks. The SmartCap is commercially available through CRCMining’s subsidiary company EdanSafe.

A prototype hard hat with SmartCap sensors has also been developed, and testing and re-certification are currently under way.

FATIGUE MANAGEMENT INTERNATIONAL
The Advisory System for Tired Drivers (ASTID) was developed by Professor Jim Horne, a leading expert in driver sleepiness at Loughborough University in the UK, in collaboration with Fatigue Management International (FMI). The system was designed to be an unobtrusive and predictive fatigue-risk determination system.

ASTID comprises two linked systems designed to monitor and advise a driver about their alertness while driving. The first is a ‘knowledge-based’ system that provides an electronic template predicting hour by hour the likelihood of the driver falling asleep over a 24h period. This template, which is based on
extensive research, is also influenced by a sleep weighting factor benchmarked against the Karolinska Sleepiness Scale.

The second system is a ‘steering sensory’ system able to detect monotonous driving conditions and vehicle steering characteristics typifying sleepy driving.

Thomas says: “The knowledge-based system forewarns the likelihood of falling asleep, while the steering system warns the driver when they are doing so. The assessment of these factors is used to produce both visual and audible alarms.”

The knowledge-based aspect of ASTiD is based on global scientific research and statistical crash data on sleep-related accidents.

“There are two times of the day when our natural body clock is at its lowest ebb,” explains Thomas. “These times are in the early hours of the morning, about 2am-6am, and the middle of the afternoon, about 2pm-5pm. It is when you are travelling along dull and monotonous routes up to, during and out of these times that you see a peak of these types of crashes. This 24h cycle of peaks and troughs forms the basis of the ASTiD algorithm.”

The steering sensory aspect of ASTiD has three driving modes of movement that it detects – when the vehicle is stopped, when the vehicle is being driven in a monotonous style, and when the vehicle is making more pronounced and exaggerated steering movements. “During normal levels of attention a driver applies continuous, small adjustments to the steering wheel,” says Thomas. “As the level of fatigue increases, steering adjustments become less frequent and more erratic. This is monitored within ASTiD by a gyroscope detecting the angular change in direction of the vehicle.”

When ASTiD is in monotonous mode, it looks for steering corrections that typify lapses on the wheel due to inattention, lack of concentration or the early signs of tiredness. If the system detects more exaggerated steering movements, such as sharp turns to avoid obstacles, then it switches out of monotonous mode to avoid false positives being detected.

FMI says that the advantages of the ASTiD system include real-time feedback for the driver and control-room operators, enabling strategic management of truck...
assignments and breaks to accommodate operators showing signs of increased tiredness. It is unobtrusive, as the operators do not have to wear any special equipment and there are no cameras in the cab. It is also very robust and has been tested to military specifications, so it has a low failure rate.

ASTID is currently deployed in Anglo American sites in South Africa, Rio Tinto sites in Australia and other mining organisations in Peru and Chile. Up and coming this year are deployments in Brazil, Botswana, the US/Canada and further sites in Chile and Australia.

FMI and Modular alliance

Fatigue Management International has an alliance with Modular Mining Systems. “We had been conducting trials in Latin America and, although the trials went well, customer feedback suggested that the integration of ASTID into DISPATCH is required to develop the system for mining applications,” says Thomas.

“We approached Modular and started to develop the interface to enable this. After a Caterpillar report that put ASTID as the most suitable fatigue technology for the mining industry, FMI and Modular decided to cement the commercial relationship into an exclusive global alliance.”

Nassauer explains: “An integrated approach to the mine’s fatigue-monitoring technologies and their effectiveness. Of all the products reviewed, only FMI’s system incorporated predictive technology.”

Through the partnership, the ASTID technology was integrated into Modular’s DISPATCH system, forming the basis of the MineAlert Fatigue Management module. The alliance gives FMI a global presence for distribution via Modular, and also gives its customers global installation and support capability via Modular.

Both FMI and Modular believe that a fatigue-monitoring system works best when it is tightly integrated with a fleet-management system. ASTID’s integration with DISPATCH allows the operator fatigue history to follow the driver on shift if they transfer between vehicles.

