UNDERGROUND MINING

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New Projects
Roughly 56% of the world's underground mines are in North America, South Africa, and Australia. According to Ken Owen (Anglo American's senior vice president mining – South America), speaking at the *MassMin 2000* conference in Brisbane, underground mines yield 30% of the world's copper, 40% of its gold, 45% of nickel and 65% of its zinc, with a total value of up to US$20 billion.

In Australia, the current total of 68 underground mines produce approximately 61 Mt/y of ore, and employ 10,400 staff (including contractors). Around 59% of mines are gold producers, and 56% of mines are in Western Australia (Australia's *Mining Monthly - Underground Equipment & Technology 2000*, special issue for *MassMin 2000* conference).

The following comments on a selection of new, expanding or developing mining projects are from back issues of *Mining Journal Ltd* publications:

- Codelco, the owner of the world's largest underground copper mine, El Teniente (Chile), announced in August 2000 a 37% expansion to raise copper output from 350,000 t to 480,000 t/y, starting in 2003. Investments will total US$422 million.

- Anglo American (60% ownership) plans to invest US$523 million in Konkola Deep (Zambia), which is probably the largest undeveloped underground copper resource in the world (344 Mt at 3.8% Cu).

- Development is on-going at the South Deep gold project (South Africa), operated by Western Areas Ltd (50%-owned by Placer Dome). The mine will have the world's longest single-drop shaft.

- Palabora (South Africa; Rio Tinto 48.6%) committed US$185 million in 1996 to underground development. The transition from open pit to underground production will occur over the next two years, as production from the new underground block cave increases. Output will be about 30,000 t/d of copper ore, extending the mine life for 20 years. The new underground mine is one of most technologically advanced underground projects in the world.

- At De Beers' Premier Diamond mine (South Africa) a decision to proceed with the C-Cut expansion and start shaft sinking is expected soon. The project requires two new vertical shafts to a depth of 1,200 m. The total capital cost, including new plant, could be US$400 million.

- Anglo American plc committed an initial US$240 million at the end of 1999 at Flin Flon (Manitoba, Canada), operated by Hudson Bay Mining and Smelting. The funding will extend the mine life to 2016, and includes the development of the Triple Seven group of ore bodies. A new shaft is 60% complete, and the first ore is due in 2003, at a rate of 1 Mt/y. Total capital expenditure by 2016 could approach C$1.0 billion.

- Construction was completed in April this year at Barrick Golds' Bulyanhulu mine (Tanzania). The US$280 million gold project begun in late 1999. Production has commenced, and will reach 0.4 Moz/y in 2002.

- Bafokeng-Rasimone (South Africa) is a new mine being developed by Anglo Platinum, and will produce 250,000 oz/y of platinum group metals (PGM).

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Construction is scheduled to be completed in 2002. The project is part of a major US$1.8 billion expansion to lift annual platinum output from 2.0 Moz to 3.5 Moz, through new mines and expansions. By 2004, Maandagshoek should also be in production.

- Northam Platinum Ltd (South Africa) is expanding its underground UG2 PGM-Au project from 270,000 oz/y to 370,000 oz/y, using mostly existing infrastructure, although a new shaft has been constructed.

- Rand Merchant Bank approved R345 million financing for a new underground PGM project at Messina (South Africa).

- At the Black Mountain base metal mine (South Africa), Anglo American approved a US$110 million new shaft in May 2000. This will extend mine life until 2013.

- In Australia, a decision is still awaited from Rio Tinto regarding the possible new underground diamond mine at Argyle.

- Rio Tinto's acquisition of North Ltd included the Northparkes Mine (Australia), and the group approved development of the Lift 2 block cave mine, directly beneath the existing Lift 1 operation. The Lift 2 mine extends the application of leading edge technology to underground mining, and the layout includes a number of refinements of the Lift 1 design.

- In Europe, production capacity at the Lisheen mine, operated by Anglo Base Metals (Ireland), will be 300,000 t/y of zinc concentrate, plus 40,000 t/y of lead concentrate, from 1.5 Mt/y of ore. The shallow US$280 million mine produced its first ore in September 1999 and was officially opened in June 2000. Water ingress problems have had to be addressed.

