Where’s the operator?

John Chadwick takes an annual look at the advance of autonomous and remote control mining equipment and new products in the field

There are two key issues behind the drive to develop ever more sophisticated – safety and the shortage of skilled and unskilled workers. It has never really been an issue of replacing people, but to get them out of hazardous areas and make their jobs safer. However, automation both remote operation and automation mean more machines can be managed by fewer people, and since fewer people are available to mining, it makes perfect sense. There are many other reasons to automate – reducing costs, improving quality and productivity, increasing capacity and reducing.

One of the most significant recent pieces of news is Rio Tinto signing a deal to buy at least 150 machines from Komatsu over the next four years – the world's largest fleet of driverless trucks. The new Autonomous Haulage System (AHS) trucks, which start being delivered this year, will be used in Rio Tinto's Pilbara iron ore mines in Western Australia and be controlled from its Operations Centre in Perth more than 1,500 km away. (IM January 2010, pp16-19). The move signals a 15-fold expansion from its previous plan to double the fleet to 30 trucks.

Part of Rio Tinto's Mine of the Future program, the aim is to reduce costs, increase efficiency and improve health, safety and environmental performance. The group believes that by implementing autonomous haulage on this scale, more material can be moved more quickly and safely, creating a direct increase in productivity.

In Tokyo Rio Tinto Chief Executive Tom Albanese said: “This reinforces our long-standing alliance. We have been partnering with Komatsu, using their advanced truck technology at our mines, for almost 20 years. Autonomous haulage is an important component in our Mine of the Future program. These 150 new trucks will work with our pioneering Operations Centre that integrates and manages the logistics of 14 mines, three ports and two railways. These technologies are revolutionising the way large-scale mining is done, creating attractive hi-tech jobs, and helping us to improve safety and environmental performance and reduce carbon emissions.”

Komatsu President and CEO Kunio Noji commented: “We are confident that our leading-edge AHS Technology will accelerate Rio Tinto's Mine of the Future objectives through improving safety and mine operations.” Rio Tinto has been testing the Komatsu AHS, the world's first commercial autonomous mining haulage system, in the Pilbara since December 2008. Elsewhere in the program, Rio is set to begin more widespread deployment of its automated drills, both in the Pilbara and at coal and copper mines in its portfolio.

AHS is a comprehensive fleet management system for mines. The trucks, which are equipped with vehicle controllers, a high-precision global positioning system (GPS), an obstacle detection system and a wireless network system, jointly developed by Komatsu, Komatsu America and Modular Mining Systems, are operated and controlled via a supervisory computer. Information on target course and speed is sent wirelessly from the supervisory computer to the driverless trucks, while the GPS provides their position. When loading, the trucks are automatically guided to the loading spot after computing the position of the bucket of the GPS-fitted hydraulic excavator or wheel loader. The supervisory computer also sends information on a specific course to the dumping spot.

Safety is enhanced because the fleet control system prevents collisions with other dump trucks, service vehicles or other equipment at the mining site. In case an obstacle detection system detects another vehicle or person inside the hauling course under AHS operation, the vehicles will reduce speed or stop immediately.

In addition, AHS enables stable operation in gruelling environments, such as at high altitudes or in sparsely populated, arid desert areas. At the same time, by optimising operations, the system contributes to reducing maintenance costs, conserving energy and curbing CO2 emissions.

In June, Rio Tinto announced that it would deploy driverless trucks at Yandicoogina, the largest mine in the Pilbara, following a two-year trial of AHS technology on trucks at the West

Situations like long queuing times and misrouted loads have a significant impact on productivity. Cat's MineStar fleet assignment and optimisation technologies can help mines address these issues

Angelas mine, which has performed “well above expectations.” The trucks will dump ore for the first time, marking a major step in the evolution of the project towards full operational deployment. Previously the trucks only dumped waste product. Rio Tinto Iron Ore Pilbara Operations president Greg Lilleyman said: “This is an exciting step in achieving our Mine of the Future vision, and a critical one in our drive for outstanding safety and production efficiency as we grow our business towards 333 Mt/y capacity. It will be the first operational deployment of this technology in Australia, or anywhere on this scale. The trucks will be used for all haulage requirements in the Junction South East (JSE) pit, moving high grade, low grade and waste material from multiple loading units.”

The AHS project at West Angelas, operating around the clock for more than two years, has moved more than 42 Mt of material in approximately 145,000 cycles, travelling more than 450,000 km. In that time, performing a number of tasks, Rio Tinto states that the AHS technology has demonstrated clear value to the business, especially in the areas of health, safety and productivity. The AHS trucks use pre-defined courses and navigate autonomously from loading units to dump locations, including waste dumps, stockpiles and crushers. The main navigation system is GPS, combined with a secondary navigation process. The existing five Komatsu 930E trucks fitted with Komatsu’s ‘Frontrunner’ AHS system, will be moved from West Angelas to the Yandicoogina mine, where they will combine with five new 930E trucks, and operate the JSE pit. The 10 autonomous trucks will operate at Yandicoogina JSE under the control of Yandicoogina mine management, supported by the AHS support team. It is expected to be fully deployed by April 2012.