Nassauer says: “The MineAlert Fatigue Management module. As the MineAlert Fatigue Management module can predict fatigue much earlier than other technologies, it is claimed. Early detection of fatigue can be used as an input for fleet-management optimisation algorithms, for the purpose of active management of fatigue risk.

There is also a high level of operator acceptance of the core ASTID technology because it does not require the operator to wear obtrusive equipment, such as glasses or headgear.

When customers purchase Modular’s MineAlert Fatigue Management module, they also receive training and consulting services. Modular will evaluate the customer’s current fatigue-management programme and suggest improvements and changes to help minimise fatigue risk.

In addition, Modular provides a well-guided development process to promote optimal use of the MineAlert Fatigue Management module. As each mine is different and there is no one-size-fits-all solution, Modular creates a development plan tailored to the unique culture of each operation.

Nassauer says: “The MineAlert Fatigue Management system is a relatively new product offering for us. However, despite its short time in the market, several sites around the world have installed it and new orders are coming in. Through cooperative trials and demos, we are promoting the technology and spreading the word in lesser-known areas.”

How FMI’s ASTID system works with Modular’s DISPATCH

The calculated fatigue score could fall into one of the following zones: safe (000-089); risk (090-119); high-risk (120-149) or warning (150 or higher).

The calculated score is immediately displayed on the operator’s mobile device (optional) and simultaneously transmitted (via the mine’s wireless network) to the dispatcher’s screen in the central control room. This enables the operator and the dispatcher to take immediate corrective action. In addition, if the fatigue level reaches the warning zone, the dispatcher is immediately alerted to the situation via an exception message to which the dispatcher must respond to clear the screen.

Ideally, mines will have processes in place that will allow the mine to mitigate fatigue before it reaches high levels,” says Nassauer. “For example, dispatchers can use fatigue-score data to plan work schedules according to each operator’s needs. The dispatcher may give the operator a more varied route, schedule non-standard break times, or assign the operator to a different task or equipment unit.

“It has been shown that when the rapport between dispatchers and operators is good, and the MineAlert Fatigue Management module is used to full advantage, supervisors can very effectively manage their crew’s fatigue.”

The MineAlert Fatigue Management module can estimate the probability of fatigue onset, so the module can predict fatigue much earlier than other technologies, it is claimed. Early detection of fatigue can be used as an input for fleet-management optimisation algorithms, for the purpose of active management of fatigue risk.

When customers purchase Modular’s MineAlert Fatigue Management module, they also receive training and consulting services. Modular will evaluate the customer’s current fatigue-management programme and suggest improvements and changes to help minimise fatigue risk.

In addition, Modular provides a well-guided development process to promote optimal use of the MineAlert Fatigue Management module. As each mine is different and there is no one-size-fits-all solution, Modular creates a development plan tailored to the unique culture of each operation.

Nassauer says: “The MineAlert Fatigue Management system is a relatively new product offering for us. However, despite its short time in the market, several sites around the world have installed it and new orders are coming in. Through cooperative trials and demos, we are promoting the technology and spreading the word in lesser-known areas.”

The calculated score is immediately displayed on the operator’s mobile device (optional) and simultaneously transmitted (via the mine’s wireless network) to the dispatcher’s screen in the central control room. This enables the operator and the dispatcher to take immediate corrective action. In addition, if the fatigue level reaches the warning zone, the dispatcher is immediately alerted to the situation via an exception message to which the dispatcher must respond to clear the screen.

Ideally, mines will have processes in place that will allow the mine to mitigate fatigue before it reaches high levels,” says Nassauer. “For example, dispatchers can use fatigue-score data to plan work schedules according to each operator’s needs. The dispatcher may give the operator a more varied route, schedule non-standard break times, or assign the operator to a different task or equipment unit.

“It has been shown that when the rapport between dispatchers and operators is good, and the MineAlert Fatigue Management module is used to full advantage, supervisors can very effectively manage their crew’s fatigue.”

The MineAlert Fatigue Management module can estimate the probability of fatigue onset, so the module can predict fatigue much earlier than other technologies, it is claimed. Early detection of fatigue can be used as an input for fleet-management optimisation algorithms, for the purpose of active management of fatigue risk.
and is approved by the US Food and Drug Administration and Health Canada.