- An 800 m decline has recently commenced at the Storliden zinc project (Sweden), owned by North Atlantic Natural Resources, in a joint venture with Boliden. Production is to commence early in 2002, producing 25,000 t/y of zinc in concentrate and 10,000 t/y of copper in concentrate. The project has a low capital cost of US$16 million, and the concentrates are to be treated at the Boliden mill. Boliden also continues its expansion of the large underground Kristineberg Zn-Pb-Au mine (Sweden).

- The US$248 million Au-Ag-Pb-Zn Olympias project, owned by TVX Gold Inc. (Greece), received EIS approval in September 2000.

- In Peru a range of expansion programmes are in progress at the Carahuacra/San Cristobal/Andaychagua mines in the Yauli distract, plus the Cerro de Pasco mine in Pasco Province. All these zinc/lead/silver operations are owned by Volcan Compania Minera.

- In Canada, De Beers has filed an application to develop the Snap Lake underground diamond mine. The operation would produce 3,000 t/d over a mine life of 20 years, and production is expected to commence in 2004.

- Inco has approved the US$48 million deepening of the Birchtree nickel mine in Manitoba. This follows work by an employee co-design team which demonstrated that operating costs could be reduced by 25%. The production is to increase from 1,635 t/d to 3,175 t/d, and mine life is extended to 2016.

- Barrick continues to expand its properties at Goldstrike (Nevada), including the Meikle underground mine. Production for the area will reach 2 Moz/y.

- Cominco is to re-build the mill, and re-open the Pend Oreille zinc mine in

Washington. The US$70 million two-year programme includes a new 380 m internal shaft. Production start is scheduled for 2002, at 97,600 t/y of zinc concentrates, and 14,300 t/y of lead concentrates, over a mine life of 10 years.

- Expansions at Stillwater (Montana) are scheduled to achieve 575,000 oz/y of platinum and palladium, at cash costs of between US$155-175/oz. The expansions include developing new areas at Stillwater itself, together with new engineering studies at the East Boulder project.

Information Technology

It is perhaps appropriate that the first edition of *Mining Annual Review* in the new millennium should focus on new technologies which have the potential to change radically the way we mine in the future. Aside from continuous improvements in bigger and better equipment, the industry is also seeing a sharp increase in new, sophisticated technologies being successfully applied in equipment automation, remote sensing, IT and communications, and others. As suggested by Mike Hood and his colleagues at the Cooperative Research Centre for Mining Technology and Equipment (CMTE) in Brisbane (*Mining Magazine*, October 1999), mining in 2015 could be very different, though it is perhaps likely that in that time frame only industry leaders and major mining operations would have wholeheartedly adopted the new technologies. As Mr Hood notes, basic mining operations such as rock breakage will remain, but equipment such as drills, LHDs and trucks are likely to be in the process of being replaced by continuous, intelligent, semi-autonomous mining systems.

One of the most notable features of the global economy in 2000 was the dramatic rise, and in many cases fall, of the dot.com ventures. The mining community entered the e-commerce fraternity with a number of ventures in 2000, most notably the launch of the mining world's largest on-line marketplace. Based in the US, *Quadrem* (www.quadrem.com) had by year-end 18 shareholders, including notably Rio Tinto, Alcan Aluminium, Anglo American, Barrick Gold, BHP, Codelco, De Beers, Inco, Newmont Mining, Noranda, Pechiney, WMC Resources, Normandy Mining and others. Each of the founding shareholders is expected to invest approximately US$100 million over the next 18-24 months. Whilst the turnout of equipment suppliers at the group launch was very encouraging, some suppliers remain sceptical, and the public debate continues on whether those involved will achieve the levels of savings suggested (*Mining Monthly*, December 2000).

In a similar development, an e-market collaboration between major mining houses Anglo American, Billiton, Glencore and Rio Tinto was announced in late 2000 (*Mining Magazine*, December 2000). The group is to develop a number of independent global commodity marketplaces, the first of which will be for coal in partnership with Internet specialists Accel-KKR. *Globalcoal.com* plans to begin trading in early 2001, initially focusing on the spot and tender markets in thermal (steam) coal. The participating mining companies have each committed to channeling coal through the site, and intend encouraging their customers to use it.

Other e-commerce mining market places which were launched included www.matrax.com, an e-procurement platform focusing on the African mining industry, developed between companies Mattrax Ltd, Ezee-Dex (a South African supplies catalogue publisher), and Corunna Systems, a UK-based software firm. Also, the E14 on-line procurement website was launched in mid-year – E14 is a collaboration between 14 mining companies, who state the site will offer buyers a large pool of suppliers, and facilitate purchases on a large scale (www.mmprocurement.com). 2001 will certainly bring more of these e-procurement ventures, but will the claimed benefits be realised?