In a key development in its autonomous truck program, Caterpillar together with Australian
The integration of all tasks related to elements, including the full CAT® MineStar™System technology suite and an initial fleet of 12 Command for hauling autonomous 793F trucks to be implemented in the second half of 2012. At full operational capacity, it is anticipated the Solomon mine will have some 45 autonomous trucks by 2015.

Chris Curfman, Vice President, Caterpillar Global Mining: “By working closely with mining customers, we are able to tailor a solution to their specific business needs using Caterpillar’s broad range of products, technology and services. This collaboration will also positively impact sustainability at Fortescue’s Solomon mine through reduced environmental footprint and machine efficiencies.”

“Innovation is at the heart of Fortescue’s values,” said Fortescue’s Chief Operating Officer, Neville Power. “It is how we started this business through different exploration and mining practices, and it will be critical in how we implement our extensive growth aspirations. One of the key growth challenges we face is around availability of people and the need to best utilise this valuable resource. As such, it is incumbent upon us to look at new ways of doing things. Partnering with the world’s leading mining equipment supplier to develop the automation of our mining operations is a great outcome. It is the unique capabilities that the three parties bring to this agreement that will deliver the world’s leading autonomous mining solution at Solomon.”

Caterpillar and WesTrac will work together to implement and operate this autonomous solution. The two organisations together will provide product and technology implementation, consulting and change management services to Solomon mine, as well as operate the complete autonomous system once it is implemented. In addition, WesTrac will be fully responsible for supporting the large Caterpillar mining fleet at Solomon with machine and technology technicians and support personnel. “For the past 10 years, WesTrac has been a leader in selling, implementing and supporting mining technology products that help mining companies achieve improved productivity and asset utilisation. By marrying our deep CAT product expertise with these ‘building block’ technologies, we are well positioned with Caterpillar to provide Solomon mine with a turn-key autonomous mining solution,” said WesTrac Group CEO, Jim Walker.

The implementation of Command for haul trucks at the Solomon mine is a significant step in executing Cat’s autonomous mining strategy. Command is part of Cat MineStar system and provides remote control, semi-autonomous and autonomous systems for both surface and underground mobile mining equipment. By integrating the capabilities of Fleet, Terrain, Detect and Availability, it can deliver significant operational improvements in safety, productivity and availability.

MineStar is the industry’s broadest suite of integrated mine operations and mobile equipment management technologies, configurable to suit an operation’s needs. Its capability sets are Fleet, Terrain, Detect, Health and Command. They contain a range of technologies allowing the management of everything from fleet assignment and condition monitoring to remote and autonomous control. Now, of course, there is a vastly larger Cat product line to apply these technologies – such as its drilling units, draglines and both electric and hydraulic loading shovels.

Fleet provides real-time machine tracking, assignment and productivity management, giving a comprehensive overview of all operations from anywhere in the world. Terrain enables high-precision management of drilling, dragline, grading and loading operations through the use of guidance technology. It increases machine productivity and provides real-time feedback for improved efficiency. Detect helps increase operator awareness, enhancing safety. It includes a range of capabilities designed to assist the operator with blind spot and proximity detection of fixed and mobile equipment.

Scheduling is important to automation and Gemcom Software International has released Gemcom MineSchedTM 7.1, the latest version of its next generation scheduling software for surface and underground mines of all types and sizes. MineSched provides capabilities to develop economic, easy-to-mine schedules to maximise productivity and profits. MineSched 7.1 provides fully integrated 3D scheduling experience.

MineSched provides easy-to-use features which enable mining engineers to produce efficient and cost-effective schedules, explained Stephane Cantin, Gemcom Product Line Manager. “In addition to many across-the-board enhancements, MineSched 7.1 enables underground schedules to be completely set up in a 3D graphical environment. Underground mining engineers can now interact with both development and production in the same 3D environment to perform tasks such as defining mining precedences. This saves users significant time and helps them achieve more accurate schedules.”

In this version, surface mine schedulers have the ability to calculate truck hours directly in the software. This enables more accurate calculation of fleet requirements, leading to substantial cost savings where fleet requirements can be reduced through more efficient scheduling.

MineSched 7.1 benefits include:

- The integration of all tasks related to development and production scheduling into the same 3D environment simplifies setup and ensures more accurate underground scheduling
- Enhanced interactive graphical sequencing allows users to visualise and select the optimum sequence of blast polygons while
New truck haulage capabilities allow for the creation of accurate models by defining haul routes across benches, multiple truck types and detailed haul route velocities

MineSched reports on truck hours and fleet requirements in the dashboard, allowing for quick analysis of changing requirements over the life of the schedule and ensuring the most efficient haulage is always maintained.

