

Rio leads open pit automation

Key building blocks for automated mine-to-port Pilbara iron ore operations are being commissioned by Rio Tinto. Already there are automated drills and Rio will develop autonomous mine trucks

In 2007, Rio Tinto set annual production records for iron ore, bauxite, alumina, aluminium, refined gold, and refined copper on a like for like basis. Very significant expansions are underway in iron ore. Output set a new annual record at 179 Mt in 2007. The Pilbara operations in Western Australia continue their rapid expansion with the Hamersley mines raising production by 17% compared with the fourth quarter of 2006. At the end of December 2007 the Pilbara ports were operating at a rate of 190 Mt/y (164 Mt attributable). Rio's newest iron ore mine, Hope Downs, commenced production in November 2007, three months ahead of schedule. With the first expansion already approved, it is expected to reach 30 Mt/y in 2009 - a rapid and sizeable increment to production in the Pilbara.

However, the medium-term plans are much greater than this. In December 2007, Rio Tinto announced it would place up to 15 Mt of iron ore on the spot market in 2008, recognising both very strong demand for iron ore and the gap between benchmark and spot prices, under which Rio Tinto has made sales at up to \$190/t (compared with the start of 2008 equivalent benchmark price of \$85/t).

In November 2007, Rio announced the approval of the \$2.4 billion development of two new mines, Brockman 4 and Mesa A (Rio

Tinto share \$2.0 billion), with eventual annual production expected to reach 22 Mt and 25 Mt respectively. Both mines will commence production in 2010, and Brockman 4 has potential to be expanded to 36 Mt/y. Plans were unveiled in the first half of 2007 to lift iron ore production capacity from the Pilbara to 320 Mt/y by 2012, and a conceptual roadmap was outlined in November 2007 to add a further 100 Mt/y in the Pilbara. A feasibility study to 320 Mt/y is well underway and will be completed in 2009. In addition, a \$71 million feasibility study was approved for Hope Downs 4, as part of the project to increase annual Pilbara capacity to 320 Mt.

This expansion program includes some very significant automation projects, which include:

- Mine operations in the Pilbara to be controlled from 1,300 km away at a new Remote Operations Centre (ROC) in Perth
- Driverless trains to carry iron ore on most of the 1,200 km of track
- Driverless 'intelligent' truck fleet
- Remote control 'intelligent' drills

Tom Albanese, Rio Tinto Chief Executive, unveiled his vision of the 'mine of the future' in Perth in mid-January. The group aims to be the leader in integrated and automated mining and transport in the Pilbara iron ore region, which it says will lead to "greater efficiency, lower production costs and more attractive working

Loaded iron ore train. The first units of a fleet of new generation locomotives has just arrived in Dampier to haul iron ore on Rio Tinto's 1,300 km rail network. The 10 locos mark the beginning of a major investment in rail infrastructure and rolling stock to keep pace with rapid mine expansions and increases in port capacity. RTIO will progressively upgrade its locomotive fleet to the new General Electric model, which will produce significantly lower emissions than existing diesel engines. It intends to purchase a further 30 GE Evolution-Series locos in 2008, of which 12 will replace the Dash 7 and Dash 8 locomotives purchased by Hamersley Iron and Robe River, which are now more than 30 years old. The remainder will cater for expanding production. The new locomotives use a 12-cylinder, 3,360 kW engine that offers improved fuel efficiency and more flexible maintenance requirements. The upgrade of the loco fleet is in tandem with the addition of 1,200 new ore cars in 2008, about 500 to cater for expansion and another 700 to replace the ageing cars that have been operating for up to 40 years

conditions that will help Rio Tinto to recruit and retain staff in the highly competitive labour market."

Major components of the 'mine of the future' are being commissioned in Rio Tinto Iron Ore (RTIO) operations in 2008 and 2009 including establishing the ROC in Perth to

manage operations in the Pilbara mines hundreds of kilometres to the north. This allows operators overseeing RTIO mines and process plant facilities to be physically located in Perth. This will relieve overcrowding at Perth airport (*IM*, The Leader, November 2007) and, more importantly, relieve great pressure on mining families that are regularly split when husbands and wives have to separate as one flies out to mines for their weeks 'on'.

