AMC CONSULTANTS

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DIGGING DEEPER

AMC ADVANCED TECHNOLOGY

AMC is pleased to announce the establishment of AMC Advanced Technology, a new business unit that will enhance the delivery of technology to AMC's clients around the world. It will interest mine operators, mine designers, equipment suppliers, business improvement units and university researchers, while providing an exciting environment for AMC's consulting staff to extend their skills and pass on their experiences.

Advanced technology means different things to different people in the mining industry. To professionals working in modern mines it may mean new equipment, software, automation or new mining and processing techniques. However, half of the world's mining industry simply wants to attain the standards presently enjoyed in the more technologically advanced nations. In many parts of Eastern Europe, Central Asia, the Subcontinent, and China for example, access to the latest equipment is not helpful unless it is combined with improved mine access, materials handling, planning, scheduling, and maintenance.

Aran Paste Plant at Kencana – Gosowong

AMC Advanced Technology will address the needs of all industry participants. At the most advanced level it will lead or participate in research related to:

- Exploration and resource assessment.
- Open pit and underground mining.
- Mine scheduling and optimisation.
- Mine automation.

Projects under way include participation in rock drilling, underground processing, and mine optimisation research. While completed projects include research into backfilling techniques, orepass design and inspection, longwall support, microseismic monitoring, residue disposal, and flow of caving material. There have also been independent reviews of many research projects carried out by others, including novel rock breaking techniques, conveyor systems, new rock drill designs, trial stoping methods, rapid mine development, and shaft sinking.

At the next level, AMC Advanced Technology will assist clients to integrate the new technologies into existing operations, or design new operations around those technologies. This activity includes assisting equipment suppliers to understand the operational context in which new and automated technologies will be operating. For example, AMC is working with suppliers and operators of automated mining equipment at several mines on three continents to ensure that the potential benefits of automation are realised.

For older operations, AMC engineers bring decades of experience of the transition to more mechanised techniques, helping clients to choose appropriate technology while avoiding the pitfalls that others have encountered along the way. AMC is doing this as part of expansion and optimisation studies at many mines around the world. For example, the very successful expansion of Hindustan Zinc's Rampura Agucha open pit mine is now being followed by expansions of the group's underground mines, which involve integration of new equipment with access, haulage, and stoping techniques.

Thus AMC Advanced Technology can deliver new (sometimes unproven) and developing technologies to push the boundaries of performance, or transfer proven and sound technologies to enhance older or less advanced operations. AMC has for some time been a global leader and employer of choice for people interested in advanced mining technologies. AMC Advanced Technology will provide a focus both internally and externally to further develop this leadership. With one of the largest independent groups of experienced mining professionals on the planet, AMC has the capacity to support its clients' requirements and to make a solid contribution to the industry as a whole.

Areas of interest for the near future include remote mine planning and operation, autonomous loaders, trucks and drills, "zero exposure" underground mining, underground processing, and small-scale selective underground mining. AMC is negotiating relationships with interested parties.

For further information contact Peter McCarthy.

AUTOMATED UNDERGROUND MINING – HOW TO GET THERE

Automated production drills have been available since the mid 1980s, although at that time rig relocation and bit changing remained manual operations. INCO trialled bit changing and remote tramming on their Tamrock production drills in the late 90's, but these functions are yet to gain widespread acceptance. Automated LHDs are now commercially available, although automation of the dig cycle is a problem in anything but very well broken rock. At Olympic Dam mine, LHD automation produced an extra 2.4 hours per shift of production by operating the loaders manually and then swapping to automated mode during shift changes and crib breaks. Automated trucks have operated reliably at the Finsch mine in South Africa for some time.

Longwall coal mines achieved partial automation of a relatively repetitive (continuous) mining system in small steps by automating one easily defined machine operation or task while the rest of the operations remained manual. Debugging and redesign continued until the automated operation achieved the required degree of reliability. Then the process was repeated for another candidate for automation. Over several years, a reliable and integrated partially automated system was built.

By contrast, in drill and blast operations, the cycle of activity currently requires human entry and intervention for many tasks ranging from geological sampling to the relocation of pumps and electrical supplies. There has been no attempt at automation for a large number of tasks. Narrow vein mining operations such as those in South Africa are just beginning to make significant inroads into mechanisation, an obvious precursor to any consideration of the application of automation.

It is generally accepted that for safety reasons humans should be prohibited from entering an automated mining environment. Electronic lockouts or physical barriers ensure that the automated systems shut down before humans approach them for inspection, maintenance, or to perform tasks in their vicinity. These lockout measures have limited the use of mobile mechanised equipment to the production phase of block caving operations.