**Truck monitoring**

ArcelorMittal’s Minocra iron ore mine, nestled in the Mesabi Iron Ore Range in Virginia, Minnesota, chose Wenco International Mining Systems to outfit their 13 haul trucks, two hydraulic excavators and five loaders with Wenco’s Fleet Management System (FMS). In addition there are two Mobile Supervisor Terminal applications that allow the foremen to compare bench elevation to the mine plan. Two other crew trucks are now monitored for speed and location throughout the pit.

Looking to improve the accuracy of information within the mine site, Minocra is focusing on key areas using Wenco’s FMS technology in automated pit reporting, improved blend control, improved material tracking, and overall pit management and productivity efficiency.

Tyres remain a huge cost item and their proper management should be at the forefront of mobile fleet maintenance considerations. Remote monitoring of truck tyres is becoming much more common and more important, whether trucks are operated autonomously or manually. As noted last month (p62) a trial of leading-edge tyre monitoring systems on Thiess-operated mines is saving time, money and tyre life according to the contractor. The Rimex TyreSense system and Michelin’s MEM) are being trialled respectively on the Thiess fleet of Caterpillar 797s at the Burton coal mine and Liebherr T282 trucks at Curragh North in central Queensland.

Vanessa Zaroor, Director of Marketing at Advantage PressurePro says “PressurePro is the world leader in tyre pressure monitoring. TPMS technology provides fleets of all types the information needed to extend tyre life, decrease maintenance and downtime, add safety and much more. We work alongside numerous leaders in Telematics to bring customers fully automated TPMS/Telematics offerings. These integrated solutions not only allow fleets to add TPMS features to their vehicles without the addition of distracting screens in-cab, it brings fleets the ability to remotely monitor their tyres. This brings tyre maintenance to a new generation by allowing a single maintenance manager to monitor every tyre on a fleet (locally or worldwide) from one, central, location – 24/7. Further, along with providing real time tyre pressure readings as well as alerts to low and high pressure situations (which can then be set custom by each fleet in their reporting software) in remote applications, we also have the ability to tie in other partnering product technologies such as brake stroke and weight (scale) information and pass that information through our system to the communications provider.”

Another problems caused by underinflated tyres is increased fuel consumption.

Looking in more detail at just one of these points, in extending tyre life and adding greater tyre integrity. Under inflation causes added stress and wear on tyres, shortening life and leading to tyre damage. A tyre will wear out 12% faster at just 10% under inflation. In addition to sidewall/casing damage and breakdowns,ply separation, tyre disintegration and heat build-up, duals (twin tyre sets) experience even greater problems when underinflated. A small difference in pressure on a set of duals literally drags the lower pressured tyre significantly.

Also in tyre pressure monitoring, Rimex has introduced TyreSense 3.0. Accurate real time tyre pressure and temperature data can be relayed to a PC, handheld device or mobile phone. TyreSense is completely customisable to each individual mine and can integrate with more than five major fleet management systems. The data collected by TyreSense is presented in an easy to read data log graph and Excel spreadsheet. The data can be accessed by the user the moment it is collected, eliminating any need to send away for data processing. The new 3.0 software allows the mining customer to also monitor the speeds, running hours, and mapped location of their equipment using integrated GPS. New features such as the automated sensor ID scanning help to eliminate manual entry errors when programming a sensor to a specific tyre position.

**Automated drills**

Flanders Electric has been one of the leaders in drill automation with its ARDVARC™ (Advanced Rotary Drill Vector Automated Radio Control) system, which it says “can help improve productivity and machine life cycle management.” There are three systems to choose from providing the specific level of drill automation that is right a particular operation. The ARDVARC One-Touch Drill system is the most popular option, converting a manual machine to a “one-touch” drilling unit. The operator needs only to put the machine over the desired target and press a button on the 15” daylight readable touch screen to initiate the drilling process. The drill automation system will then level the machine, collar the hole and drill to the desired depth then, retract the bit and reset the jacks in preparation of the next propel cycle.
For users who desire a complete data collection system without the automation of the machine, there is the ARDVARC Blast Plan is right for you. Data is collected in a Microsoft SQL database and is stored perpetually on the machine ensuring that no data is lost. The data from the drill data collection system is stored in three production tables and three event log tables and is easily accessed using any standard data reporting tool. Production data is broken down into shift totals, single-hole production records, and a metre by metre record of the entire drilled hole. Event data is stored in a fault and alarm table, a machine status table and a detailed machine status table providing information on what is happening, and why.

For true drill automation, ARDVARC Auto Propel has now racked up more than 1 million holes drilled without human interaction. With Auto Propel, the machine accurately and precisely positions itself on the design hole without human interaction and begins to drill the hole. It can monitor the surrounding area for obstacles using the Flanders Electric HazCam 3D imaging system to ensure safe operation of the machine. Flanders Electric says “incredible productivity gains, as much as 30%, can be realised by reducing machine down time due to blasting and shift changes.