Remote control 'intelligent' trains, drills and trucks will be operational within RTIO during 2008. Humans will no longer need to be hands on as all this equipment will be autonomous. Operators will oversee the equipment from the ROC. Albanese said, "Rio Tinto is changing the face of mining. We have at least a three year start on the rest of the industry, which has focused on discrete technologies rather than modernising the whole mine-to-port operation. We're aiming to be the global leaders in fully integrated, automated operations. It will allow for more efficient operations and directly confront the escalating costs associated with basing employees at remote sites, giving us a competitive advantage as an employer along the way."

The ROC will be built for Rio Tinto near Perth's domestic airport. When completed in 2009, the ROC will house at least 320 employees who will work with Pilbara-based colleagues to oversee, operate and optimise the use of key assets and processes, including all mines, processing plants, the rail network, ports and power plants. Operational planning and scheduling functions will also be based in the ROC.

ROC-based management would oversee pit and plant control, as well as manage the most effective use of power distribution and support activity such as maintenance planning. Remote operation of RTIO mines and plant in the Pilbara has already been successfully trialled. The centre will feature an operational control room, office block and supporting infrastructure, and allow for potential significant expansions beyond its initial scale.

HighGrade reports that CRCMining says it is working with Rio Tinto to develop an automated blasthole drill at the company's West Angeles operation. The work involves robotics experts from the University of New South Wales and is understood to have recently delivered significant breakthroughs in the area of real-time rock property recognition, data collection and automated drill performance variation.

A Rio Tinto spokesperson told *HighGrade*: "The bandwidth available now to handle both data, and more specifically video for



Fortescue's Wirtgen Surface Miners in action

monitoring, means it is realistic to be talking about 20 millisecond latency between a site in the Pilbara and the remote operations centre in Perth. Now you get very high fidelity [remote operating capability] and very high wireless data rate transfer at a much cheaper cost.

"There are so-called off the shelf technologies and then there are proprietary systems, and Rio's model is that we own a lot of stuff, and the other model is you outsource and contract everything. Getting a contractor to do what we're doing, assuming you can buy technology off the shelf won't be easy."

Freeport McMoRan Copper & Gold's mining technology head Steve Holmes told *HighGrade* that his company's autonomous drill program was progressing but couldn't say whether Freeport or Rio was out in front. "I can't comment on Rio's effort, but I can tell you that Freeport is engaged in automation in our open pit and underground operations," he said.

"Our [surface] autonomous drill, known as ARDVARC, is undergoing final field trials in our new Safford mine property in Arizona. At Safford we have three ARDVARC equipped Atlas Copco Pit Viper 271 rotary drills. We are carefully and deliberately advancing the technology and operating practices – which is very important in how this technology is used – and expect the fleet to be fully autonomous by mid-year. The schedule depends on what issues we encounter.

West Angelas

The technology trials are focused on the West Angelas mine, where a technology testing hub has been created, with everything centralised in one place. Some work is also going on at Yandicoogina. The projects include autonomous

drills, autonomous haul trucks, the East Pilbara ROC and remote planning and continuous miners, which Fortescue Metals believes it has proven at its developing operations with Wirtgen surface miners.

At Fortescue's Cloud Break the flat lying nature of the deposit lends itself to layouts similar to those used in the strip coal mines in the Powder River Basin (USA) and in Queensland (Australia). At Cloud Break overburden is removed by large hydraulic excavators (shovels or backhoes). It is then loaded into a hopper then onto a conveying system that will deposit it in the mined out strip, although initially this process will involve truck and shovel machines only. The conveying system is mobile and is programmed to enable the deposited material to take up a similar land form to that which existed before the overburden and ore was removed.

The iron ore is thereby exposed as a reasonably flat tabular body, allowing the iron ore to be extracted with surface miners. The first group of 14 Wirtgen Surface miners have been mobilised to site. Although uncommon to the iron ore industry, results using the surface miners have been encouraging with many others in the industry following Fortescue's lead.

RTIO is taking a global lead by introducing the Komatsu Autonomous Haulage System into the Pilbara, which will allow for a fleet of 320 t capacity off-highway trucks to be operated without drivers. The system will be commissioned before the end of 2008 and is expected to be more widely deployed in new and existing RTIO operations by 2010.

A significant component of the ambitious Pilbara automation venture is the formation of



West Angelas train loading at dusk

an alliance with Komatsu to develop and deploy advanced Autonomous Haulage solutions. Rio Tinto and Komatsu have agreed to work together to establish an autonomous mining operation in the Pilbara.

Albanese said, "Komatsu has been the Rio Tinto Group's preferred supplier of haulage equipment for over ten years. Komatsu is our partner of choice in the development and deployment of autonomous haulage solutions and this alliance marks an important extension to our successful business relationship. Rio Tinto is committed to the development and deployment of integrated autonomous mine-to-port operations. We are closely focussed on supporting our Pilbara iron ore expansion through the application of world-leading automation technologies."