Secondly, the system measures fatigue using the Sleep, Activity, Fatigue and Task Effectiveness (SAFTE) model that was developed and used by the US military, and validated by the US Department of Transportation. This software automatically converts sleep data from the Readiband into fatigue scores. This software will show the different levels of fatigue at any point the person is awake.

Thirdly, it measures accident risk using research undertaken by the US Department of Transportation that examined over 1,400 accidents in relation to the fatigue scores from Fatigue Science’s Fatigue Avoidance Scheduling Tool (FAST). This study validated how FAST can predict the risk of a fatigue-related accident.

The Readiband detects fatigue from a lack of sleep and is a prevention tool – it does not rely on measuring fatigue-related symptoms after the worker is too tired.

“The Readiband system also has the advantage of being highly accurate and independently validated,” says Byrne. “All of the validation research papers are publicly available. Even Harvard medical school uses the Readiband system to prevent fatigue-related incidents with its surgeons.”

In addition, the Readiband system is designed to enable the mining company to manage fatigue itself without having to rely on outside consultants. Byrne explains: “In this way, fatigue risk can be managed by the company in the same way that they manage all their health-and-safety risks.”

Rio Tinto uses Readiband in 15 global operations. In one, the company discovered that the highest number of fatigue-related accidents happened at the end of the first day shift and the last night shift. After implementing a new rule that workers cannot operate equipment after being awake for 14 hours, the company lost no productivity and eliminated all fatigue-related accidents. In addition, Rio Tinto has seen employee morale go up, with many saying that getting more sleep has proved life-changing.

GUARDVANT
Guardvant’s OpGuard system uses sophisticated head and eye tracking software, and pattern-recognition algorithms to monitor operators for commonly recognised signs of fatigue such as eyelid movement, blink rates and blink durations. It is also able to detect the condition commonly referred to as a micro-sleep, and the pitch and yaw of the operator’s head movement.

The software operates on a Guardvant-manufactured, ruggedised mobile server applications platform using the latest-generation computing hardware that is small in form, and rated IP67 for protection against dust and water. The OpGuard on-board software processes data captured from a high-quality, wide-angle, infra-red video camera that observes the operator. The wide-angle camera ensures that a range of operator heights can be tracked through a high range of movement and motion in the seat. The infra-red light used by the camera allows operators’ eyes to be tracked while wearing glasses and during low light conditions.

Guardvant says that the high-quality camera hardware and software provides superior tracking rates and minimal false positives.

Smidt explains: “The sensitivity of the fatigue-detection software is configurable to allow system administrators to set the system for any unique local conditions and to minimise false positives as required.”

Smidt adds that the OpGuard system has a number of advantages: “It is a fully automatic and completely non-intrusive, passive system. The operator does not interact with the system in any way, nor do they have to wear any sensors such as glasses or hats.

Simply by sitting behind the steering wheel, the software processes data captured from a high-quality, wide-angle, infra-red video camera that observes the operator. The wide-angle camera ensures that a range of operator heights can be tracked through a high range of movement and motion in the seat. The infra-red light used by the camera allows operators’ eyes to be tracked while wearing glasses and during low light conditions.

Guardvant says that the high-quality camera hardware and software provides superior tracking rates and minimal false positives.

Smidt adds that the OpGuard system has a number of advantages: “It is a fully automatic and completely non-intrusive, passive system. The operator does not interact with the system in any way, nor do they have to wear any sensors such as glasses or hats.

Simply by sitting behind the steering wheel, the software processes data captured from a high-quality, wide-angle, infra-red video camera that observes the operator. The wide-angle camera ensures that a range of operator heights can be tracked through a high range of movement and motion in the seat. The infra-red light used by the camera allows operators’ eyes to be tracked while wearing glasses and during low light conditions.

Guardvant says that the high-quality camera hardware and software provides superior tracking rates and minimal false positives.
Guardvant says that the OpGuard fatigue-monitoring system is only the technical foundation of a much broader fatigue-management plan. The OpGuard system at its core provides two key components: a real-time alert system to operators to interrupt high-risk situations, and a quantified measure of the number of fatigue events detected across the haul-truck fleet.