Sandvik and Flanders have entered a formal partnership to automate surface mining drill rigs and provide autonomous operation. The companies say the “agreement ensures that drillers get the world’s best combination of technologies for state-of-the-art automation or machine autonomy.” ARDVARC systems have been field-proven on multiple blasthole drills around the world. For factory-supplied systems on new Sandvik drills, the initial automation modules will be offered starting in the first quarter of 2012 on machines with electric-over-hydraulic controls.

“Together, we will deliver automated and autonomous machines directly from the factory, and offer sophisticated retrofits for more than 2,000 Sandvik drill rigs currently operating globally,” says Gregg Scanlan, VP of Surface Drilling Equipment at Sandvik. “Our strategy is to combine proven automation with worldclass drill rigs and a strong global aftermarket support.”

Allen Patterson, Chief Operating Officer at Flanders explains: “Working with Sandvik helps us in our mission of being a force for good to our customers, business partners like Sandvik and the communities we serve. Together we can better standardise the offering and formalise field support on a global scale. Our partnership will accelerate implementation and acceptance of ‘automation’ on drill rigs and benefit a growing number of mining companies.”

The driving factors for considering automated or autonomous operation vary from mine to mine, but are typically a combination of the following according to Sandvik and Flanders:

- **Safety** - by physically removing the driller from the machine, particularly when drilling near the toe or the crest, risks are reduced or even eliminated depending on the level of remote control.
- **Utilisation** - blasthole drills commonly only drill 40-60% of the shift time. Utilisation increases incrementally with the level of technology, e.g., one-rod automation, one-hole automation, or complete blasthole pattern autonomy. The greatest contribution of complete rig automation is increased utilisation of the equipment by enabling mine operators to drill through blast outages, shift changes and operator breaks.
- **Training and recruitment** - if finding skilled drillers or training them is a challenge, automated rig functions can compensate for limited skills. If there is a shortage of operators in general, remote control or autonomy can help resolve the problem. Also, the built-in intelligence in the drill controls protects against inappropriate operations and helps all drillers perform at a more uniform level.
- **Reliability and maintenance planning** - health monitoring systems provide real-time information on the operating parameters of the drill. This information can be used to detect harmful conditions (preventing damage), schedule on-demand maintenance (reducing maintenance cost), improve preventative maintenance (improve availability), or a combination of these factors.
- **Productivity** - automated, or drilling assist, functions increase the average production rate among all drillers. Combined with increased reliability and utilisation, the total net productivity can increase dramatically.
- **Reporting and management** - by displaying drilling information directly in the cab as well as in exported reports, the driller, the operations manager, and the maintenance manager can better address real or potential problems.
- **Total drilling cost** - the net effect of increased productivity, better capital use and lower labour costs is to dramatically reduce total drilling cost. One particularly easy saving to measure is the reduced fuel cost thanks to the Compressor Management System.
- **Bench control** - a combination of GPS location, autolevelling, and exact hole depth control allows for more level benches.
- **Fragmentation** - combining improved hole straightness and location with integrated strata recognition gives the opportunity to
load each hole for optimised blasting and fragmentation. This may shorten the shovel loading cycle, but primarily improves the throughput in the crushing plant or the materials handling systems.

Atlas Copco says EDGE, is “the world’s first system for deep hole monitoring. EDGE is a three-component system that gives a driller continuous, instant feedback about the performance of the hammer as it strikes the bit. It can be fitted to all types of deephole drill rigs that use Secoroc DTH (down-the-hole) hammers.” It consists of a sensor, a data processing unit and a rugged display screen.

The sensor captures vibrations that travel directly from the bit itself through the drill string. It sends these to a PC, which translates these signals into numerical readouts and graphic images on the display mounted next to the drill controls at the operator’s eye level. With this display the driller is always ‘seeing’ the performance of the bit and makes instantaneous decisions based on this real-time information.

In the graphical view, any problems or unexpected changes are displayed with alerts, the driller responds to this feedback, continuously optimising the drilling process.

When a new type of rock formation threatens to ‘shank’ the bit, the driller has time to make adjustments before catastrophic failure. Or perhaps the hole is not being flushed properly, and the drill string is in danger of jamming. Maybe a slight vibration is caused by movement inside the chuck due to insufficient feed force, gradually reducing the efficiency of the cutting capacity.

Atlas Copco further notes that down-the-hole hammer drilling is not as commonly used as it could be because rotary drilling is easier to master and costs less in tooling. “EDGE removes these barriers and brings the benefit of percussion drilling to deep hole drilling: quickly acquired and sustainable driller performance and improved penetration rates that mean less time in the hole, fewer tooling issues, and a better bottom line.

The SmartROC D65 surface drill rig has been upgraded to enable direct communication with the rig’s control system. This includes...
transferring drill plans to the rig and receiving drilling data log files. When the SmartROC D65 was launched in 2010 it was immediately recognised for its power and productivity, which is considerable, but also for its intelligence and communications capability provided by its unique, computer-based Rig Control System (RCS), Atlas Copco says.