Typically only 50–60% of underground employees are direct operators of equipment and any labour saving through automation will be largely offset by the need for specialised maintenance support. Some productivity improvements are possible, notably at shift changes, but automation will be justified based on the improved occupational health and safety benefits.

Fully automated machines must be able to detect and correct their own operating problems. However, the automobile manufacturing industry does not currently consider this cost-effective, and has found that partial automation achieves 90% of the benefits of full automation. It seems

Mine Rescue Robot
The robotic vehicle, developed by U.S. Department of Labor, Mine Safety and Health Administration, can travel through an underground mine in conditions that might be unsafe for miners to pass through.

MESSAGE FROM THE MANAGING DIRECTOR

There are three big challenges facing our industry in Australia today. On is physical – maintaining and adequate supply of good-quality water. The second is political – the carbon trading scheme, effectively a tax that our competitors will not bear. The third is demographic – we don't have enough skilled and experienced people. Each of these problems will get much worse before it gets any better.

Climate change is real; geologists know that the climate has always changed and always will, and sea levels have gone up and down. It is probably getting warmer at present, though we don't know that for sure, and if the cooling trend of the last few years continues, the climatologists will be able to explain that in retrospect. It is definitely drier now than it was in the 1860s and 1870s when water-wheels were installed to drive quartz-crushing batteries right across central Victoria and the Gippsland goldfields. The current shortage of water is possibly reflected in the price of $8.50 per litre of bottled water charged by leading hotels. At that price, and assuming a tonne of water per tonne of ore processed, your next processing plant will have an operating cost of $8,500 per tonne for water alone!

The low-margin projects that shut down because they cannot afford the carbon trading cost may well be some of our cleanest and most environmentally friendly metal producers and aluminium smelters. The lost production will be immediately picked up by China and other countries using coal-fired power, discharging far more carbon than the plants that were shut down.

I get excited about big ideas like project-specific concentrated solar energy plants, or the range of 10 to 50 MW modular, transportable nuclear power plants that are in various stages of design and development around the world. The Russians are likely to be first with their barge-mounted nuclear plants, as the technology already exists in their submarine fleet. I also like Codelco's huge Andina processing plant that is built entirely underground, and Gecko's new modular Python plant which also saves energy by avoiding the need to raise large tonnages to the surface. At the other end of the scale, the greatest energy saving technology that impacts on me personally is the little set of wheels on my suitcase.

The externalities we face – the water shortage, political forces and skills shortage, will have a far bigger effect on our industry than anything you or I can do in our own area of expertise and responsibility. However, the difference between progress, growth and improvement on the one hand and regression, recession and ultimate failure on the other, is just a few percent of annual performance. Each of us can contribute a small part of that increment, and between us we can change the world we live in, as long as we don't forget what we already know in the process of generational change, as long as we adapt our technology to meet the real challenges, and as long as we keep our politicians in check. We might have to settle for two out of three.

Peter McCarthy
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unlikely that a transition to a fully automated environment will be possible unless mining passes first through an intermediate phase that enables the development of the platform technologies to a satisfactory level of reliability, a process that is likely to take at least two decades.

During this intermediate phase, non-repetitive manual tasks such as sampling, surveying, maintenance, and installation of services will be progressively mechanised and controlled by operators using adaptable multi-purpose manipulators from a specially designed cab on a general-purpose machine. These tasks could then progress to tele-remote operation and form part of the concept of a fully automated mine. They are however unlikely to attain a point where humans do not intervene in their cycle.

General-purpose vehicles will be fitted with falling object protection systems, rollover protection systems, and collision avoidance systems that communicate continuously with all other vehicles in the vicinity. Effectively the mine environment will be treated as hostile and a mobile safety capsule will be provided for all personnel entering that environment, in much the same way as is provided for workers in undersea or outer-space environments. Operators will remain within the vehicle cabin for the entire duration of a task or shift, and an alarm on the vehicle door will warn a control room operator and shut down operations if the door is opened while in the active operating area.

Machines such as drill rigs, trucks and loaders can be readily adapted to such specifications and in many other cases the capsule will be a robust four-wheel drive vehicle with general-purpose and specialized manipulators. Some applications are straightforward while others such as routine and breakdown maintenance may require fundamental changes in machine design. The primary intent is that if personnel are not outside vehicles then vehicles or rocks cannot strike them – any collision or impact is avoided or absorbed by the vehicle protection systems. Other safety benefits include removing personnel exposure to fumes, dust, radiation, heat, lifting and pinching hazards and uneven and slippery surfaces.

Consider the non-repetitive task of placing a portable pump in a sump using a hydraulic crane mounted on a flat bed truck. The operator stands beside the truck to operate the crane and then connects the pump manually. Automation of this process would require a redesign of the electrical and water couplings and the development of a sophisticated manipulator enabling remote unloading of the pump and then connection of the discharge line and power cable. An operator could use the same manipulator to perform many other tasks if it is of a universal design.

