



Manta, a new control mantra

ControlLogix joins forces with the advanced process control algorithm 'Manta Cube' to achieve operational stability on a closed-loop single-stage SAG mill at Western Australia's Gold Fields St Ives gold mine.

'EXPERT control' is an area of process control often shrouded in mystique. Typically used to control complex multi-variable process applications, these so-called 'knowledge-based' control systems are founded on a wide range of predictive, adaptive and learning algorithms. In the main, the traditional standalone expert control system is complex, costly and often a proprietary-platform 'black box'.

Yavuz Atasoy, Metallurgical Superintendent at the Gold Fields St Ives mine in Western Australia, holds strong beliefs about the use of any control systems – expert or otherwise. "We hear many stories about sites implementing 'trial' expert control systems that ultimately spend much of their time switched off by the operators," he says. "We believe that an expert system utilisation should be 100 per cent as a minimum! Acceptance by the operations team is the key issue here. Our view is that if the

controller is really doing its job, it should never be turned off."

Atasoy, who heads up the mine's Lefroy gold processing mill, is well qualified to make this comment. He and his team have recently deployed an advanced multi-variable control system to control the Lefroy mill's centrepiece – its 11m-diameter semi-autogenous grinding (SAG) mill. A key indicator of the success of this deployment is that the new control system runs continuously. The mill operators demand and depend on it.

Developed on the Rockwell Automation ControlLogix plant automation platform, the SAG mill's new control system uses a unique process control algorithm called the 'Manta Cube'. Developed by South Australian process control engineering group, Manta Controls, the Manta Cube is an innovative alternative to the traditional expert system. At the Lefroy mill, the Manta Cube accurately mon-

itors and responds to the dynamic behaviour and multi-variable nature of the SAG mill and its associated processing circuit. To make this happen, Manta Controls has taken advantage of the unique advanced process control functionality of the mill's existing ControlLogix platform, coupled with the open nature of the ControlLogix development environment.

Closed-loop SAG

Commissioned in 2004, the Lefroy mill was part of an A\$125 million upgrade at the mine. Located at Kambalda, 80km south of Kalgoorlie, the Lefroy mill comprises four main process circuits: comminution (crushing, grinding and classification by cyclones), gravity separation, leach/adsorption, and carbon handling/electrowinning. The comminution circuit largely comprises primary crushing, coarse-ore storage and feeding, a bank of ten hydrocyclone classifiers, and the SAG mill – an enormous tumbling mill mounted on load-cells and powered by a 13MW wrap-around drive.

Control-system wise, the entire Lefroy mill is handled by a Rockwell Automation Integrated Architecture solution. A total of seven separate ControlLogix plant automation systems support all mill control applications. These are coupled with Rockwell Automation's advanced RSVIEW Supervisory Edition (SE) PC-based human-machine interface (HMI). Integrated Architecture's NetLinx open network communications architecture ensures that the plant-wide automation system is linked end-to-end – primarily using ControlNet to achieve controller-to-I/O rack connectivity, and EtherNet/IP for peer-to-peer and controller-to-HMI connectivity.

The prime objective on any SAG mill operation is to adjust the various process parameters (mill in-feed, SAG mill speed, cyclone operations and pressure, and so on) to ensure that the SAG mill weight remains as close as possible to the target weight. Maintaining the mill weight to set point as close as possible ensures precision control of the key parameters that impact on mill throughput: grind/particle size, product density and tonnage throughput. In short, it impacts directly on the production bottom line.

Post commissioning, Atasoy noted problems with the SAG mill's operations – both in the way it was operated, and the throughput. "With an

open-circuit SAG, operation is relatively straightforward," Atasoy says. "The challenge here at Lefroy is that the SAG mill is in closed loop with the cyclone underflows and the pebble crusher. We also don't have a ball mill, so the SAG mill does all the grinding. As a result, it is a very challenging process control situation."

Atasoy noted a lack of stability in the operation of the mill, and a critical need to micro-manage the mill operations. "We don't blend the ore to make the feed uniform at Lefroy," he says. "We have the ore feed coming from different sources, which means they have different hardness, mineralogical compositions and grades. This coupled with the unpredictable nature of the SAG mills closed-loop feed, made it very difficult to control the SAG weight on a sustainable basis."