At that time, drill plans prepared in the mine office were installed into the rig’s control system via a USB memory stick. Now the SmartROC designers have enabled the rig to download this data directly via the worksite’s own local area network (LAN) or wireless network WLAN.

It is the latest addition in the ongoing development of this highly modern drill rig which, among other benefits, offers hole navigation by GPS positioning and automatic drilling.

“This is an ethernet application module for SmartROC D65 rigs working in a fixed installation in mines and larger stone quarries,” explains Olav Kvist, Product Line Manager at the company’s Surface Drilling Equipment Division. “The SmartROC is characterised by its intelligence and connectivity and the ability to transfer drill plans and other data to the rig is all part of the effort to optimise operations on the site.”

The new interface not only makes data transfer simpler and faster. It is also more user-friendly as it allows planners to more easily make changes and last minute adjustments. In addition, Kvist points out, it paves the way for mines to install wireless systems.

SmartROC D65 shares its intelligent platform with all rigs in the SmartROC family, including the Atlas Copco PitViper series. The rig communication standard is all based on the International Rock Excavation Data Exchange Standard (IREDES) enabling total management and operation control.

**Leica and ASI**

Last September, Leica Geosystems Mining announced an exclusive industry partnership with Autonomous Solutions Inc (ASI) to provide completely OEM independent remote and fully autonomous mine machine control. Leica Geosystems Mining said at the time, “The fact that the technology is not connected to a machine manufacturer and introduces an entirely new approach to mining automation has sparked a huge amount of industry interest.”

The ASI technology is pivotal to the Leica Jigsaw product suite which offers three levels of machine control: fleet management (Leica Jfleet systems), high precision guidance (Leica J2guidance systems) and now, with ASI, automated control (Leica J3autonomous systems).

Choosing an industry partner for such an important role was not done lightly. Haydn
Roberts, CEO of Leica Geosystems Mining states, “We chose to work with ASI because they are the only OEM independent company that has developed and field tested fully autonomous mining equipment. They have a strong history in R&D and have hundreds of unmanned vehicles in industries like agriculture, mining, material handling, and the military.” For six years ASI has worked specifically in the development and deployment of automation packages for mining trucks, bulldozers, drills, and shovels. In partnership with Leica Geosystems ASI plans to transition its fully autonomous trucks, dozers and other robotic technology into the global mining market.

They say the fundamental differentiator and the key to the successful integration of this automation technology into mining is the incremental fielding approach proven in the agricultural industry. They will work within the specific needs, constraints and safety requirements of their clients, rather than dictating parameters to them.

ASI is taking the fully autonomous truck, dozer and other vehicle technologies and working with Leica Geosystems to quickly field the capabilities like AutoSpot that will provide immediate financial returns while largely keeping people in the vehicles. ASI President and CEO Mel Torrie notes: “This progressive approach in agriculture has led to farmers reaping incredible financial benefits far sooner and at every step along the way to full automation without the risks associated with the all or nothing solutions currently being proposed in the mining industry.”

He explained that by building up the hours of system use, its reliability is clearly demonstrated. “Trust in our sub-systems is being established with the end user one capability at a time until the site wants to graduate to a full autonomous operation.”

A number of semi and fully autonomous control systems are available as a part of the Leica J3autonomous solutions. These include:

- Haul truck “guideline” convoy system
- Remote-controlled, line-of-sight operated systems
- Tele-operation systems (operators work remotely via an operations centre using video feed and site plans)
- Fully autonomous ripping for dozers (with a resultant 50% faster ripping rate)
- A fully remote controlled all terrain walking track robot for underground mine surveying, post-blast analysis, and safety operations using its many sensor and robotic arm options.

Entry level base-line tele-operation and remote control solutions are available for any mine machine and can be upgraded to a fully autonomous solution according to client requirements. Other product offerings are in user trials and will be announced soon.

**Machine management**

Companies including Vale, Kinross, Anglo American, Anglo Gold Ashanti, Yamana Gold and Samarco use Devex’s SmartMine mine automation and control technology. For instance, Devex has been tasked by Vale to take over part of the current management system of the Carajas Sierra mine, to optimise and contribute to the expansion of production. The application of SmartMine will permit the mine to
know where are, on the immense site, precisely the best opportunities and potential losses in the production process.

"With SmartMine implantation, Vale starts having more security conditions, efficient maintenance and instantaneous decision making on its hands. In all these 14 years of DeveX, we have invested maximum energy in getting experience and knowledge, always based on innovation, flexibility, velocity and high technology. Vale has recognised the level of excellence of our products and services".

Initially around 180 machines are being installed with the DeveX equipment. Dozers, graders, water tankers and haul trucks have been equipped with GPS and on board computers. The installation includes a central dispatch and control room. "We offer Vale a customised service, based on our experience and on personalised service," said Rodrigo Guilherme Couto, responsible for SmartMine technology sales.