The first critical milestone will be to remove people from exposure to the underground mine operating environment by enclosing them in specially designed cabs. This will probably achieve the majority of any productivity and safety benefits gained from full automation in any case. It then becomes a question of when (or if) progression to tele-remote operation and full automation is desirable.

Substantial funding, strong leadership and belief in the vision of an automated mine system will be required from the industry.

This is a summary of a paper prepared for the AusIMM Future Mining Conference 2008 by

David Noort of Momentum Partners and Peter McCarthy of AMC Consultants.

PROMOTION

Clay Wittchen

Clay has recently been promoted to Principal Mining Engineer located in the Brisbane office. With more than twenty years experience in the industry, Clay's areas of expertise include managing all mining engineering aspects in very technically challenging conditions, shaft sinking and uranium mining. He has experience in writing and managing contracts and budget preparation. Since joining AMC in January 2008, Clay has been involved in such interesting projects as providing assistance with the designing of the trial sub-level open stope at PTFI's Big Gossan Mine in Indonesia and investigating potential alternative (non-conventional) mining methods for BHP Billiton Diamonds Ekati operation in Canada. He has also provided some assistance on another Canadian project and will be working on a project reviewing a potential uranium deposit in Europe.

NEW EMPLOYEES

Anthony Stepcich

AMC is pleased to announce Tony Stepcich has joined AMC as Principal Mining Engineer based in Brisbane. Tony has 16 years experience in mine planning and production in underground and open pit environments. Tony's main expertise includes planning, modeling, scheduling, dewatering and blast design in underground and open pit mines. Tony has postgraduate qualifications in economics and finance and has spent 3 years working as a mining analyst in Sydney.

Mort Shannon

Mort recently joined AMC's Vancouver office as Principal Geologist. He has returned to Canada after 5 years working as Chief Geologist at Barrick's Porgera Gold Mine in PNG, and living in Australia. Prior to Porgera he had been in Canada where he worked in senior geological roles, for Placer Dome and Billiton. In his career in the business he has worked in a variety of production situations and explored for different commodities in various geological environments, around the world. His main expertise is managing production and exploration activities.

Charles Hastie

Charles joined AMC in July 2008 as Principal Mining Engineer. Charles' expertise lies in the design and operation of both open pit and underground mines. He has broad experience in gold, iron ore and base metal (zinc, copper and nickel) operations in both planning and management roles. In these various roles, he was responsible for ore reserve reporting, equipment selection and specification, pit design, underground design, scheduling, budgeting and mining operations management.

Sonia Konopa

Sonia recently re-joined AMC as a Principal Geologist in the Brisbane office. Sonia's areas of expertise are technical data collection protocols and management, 3D geological modelling, geostatistical analysis, resource estimation and resource project auditing and management. Sonia has more than 20 years experience in exploration and resource evaluation geology in gold, base metals and iron ore commodities.

Christopher Sykes

AMC is pleased to announce that Chris Sykes has joined AMC as Principal Mining Engineer based in Adelaide. Chris is a mining engineer with over 17 years experience. He has broad experience in due diligence reviews, feasibility studies, open cut design and scheduling, mining contract preparation with specialist capabilities in industrial minerals, uranium and mineral sands.

Ian de Klerk

Ian recently joined AMC as Principal Geologist in Brisbane. Ian's area of expertise is in resource and reserve estimation for coal, coalbed methane and uranium. He also has extensive experience in technical reviews and auditing, scoping and feasibility studies and due diligence and valuation work. He also has experience in project scheduling and management, economic appraisals, life-of-mine strategic planning, joint venture negotiations and geostatistics, and is an expert in the use of MineScape and Minex geological software. Ian was formally a member of the SAMREC sub-committee on coal.

Alyn Evans

Alyn recently joined AMC as Principal Mining Engineer, in the UK Office. With more than 40 years experience in the mining industry, Alyn has an in depth understanding and extensive working knowledge of mining techniques and methodology. As a senior manager and director, he has experience of, and a sound approach to, general business administration. Working mainly in the coal sector, Alyn's particular areas of expertise are underground layout and design. He has successfully opened mines from greenfield sites, and managed large, international workforces. He has solid mining and earth moving experience in many countries including the UK, Ireland, Nigeria, India, Egypt, Australia, Papua New Guinea and Germany.

Philip Rosengren

Phil joined AMC's Melbourne office in late September as Principal Geologist. Phil has been involved in many aspects of exploration for a wide range of commodities and deposit types in Australia, New Zealand, SW Pacific and Asia since the mid 1970's. His expertise is in exploration project assessment, generation and management.

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