Rio Tinto is already using bespoke autonomous drill technology in the Pilbara to support the 'mine of the future' strategy. A number of key technologies have been introduced on a staged basis, beginning in 2006 with the development of the autonomous drilling rigs for the Pilbara.

In early 2007, Rio Tinto established and funded on a long term basis the Rio Tinto Centre for Mine Automation in partnership with The University of Sydney. Under this partnership Rio Tinto has secured exclusive access to world renowned robotics experts dedicated to addressing Rio Tinto's 'mine of the future' opportunities. This year RTIO will start running extensive trials at dedicated mine test site. Trials will combine the Komatsu Autonomous Driverless Haulage System with a range of other advanced remote control and autonomous technologies in order to provide an industrial scale proving ground and template. Experience gained by the business will allow for further deployments in the Pilbara in 2010 and will also have application at other Rio Tinto mines.

HighGrade quoted one, unnamed industry expert saying: "The autonomous trucks that are running around the world, I would say quite successfully – and Komatsu are leading the way – have to have a quarantined area. Without it there is no guarantee of consistency."

HighGrade went on to say the 'quarantine' experiment by Codelco at Radomiro Tomic in northern Chile is now leading to that company's introduction of the first fleet of fully automated haul trucks at the nearby Gaby mine in the Atacama Desert, where production is gearing up in the first half of this year. Codelco has been able to reduce its truck fleet to 11 Komatsu 930E 300-t payload units

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because, it says, the trucks demonstrated at Radomiro Tomic they could work more hours per day than manually operated units. The \$3.6 million trucks at Gaby will haul ore along programmed routes, guided by GPS technology, and are expected to deliver fuel, and repair and maintenance, cost savings.

Iron horses

Studies are being finalised on the application of the Automated Train Operations (ATO) technology in a heavy haul capacity and are expected to lead to significant efficiency benefits. Mainline trials conducted with the Western Australia Office of Rail Safety have progressed well and a decision on the next stage of the project is expected in mid-2008. Automated rail management is the first major operation scheduled to be run from the ROC

Richard Cohen, General Manager Rail Operations – Iron Ore explains that the rail system (1,200 km of track) is an integral part of product blending from multiple mines. It is also key to the logistics chain. The backbone (170 km) of the network is already dual tracked and all trains are operated by one driver only. The average cycle time is some 35-36 hours. He says the “trial of automatic train technology is well advanced.”

Ore is railed from nine rail load-outs to five dumpers, three at Dampier and two at Cape Lambert. For RTIO to ship 220 Mt/y the rail system has to achieve:

- 600,000 t/d or 4.2 Mt/week
- 28 trains per day
- Finish unloading a train every 50 minutes
- Train movement every 25 minutes.

The gross mass of each train is 29,800 t for the Pooled Fleet System and 20,000 t for the Mesa J System 20,000 t. Each train is up to 2.4 km long and consists of two GE Dash 9 locomotives hauling 230 ore cars (Paraburdoo, Yandi and West Angelas – the pooled fleet) or three GE Dash 9 locomotives hauling 150 ore cars (Robe, Mesa J).

Approximately 800km of mainline track is signalled with the Integrated Control Signalling System featuring:

- In cab signal indications
- Continuous update of driver's limit of authority
- Train location and route data transmitted to train from track transponders
- Automatic train protection for full speed and limit of authority supervision
- Computer based train control system with real time train scheduling capability along the rail network.

The train control system is located at the 7 Mile yard facility and is responsible for about 120 trains per week, servicing ten mines. It allows the train controller to issue commands about switch or point movement and limit of authority changes. The controller receives confirmation that the command has been received and actioned all within one second. Commands are sent via a microwave/radio or fibre optic system to vital signalling equipment.

The ATO involves leading edge technology for heavy haul and freight rail and has taken two years of R&D. Its control system will be an extension of the existing advanced signalling systems. Trials are well progressed with, by mid-January, more than 70 successful runs of full trains on the main line. If the trials are successful, automated trains will be progressively introduced. ATO will support further expansion and help manage the skills shortage. A decision is expected to be made by April 2008

Rio says “The ‘mine of the future’ program will provide opportunities for technology driven performance improvements to support RTIO’s announced plans to take annual global iron ore production beyond 600 Mt. *IM*

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