DeveX's portfolio, developed totally in-house, centres on its SmartMine real-time mine automation and control technology for operations such as dispatch, fleet management, proactive telemetry, asset health monitoring, maintenance control, ore control, quality assessment, and production management.

"And SmartMine can be integrated with various other systems such as weigh stations and conveyors and is currently available in five languages including English, Spanish, French, Russian and Portuguese," the Director of DeveX Asia Pacific, Aston Bell, explains.

DeveX technology also includes:

- MineInside 3D virtual reality software for planning, monitoring, reconstruction and analysis for open-pit and underground
- Argus remote operations control software for receiving and interpreting mine information.

"This represents a new concept in terms of the mining control room and visually integrates data from different areas of a mine, enabling shared decisions and multiplying production gains," Bell said.

DeveX was established 14 years ago and has its head office in Brazil and its Asia Pacific head office in Queensland. It also offers on-board touch-screen trackers, precision systems, access points, repeaters, antennas and cabling.

**Plant automation**

Last year ABB won an order to provide the complete electrical and automation system for six inclined underground mine conveyors for Newcrest Mining's Cadia East gold and copper project in Australia. ABB's scope of supply for the project included a state-of-the-art conveyor control system that optimises the overall performance, reliability, energy efficiency, and operational flexibility of the conveyor system over its life. ABB designed, engineered and supplied a full electrical solution with modular switchrooms, transformers, 33 kV ring main units, water chiller systems, motor control centres (MCC) and mine conveyor control program (MCCP) to manage ABB's ACS 6000 multi-drives and motors.

"ABB's global engineering resources and mining industry expertise, combined with our proven technology, provide a technically robust and energy efficient system that will optimize performance over the entire productive life of this mine," said Veli-Matti Reinikkala, head of ABB's Process Automation division.

**Process control engineering firm MIPAC has developed a standardised Rockwell Automation ControlLogix™ and Wonderware ArchestrA™ framework that it says can save up to 300 engineering hours and tens of thousands of dollars on the average automation project. The framework's library of objects enable a project's rapid configuration. It supports the following features:**

- Objects to support alarming and set points managed within the PLC
- Ease of configuration with functionality similar to a DCS
- Standard window layouts and navigation standards
- Multiple monitor support

**Cradle to cradle**

Exploration, feasibility, due diligence, engineering and operations through to mine closure.

Our global experience gives you expert, integrated solutions on every phase of your mining project.

Same team — start to finish.
Windows for alarm summary, alarm history, event history, help files and reports
ControlLogix™ function block library
Built-in I/O simulation capability
Analogue signals with standard HH, H, L, LL, out-of-range and deviation alarms with time delays and deadbands.

“The framework enables express deployment of projects while providing sophisticated DCS-style functionality,” MIPAC managing director Eddie De Rivera says. “Rather than repeat configuration steps for each project, MIPAC’s proven framework reduces engineering time on the average project by about two months, increasing clients’ profits and productivity and improving production quality even sooner.”

Remote sophistication
Penguin Automated Systems Inc is a research development and prototyping company. Some of its undertakings develop technologies that are derived from the Mining Automation Program (MAP). MAP was an undertaking designed to create and implement telemining systems based on Dr Greg Baiden’s (Chairman & CTO of Penguin ASI) vision for the future of applying robotics with the human touch. Baiden along with a team of academics and specialists generated a focus on the tele-operation of an underground mine and the integration of the various components necessary for the project to be successful.

MAP became an international consortium that united key academics and professionals to participate in a C$28 million, five-year program that developed several core elements of telerobotics and mine automation. The R & D was conducted at Inco in Sudbury, Ontario, Canada to address two key issues: declining economic value of mines in a developed country, and declining worker productivity. While this was a few years ago, these key issues are as valid as ever.

Penguin’s has several initiatives underway including wireless radio systems designed for telerobotic operations. With extremely high bandwidths, enabling full video feedback at significantly long ranges, this system permits the rapid deployment of robots using wireless antennas and Penguin designed Teleoperation Control Stations. This system can be adapted to suit equipment for both robust and basic tasks for underground operations. At present Penguin is operating multiple robots under this system for mining reconnaissance (patent pending), including a system consisting of a Work robot and a Telecommunications robot that have the capability of pin-point underground mapping and a specialised manipulator for placing explosives. The system is capable of building its own
telecommunications network several kilometres into the mine. Mapping work at Vale’s Copper North and South mine completed a 50 km survey with 2 cm accuracy.

Penguin has developed a patented high bandwidth, low latency communication system specifically targeted at tele-operation. It is capable of transmitting quality video, audio and control signals underground, and on surface. The solid state optical transceiver contains 70 plus LEDs per plate and holds a 180° field of view with the capability of passing information at 40Mb/s with near zero latency.”