When a fatigue event is detected, the operator is provided with an audible alert and an optional tactile alarm via a seat vibration unit. Simultaneously, an exception notification is sent to the fleet-management dispatcher and an optional SMS or email alert can be sent to selected supervisors or other designated management personnel.

The OpGuard hardware platform also includes a 99-channel GPS receiver and a three-axis accelerometer. It has the ability to interface with other on-board systems such as fleet management, vehicle health systems, tyre monitoring and equipment health monitoring to provide a broad range of situational information for system configuration and reporting, such as location, speed, direction and haul-cycle information.

Capehart notes: “The incorporation of production and equipment health data in the fatigue-reporting process will provide greater granularity in the evaluation of the fatigue risk in mining operations. By comparing fatigue and production data, managers will better understand the true effects and costs of driver fatigue to mine operations. “Quantification of fatigue costs will provide greater insight to develop effective fatigue risk mitigation and management plans.”

The data is stored in the Guardvant Central Analytics Server database, which is a web browser-based application that allows system configuration, reporting and database management. It is used to provide the exception notification to the dispatcher, send emails to supervisors and provide for a flexible reporting tool.

“Each mine site will develop some sort of real-time operator fatigue-mediation policy based on the unique circumstances at the site,” says Capehart.

“In developing the mediation policy, site management will take into account the local labour and union relationships, site risk and operating factors and the broader fatigue-management plan. In common with all mediation policies, however, is the procedure to interact with the fatigued operator in a positive way, and an escalation procedure as the driver shows multiple signs of fatigue or drowsiness.”

Guardvant has developed relationships with several mining OEMs. For example, Guardvant has worked with Liebherr to develop one of the world’s first fatigue-monitoring, proximity-detection and universal systems hardware platforms to be integrated into the dashboard of a mining-class haul truck.

The OpGuard system is in use by many mining companies with operations around the world, including Goldfields, Codelco, DeBeers, Southern Peru Copper, Anglo American and Anglo Platinum.

“Quantification of fatigue costs will provide greater insight to develop effective fatigue risk mitigation and management plans.”

The lightweight frame of the Optalert glasses is designed to provide comfortable all-day wear with an interchangeable lens design that lets operators choose the right colour to suit any driving condition, including at night. There is also a special prescription lens adaptor for operators who must wear prescription glasses when driving. All Optalert glasses are custom made to suit the user’s face shape and nose bridge.

Optalert also provides alertness monitoring to help companies understand how drowsiness and fatigue can impact on the alertness levels of operators. The alertness monitoring system is a behaviour-based tool that picks up on physiological warning signs of early-onset drowsiness, sometimes well in advance of the operator feeling the effects.

Finally, the Optalert Fatigue Risk Profiler (FRP) allows control room staff to view online and in real-time the current state of alertness of their entire team of operators, anywhere in the world.

Over time, this data can be used to quantify the fatigue risk profile of machine operators, making it a useful tool for assessing operator-pace suitability, as well as ideal rostering and break times to ensure an overall reduction in the mine site’s risk portfolio. The data can also act as a continuous improvement indicator, helping the development of targeted training programmes that give extra attention to operators whose drowsiness levels consistently deviate from the norm.

Guardvant has developed relationships with several mining OEMs. For example, Guardvant has worked with Liebherr to develop one of the world’s first fatigue-monitoring, proximity-detection and universal systems hardware platforms to be integrated into the dashboard of a mining-class haul truck.

The OpGuard system is in use by many mining companies with operations around the world, including Goldfields, Codelco, DeBeers, Southern Peru Copper, Anglo American and Anglo Platinum.

“Quantification of fatigue costs will provide greater insight to develop effective fatigue risk mitigation and management plans.”

The lightweight frame of the Optalert glasses is designed to provide comfortable all-day wear with an interchangeable lens design that lets operators choose the right colour to suit any driving condition, including at night. There is also a special prescription lens adaptor for operators who must wear prescription glasses when driving. All Optalert glasses are custom made to suit the user’s face shape and nose bridge.