The inherent instability impacted severely on the operations procedure and mill throughput. "The mill operators had to keep a constant eye on the grinding circuit to ensure continuity of the operation without creating spillages or stoppages. They needed to be there all the time, playing with the operational parameters to achieve target KPIs, such as grind size, tonnes per hour and density" says Atasoy. A further goal was to achieve SAG mill design throughput – 550 dry tonnes per hour – in a sustainable and stable manner. "We were occasionally achieving 550, but it wasn't stable. We really needed to see stability, even with the disturbances that were coming into the mill," he says.

Open platform; collaborative development

Immediately after commissioning the mill, Atasoy approached managing director of Manta Controls, John Karageorgos, to discuss potential solutions for the mill. High on his list was a system that would not only achieve the SAG mill stability goals, but would also win wide acceptance with the operations and maintenance crew.

The Manta Cube impressed Atasoy and Lefroy mill programmer/comms tech, Craig Waywood, first and foremost because it could reside on the existing ControlLogix controller platform. "We were really attracted by the fact that we could apply Manta Cube step-by-step and customise it to our conditions," Waywood says. "By being embedded in the open platform ControlLogix controller, it allowed

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our people to work closely with Manta Controls and be involved in the Cube's development."

The powerful Manta Cube is made up of four distinct parts: 'the Cube', which determines the SAG mill operating mode; the Cube 'expert decision matrix', which determines what is required to return the SAG mill to the required operating band; the Cube 'engine', which handles the core multi-variable control and decoupling techniques; and the Cube 'optimiser', which optimises the key control objectives, such as SAG mill output.

Karageorgos explains that application of the Cube algorithm demands specific high-end process control functionality. "We need two development tools to make the Cube happen: a high-level text-based code development environment, plus a rich library of pre-configured process control function blocks. We cannot do without either of these," he says. The need for a text-based code development environment is met by the ControlLogix platform's Structured Text offering. This high-level language allowed Manta Controls to tailor the Manta Cube's 'optimiser' routines.

The need for process control function blocks was easily met by ControlLogix's process Function Block library—a broad library of over 50 pre-configured process control instructions, such as the PID enhanced (PIDE) controller, lead-lag, logical instructions, alarms, select/limit instructions, scaling, multipliers and so on. These blocks were essential to allow Manta Controls to build the Cube's 'engine'.

In all, Manta Controls spent around one and a half years at the site, first installing the Cube, then 'retuning' the mill controls. "We wanted it that way," says Atasoy, "We wanted our people to follow it all, step-by-step." Manta Controls installed the first



The Lefroy mill's centrepiece is the 11m-diameter SAG mill, which utilises an advanced multi-variable control system.

Cube on the SAG mill in mid-2004, then, when things started to stabilise, began work on the remainder of the mill loops. "It's like tuning a piano," Karageorgos says. "You have to be systematic."

New age process control

Surprisingly, neither Karageorgos nor Lefroy's Waywood had worked with the ControlLogix platform prior to the Lefroy SAG mill upgrade. Both were well experienced in process control, and both were long-term users of distributed control systems (DCS). "I was aware that ControlLogix could handle process control, but unfortu-

nately, these functions weren't used in the mill at initial commissioning," says Waywood. "I've been pleasantly surprised by ControlLogix functionality, most particularly the functionality of the PIDE block."

Both Waywood and Karageorgos point to the ease with which ControlLogix met accepted process control operational protocols: it has a globalised tag system that is independent of controller and I/O hardware, advanced process control functionality such as PIDE control, and seamless connectivity with the RSView SE HMI platform.