Cattron, a unit of Laird Technologies, says its LRC remote control system “sets new standards for the industry.” It is a versatile radio controller that has been especially designed to control equipment such as LHDs, continuous miners, roadheaders, drills and dozers. The controller is equipped with the proven dual-axis joystick, and all operating elements are arranged to ensure a comfortable and safe one-hand operation. The LRC can work with several type of Machine Control Units (MCU) such has CANopen, Profibus, PWM and Digital/Analog MCU.

For safety-critical applications, a dual channel redundant architecture is implemented on both OCU and MCU. Both units have two processors: a Master processor and a Slave processor. Basically, the two perform similar operations on process data, and compare their results at specific check points in the process. If any inconsistency between the two processors is detected, or if any processor detects a failure, an error is declared and the system stops. With the architecture, the system exceeds the strictest regulation including the new European machine directive EN 13849-1 Performance Level d ATEX. This system also complies with the Australian AS4240 standard (remote control systems for mining equipment). An ATEX version for coal mining is also available.

System configuration is via a removable, contact-less RFID memory device, the Transkey. Transkeys are produced in pairs (one for the OCU, one for the MCU). Each pair has a unique 24-bit address. RF link can only be established between OCU and MCU sharing the same Transkey address. With this Transkey technology, if an OCU needs to be replaced, the operator only needs to take the Transkey from the old OCU and place it in the new one. Downtime is minimal since there is no need to change the MCU on the machine.

As part of the newest product available in the CattronControl™ product line, it provides the next level of safety and reliability that enables the operator to work from a more secure and efficient location,” said Eric Brouillette, Vice President of Marketing & Sales – Mining. “Nautilus has been a pioneer in remote control for many years, particularly in underground applications. It offers versatile radio remote control systems capable of controlling and monitoring all of the functions of a wide range of mining vehicles such as LHDs, drill jumbos and many others. There are control panels for operators who prefer a unit with large joysticks. Or there is, for example, the Nautilus TC-180SSF. This Thumb Controller (TC) is used by operators who prefer a small, very light unit (0.45 kg). The TC has a few advantages over the larger 140SSF Portable Control Unit; the battery lasts much longer (32 hours), it requires only a comfortable neck-strap instead of a shoulder harness and it is not so tiring to use for a full work shift. Another advantage is the TC can stay with the operator when he is in the cab.

The TC-Powercam is a combination of a long range Radio Control System and a long range video system. Three cameras are mounted on the remote vehicle and the selected video
picture (plus machine status information) is transmitted to the nearest Super-Amplifier and antennas located on the roof of the drift. A single, inexpensive coaxial cable carries the video and data signals through the drift back to the operator’s TCM unit. The same coax cable and Super-Amps also carry the radio control commands from the operator’s TC unit out to the remote vehicle. In Australia and New Zealand, mining contractors use a Toyota Landcruiser as a comfortable remote vehicle. In Australia and New Zealand, mining contractors use a Toyota Landcruiser as a comfortable remote vehicle. In Australia and New Zealand, mining contractors use a Toyota Landcruiser as a comfortable remote vehicle. In Australia and New Zealand, mining contractors use a Toyota Landcruiser as a comfortable remote vehicle. In Australia and New Zealand, mining contractors use a Toyota Landcruiser as a comfortable remote vehicle.

A simple control room is another option for such systems – a small table and a comfortable chair.

For applications where remote operators need to monitor the front and rear of the remote vehicle simultaneously because of unstable ground conditions, the Nautilus Powercam System supports two TVs of any size.

A great safety problem of radio remote control systems in the past has been serious injury and fatalities from remote operators being crushed by the machine they are controlling. The Nautilus LHD Buddy has a proximity detection system to train an operator to stay a safe distance away from the remotely controlled LHD. The operator should be detected by the Buddy System even when kneeling, lying down or facing away from the LHD. Nautilus says “if required, the proximity system is capable of detecting the operator in every location around and even underneath the vehicle but customers usually only require the operator to be detected when he is at the rear or close to the side of the loader.”

The Coal-Buddy is an operator’s proximity detection system for underground coal mines operating in an explosive (methane gas) environment. It trains operators, helpers and visitors to stay a safe distance away from continuous miners (CM). The average installation time for a complete system is one midnight shift.

Two very small, intrinsically safe MFs Antennas are installed on the CM and they radiate two magnetic fields around the complete machine. The strengths of these magnetic fields are measured by the operator’s Proximity Detection Device (PDD) and if the operator is too close to the CM his PDD will warn him. If the operator gets dangerously close to the CM (inside the Red-Zone) then the PDD will automatically disable the CM.

Macleans Engineering’s Blockholer is a single-boom drill jumbo for secondary breaking. Very often it will be used as a remote control unit and uses a C-series Rack PC to control and monitor all of the functions of the Blockholer. The Nautilus RVU (micro-controller) communicates directly with the Omron Host Link Unit in RS232 format. This makes it very easy for a customer to connect a Nautilus Thumb Controller RVU to any Macleans Blockholer using only a single (four wire) cable.

To make it even easier, Nautilus has made the RVU extremely small and light. The magnet bolted to the bottom of the RVU enclosure allows the unit to be instantly clamped to any flat steel surface on the Blockholer which is available.