Optalert also provides alertness monitoring to help companies understand how drowsiness and fatigue can impact on the alertness levels of operators. The alertness monitoring system is a behaviour-based tool that picks up on physiological warning signs of early-onset drowsiness, sometimes well in advance of the operator feeling the effects.

Finally, the Optalert Fatigue Risk Profiler (FRP) allows control room staff to view online and in real-time the current state of alertness of their entire team of operators, anywhere in the world.

Over time, this data can be used to quantify the fatigue risk profile of machine operators, making it a useful tool for assessing operator-pace suitability, as well as ideal rostering and break times to ensure an overall reduction in the mine site’s risk portfolio. The data can also act as a continuous improvement indicator, helping the development of targeted training programmes that give extra attention to operators whose drowsiness levels consistently deviate from the norm.

Optalert is an Australian fatigue-management company with global reach across Latin America, Asia and Africa. The company delivers a real-time system to detect the early onset of operator drowsiness, by accurately and constantly measuring a person’s level of alertness via patented operator technology.

Operator fatigue is measured in several ways. The Optalert Fatigue Management Glasses measure the operator’s eyelid velocity 500 times a second using a tiny invisible LED built into the frame of the glasses. It tracks the amplitude velocity ratio, or how fast and how far a person opens a closed eyelid. This measurement is translated into a score, which the operator sees inside the cab of their vehicle on the Optalert Dashboard Indicator.

The lightweight frame of the Optalert glasses is designed to provide comfortable all-day wear with an interchangeable lens design that lets operators choose the right colour to suit any driving condition, including at night. There is also a special prescription lens adaptor for operators who must wear prescription glasses when driving. All Optalert glasses are custom made to suit the user’s face shape and nose bridge.

Optalert also provides alertness monitoring to help companies understand how drowsiness and fatigue can impact on the alertness levels of operators. The alertness monitoring system is a behaviour-based tool that picks up on physiological warning signs of early-onset drowsiness, sometimes well in advance of the operator feeling the effects.

Finally, the Optalert Fatigue Risk Profiler (FRP) allows control room staff to view online and in real-time the current state of alertness of their entire team of operators, anywhere in the world.

Over time, this data can be used to quantify the fatigue risk profile of machine operators, making it a useful tool for assessing operator-pace suitability, as well as ideal rostering and break times to ensure an overall reduction in the mine site’s risk portfolio. The data can also act as a continuous improvement indicator, helping the development of targeted training programmes that give extra attention to operators whose drowsiness levels consistently deviate from the norm.

Guardvant has developed relationships with several mining OEMs. For example, Guardvant has worked with Liebherr to develop one of the world’s first fatigue-monitoring, proximity-detection and universal systems hardware platforms to be integrated into the dashboard of a mining-class haul truck.

The OpGuard system is in use by many mining companies with operations around the world, including Goldfields, Codelco, DeBeers, Southern Peru Copper, Anglo American and Anglo Platinum.

“Quantification of fatigue costs will provide greater insight to develop effective fatigue risk mitigation and management plans.”

The lightweight frame of the Optalert glasses is designed to provide comfortable all-day wear with an interchangeable lens design that lets operators choose the right colour to suit any driving condition, including at night. There is also a special prescription lens adaptor for operators who must wear prescription glasses when driving. All Optalert glasses are custom made to suit the user’s face shape and nose bridge.

Optalert also provides alertness monitoring to help companies understand how drowsiness and fatigue can impact on the alertness levels of operators. The alertness monitoring system is a behaviour-based tool that picks up on physiological warning signs of early-onset drowsiness, sometimes well in advance of the operator feeling the effects.

Finally, the Optalert Fatigue Risk Profiler (FRP) allows control room staff to view online and in real-time the current state of alertness of their entire team of operators, anywhere in the world.