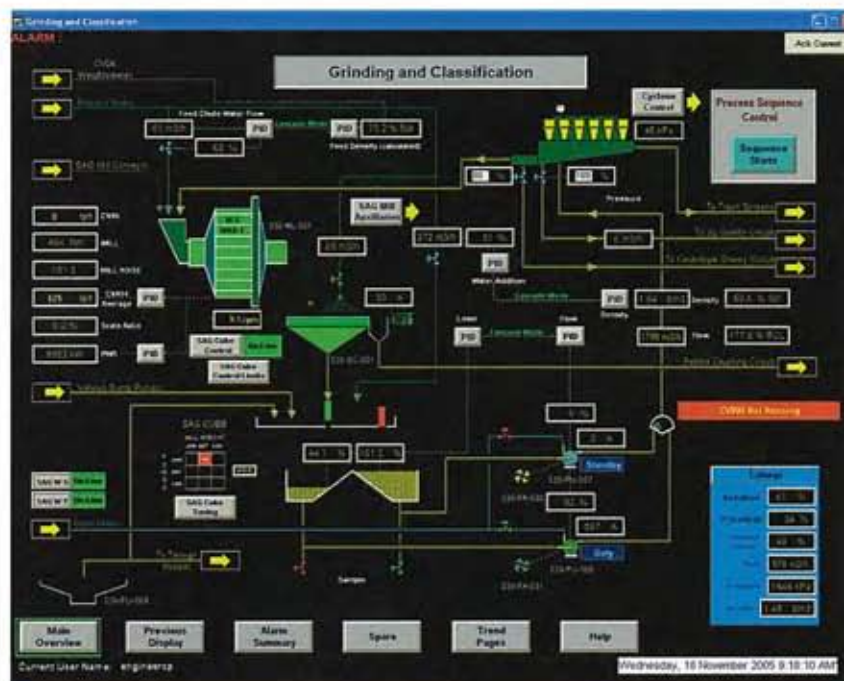
Karageorgos found the transition from DCS to ControlLogix a very

positive move. "ControlLogix provided the required flexibility during Cube development," he says. "By contrast, the legacy DCSs demand a certain structure – deviation from the structure is sometimes not possible."

A case-in-point he cites is achieving bumpless transfer during cascade/auto switching on a cascade loop configuration involving a calculation between the inner loop and outer loop. "You can't do this on some legacy DCSs, but you can with the ControlLogix PIDE function block. You simply tell the block what value to track," he says.

He also points to the ease of config-

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Yavuz Atasoy, metallurgical superintendent at the Gold Fields St Ives mine (standing), and Craig Waywood, programmer/comms tech.

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uration using the RSLogix 5000 configuration software. "It's neat and easy to use. It actually lays out the program so that you can easily see what is going on in terms of fault-finding. It's nice to work on ControlLogix – using the ControlLogix Structured Text is a lot quicker than using the equivalent coding systems of legacy DCS," he says.

Upbeat control room

The success of the Lefroy SAG mill Manta Cube is immediately obvious. The stability realised in throughput, density and product grind size – even under significant production disturbances – has impacted right through to the Lefroy leach circuit. The SAG mill now exceeds its 550 dry tonnes per hour design throughput in a stable and sustainable manner, and its weight histograms indicate a post-commissioning narrowing of the mill weight operating band of around 40 per cent. The overall process stability extends well beyond comminution to the entire mill, resulting in a measurable 6.1 per cent increase in treated ore throughput. All this can be directly attributable to the innovative Manta Cube control algorithm.

While these metrics are important, the acid test for any control system upgrade is, according to Atasoy, how well accepted it is in the control room. "The mood in the control room is greatly improved," he says. "The operators don't have to sit and play with the set points all the time. It's basically a hands-free operation now, and operators are free to focus on other parts of the circuit – not just the SAG mill. We are producing more treated ore with less labour."

Once a certain level of stability was achieved in the SAG mill, Manta Controls turned its attention to accurately tuning the control loops in other criti-

cal mill areas, and balancing the operation of the classification circuit's hydrocyclones against the SAG mill output.

A major success was achieved by Manta Controls with the hydrocyclones. Prior to this work, poor cyclone feed pressure control was resulting in frequent pump breakdowns, and labour-intensive cyclone operations. By more accurately tuning the classification circuit loops, the pump failure frequency has been cut to 25 per cent. Equally important, the hydrocyclones now exhibit the same stability that has been realised across the entire mill. They require minimal manual intervention for stable operation. "We now rely far less on operator judgement as to when hydrocyclones need to be turned off and on – we can simply leave them running if they are mechanically available," says Atasoy.

Support essentials

Technical support is an essential element in the ongoing success of the Manta Cube at Lefroy mill – both from the system integrator's and site personnel's perspective. With the Lefroy mill located 600km from the nearest capital city, the mine elected to subscribe to Rockwell Automation's TechConnect technical support program. "We joined TechConnect from day one," says Craig Waywood. "It's very good, particularly the 24X7 support. I don't use it much now, but post-commissioning, it was very valuable."

"ControlLogix gives us everything we need," says Karageorgos. "It's a vendor supported product backed by a company with global reach – this is an essential for us. The Manta Cube is now seen as a real alternative to conventional expert control, and we are currently fielding queries from around the world. It's reassuring to know that wherever Manta Controls is in the world, we can rely on Rockwell."