Parker Canbus Systems are now available world-wide for a wide variety of machines and vehicles. The advantages of using Canbus Systems include a simple two-wire system running through the machine which controls all of the functions.

Sandvik Mining has taken a lead underground by developing extremely low profile hydrostatic drive LHDDS which use the Parker Canbus System. Nautilus is currently the only company that is able to provide a radio control which is fully compatible with the demanding requirements of this Canbus System and still give superb remote control of the Sandvik units.

Hetronic Australia has a new range of IEC-approved radio remote controls for drill rigs and mining equipment working in hazardous, [Australian defined zone 1 and 2 explosive areas]. The range is said to incorporate innovative technology that raises the bar for safety and efficiency in mining and drilling equipment operations.

“The transmitter controllers offer the largest selection of joysticks on the market and include innovative features like tilt sensors, memory keys and real-time feedback, providing smooth and instant response,” Hetronic Director Paul Warren said.

Receiver interfaces include the space-saving Canbus, Profibus and RS232.

Hetronic Australia’s new manufacturing and service facility at Beresfield, NSW, provided design solutions for all remote control applications that were widely used by mining, Warren said. “The new development is in line with our goal of providing safe, reliable and affordable radio remote controls using cutting edge technology.”

Swedish control system specialist CrossControl has launched two new HMI product platforms for industrial vehicles; the Intel Atom-based Ccpiolot XM and the ARM11-based Ccpiolot XA. They come with either resistive touch screen or the new Projective Capacitive (PCAP) technology, which has contributed to making Smartphones so successful. Screen sizes are 7”, 10”, 12” and 15”.

Both products support multiple CAN interfaces, up to four video interfaces, USB, Ethernet and also optional wireless interfaces like WLAN and GPRS. They are freely programmable and a system developer can choose the tools of his preference for development on Linux or Windows. But they are also supplied with an open application software...
platform where CoDeSys is used for CAN controller tasks and Qt is used for the GUI. Qt has been chosen due its support for advanced functions like vector graphics, alfa-blending, sweep navigation, etc. The two frameworks communicate via a data repository, forming an integrated software platform with an easy-to-use tool chain.

CrossControl says “CCpilot XA and XM are designed for the next generation HMI systems. Many industrial vehicles of today are used only at a fraction of their potential. With more advanced HMI systems, operators are supported to operate the machine for higher utilisation. And an attractive GUI with high usability gives a premium user experience that strengthens the vehicle brand.”

CSIRO summarises: “Automation and remote operation of equipment is finally becoming more widespread. While the initial technological development began in earnest during the 1960s, today, many mining companies are investing heavily in this technology. In the next five years, in Australia and other advanced countries, it is likely the focus on automation and remote operation will take place at a wider system level (e.g. mining or minerals processing), rather than of individual components. Much of the previous work undertaken has focused on technologies to improve the ‘manned mining system’ but the focus now is on building ‘autonomous mining systems’.

“It appears from the literature reviewed that the more specific human factors problems and challenges associated with automated and remotely operated equipment are very similar to those encountered in other industries. These especially concern both the design (e.g. of interfaces) and deployment (e.g. operator acceptance) of technologies.

“Humans whether operators, maintainers, trainers, supervisors, or managers are a central part of the mining system rather than an optional extra. Thus, developing operator-centred approaches for the design and integration of new mining technologies is a key priority area. In this work, which forms part of the P2 stream of the Minerals Futures Project, a human factors approach is presented, where the focus is on designing equipment interfaces to fit operators, rather than purely designing and deploying the equipment based on a technology-centred approach.

“In the past there was a general view that the mining industry was slow to adopt new technologies however, current research indicates a substantial increase in the uptake of automated and semi-automated technologies. New and emerging trends with regard to surface mines seem to be focussed on excavation and loading, and producing outputs that incrementally deliver autonomous rock loading. For underground applications the focus is more toward enhancing operator situational awareness. Ideally much of the upcoming research and development will be undertaken with major equipment manufacturers to deliver upfront equipment in a form ready for the industry to use.”

The CSIRO work is being conducted as part of an overall research project that aims to identify current and emerging trends in the development of automation and remote mining technologies, and to provide an operator-centred perspective to the design and deployment of such systems. It focuses on the broad methods being developed, rather than the specific results to be obtained. The ultimate objective is to apply a broad “technology assessment approach to the design, deployment and evaluation of automated mining technologies, in particular by considering the user-centred design implications of these technologies.”

This work builds on a full review of the literature about the effects of automation in mining and elsewhere, extensive interviews with different stakeholders in mining automation and recognised best practice regarding designing for the human element in automated systems. Ideally, the proposed human element research and development process is in four stages – ranging from understanding the tasks involved in both manual and automated equipment operation through to user trials to ensure that the automated systems are acceptable to operators and are fit for purpose (dependant on appropriate site access availability). IM