Over time, this data can be used to quantify the fatigue risk profile of machine operators, making it a useful tool for assessing operator-pace suitability, as well as ideal rostering and break times to ensure an overall reduction in the mine site’s risk portfolio. The data can also act as a continuous improvement indicator, helping the development of targeted training programmes that give extra attention to operators whose drowsiness levels consistently deviate from the norm.
SEEING MACHINES

Seeing Machines is a technology company with a focus on vision-based human machine interfaces. Its technology platform is based on computer vision processing technologies that allow machines to see and track human faces and certain facial features. The Driver State System (DSS) product range is a robust, automatic platform that uses eye-tracking algorithms to detect operator drowsiness and distraction. It has been specifically designed for straightforward deployment into vehicles and environments where fatigue and attention must be monitored and managed in real-time.

The DSS system works equally well day and night, even when an operator wears tinted safety glasses or prescription eyewear. Seeing Machines says that unlike other companies’ solutions that require drivers to wear special equipment such as glasses or caps, the advantage of DSS is that it is automatic, non-contact and requires no calibration.

Audio and seat-vibration alarms immediately alert the operator when a fatigue or distraction event is detected. Site dispatchers are notified of incidents in real-time, as the DSS-IVS simultaneously transmits the event information from the vehicle to the DSS Information System (DSSi) console. Dispatchers can visually verify event data by examining the transmitted video snippets of the driver’s eyes. Properly and promptly informed dispatchers are able to intervene, keeping drivers safe and managing site risk in accordance with the organization’s FRMS.

Post-event, the DSSi’s reporting feature helps safety managers analyse trends in driver fatigue and distraction over longer periods and measure FRMS performance across shifts, sites and the business.

SIX SAFETY SYSTEMS

Six Safety Systems formed a partnership with Tobii Technology, a leading eye-tracking and gaze-interaction company, in 2012 to develop the LUCI safety system.

The LUCI system mounts two optical sensors on the dashboard of the operator’s workstation, which detect the eyes as soon as the operator is in position. “The sensors work in any lighting or environmental conditions, and the operator can be wearing any type of glasses,” says Robillard. “Specific measurements are captured and converted into an objective alertness score. This score is relayed in real-time directly to the operator, thus allowing the operator to actively manage their risk. All data is simultaneously transmitted to a central control.”

LUCI measures PERCLOS as well as other key metrics to establish the objective alertness score. The system alerts the operator when their alertness risk becomes unacceptable. Robillard explains: “Acceptable risk levels are determined by each company, taking into account a number of factors. The acceptable risk level can also be adjusted relative to changing external risk, such as adverse weather conditions.”

Once unacceptable risk is identified, an immediate alarm is triggered. Additionally, the central control room or on-site supervisors can determine the appropriate response/action to the risk by utilising company-specific assessments.

Robillard says there are a number of advantages to the LUCI system. Firstly, the LUCI system is encompassed within a comprehensive approach to mitigate worker fit-for-duty risk and is delivered by safety professionals that come directly from the energy and resource industries. Secondly, it offers two levels of real-time proactive risk mitigation and a third level of complete company risk analysis. “As Six Safety specialises in complete worker fit-for-duty risk, LUCI is designed on a platform to introduce additional functionality,” adds Robillard. “In the near future, LUCI will be able to detect operator distraction, drugs and alcohol, various medical conditions and, ultimately, an optical fit-for-duty screen will monitor drugs, alcohol, fatigue and other physiological factors such as stress.”

The LUCI system is slated for full commercial delivery in the December quarter this year. It is currently being tested in Mexico and at Canadian oil-sands mining operations. On completion, there are three multinational mining organisations that have pre-ordered the LUCI system within a comprehensive turnkey solution. Six Safety’s safety professionals are already working with some of these companies on the overall strategy.

“Acceptable risk levels are determined by each company, taking into account a number of factors. The acceptable risk level can also be adjusted relative to changing external risk, such as adverse weather conditions”

WITH SGS, NOTHING FALLS THROUGH THE CRACKS

SGS’ world-class technical expertise supports the design, commissioning and operation of metallurgical plants. Our integrated approach of specialized solutions and traditional services, all in one facility, supports the entire asset lifecycle.

Trust SGS for reliable in-plant and production services to improve the efficiency and bottom line in your mill or mine.

SGS IS THE WORLD’S LEADING INSPECTION, VERIFICATION, TESTING AND CERTIFICATION COMPANY

MINERALS@SGS.COM
WWW.SGS.COM/MINING