Interestingly, Australia's Joseph Gutnick's planned on-line mining exchange with Primus Telecommunications folded in late 2000. A spokesperson for the Gutnick group was quoted as saying the project was on hold because the numbers didn't stack up (*Australia's Mining Monthly*, December 2000).

In the field of communications, Mine Radio Systems launched a new network system in late 2000. FLEXCOM CMTS is a high-speed (30Mbps) data radio frequency communication system with instant two-way voice, data and video communication (www.mineradio.com). At these speeds internet access is also available. The system integrates with site LAN/WAN's, and can be established by upgrading existing leaky feeder systems.

Mining Methods

The *MassMin 2000* conference in Brisbane, Australia, in October 2000 was a major event for the underground hard-rock mining industry, and was very well attended, with over 330 delegates, from 19 countries. The success of the conference prompted organisers to cut the previous interlude between MassMin conferences by half, with the next conference to be held in Chile in 2005. The technology updates presented included robots in mines, 'smart loaders', digital data transmission, and e-procurement.

A number of major international underground mining projects were discussed at the conference, including the expansion of Olympic Dam in Australia, construction of the Palabora block cave mine in South Africa, the Deep Ore Zone project at PT Freeport Indonesia, deepening of De Beers' Premier Diamond mine in South Africa (the mine is currently evaluating the feasibility of producing 9 Mt/y from a block cave at 1,100 m below surface), further development of El Teniente in Chile, and rejuvenation of the Henderson molybdenum mine in the US. *MassMin* was covered in detail in *Mining Magazine*, July 2001.

The *MassMin* 2000 conference coincided with the completion of the first three years of research for the International Caving Study (ICS), funded by a number of major international mining companies including Rio Tinto, De Beers, PT Freeport Indonesia, Newcrest, Codelco, and Noranda. The ICS has apparently generated a number of important advances, particularly in respect of site characterisation for caving methods of mining, including cavability, fragmentation assessment and block cave design, though the industry at large is yet to benefit. One outcome which will ultimately be available to the global industry is a 'Handbook of Caving Methods'. The second stage of the project is now in progress.

At the other end of the underground mining scale, the Canadian Government is funding a CANMET three-year project investigating methods for improving the efficiency of narrow-vein mining. The team, based at CANMET's experimental mine in Quebec, has visited numerous narrow-vein mines in Canada, and the resulting database will be used to determine operators' needs for mechanisation and automation of the methods and equipment. According to *Mining Journal* (July 14, 2000), new ideas such as improved mining sequences and new equipment have already been identified, and may lead to specific R&D projects of their own.

An interesting paper by David Diering (*CIM Bulletin* January 2000) dealt with Mining at Ultra Depths in the 21st Century, based on an actual deep level project under evaluation by Anglogold. The issues include methods of access to the orebody, technologies for safe mining, risks and economics. The critical technologies are being examined by the 'Deepmine' research programme, a partnership between the South African Government, CSIR-Miningtek, the University of Witwatersrand and several mining houses. Other papers in the same issue dealt with deep mine ventilation and cooling and extraction technologies.

Drill and Blast

Dyno-Nobel's *Generation I EIS* electronic initiation system is in use in Canada, as part of the Inco-sponsored *Mine Automation Project* in Sudbury. The company's *DynoREM* remote initiation system has also been recently applied in Sudbury. Dyno Nobel currently developing a *Generation II* system, which is planned to undergo extensive trials in early 2002 (*Mining Monthly,* December 2000).

Orica Explosives launched its new I-kon explosive detonation system, following successful trials with massblast firings at a number of Australian mines. "The system can significantly reduce risks associated with firing large and complex blasts, so much so that these blasts may now be considered for routine production", Orica's Dave Kay told *Mining Monthly* (December 2000). I-kon comprises fully programmable detonators (with absolute delay timing precision), logger connections, and full two-way communication between detonators and control equipment.

A partnership between C-CORE (an applied R&D company based in Newfoundland) and DYI Technologies in Canada has developed an automated fragmentation assessment system, on behalf of Inco Ltd. The system uses underground video feed, calculating the size distribution of broken material in a loader bucket. In 2000, it was successfully tested at an Inco mine in Sudbury. C-CORE is part of the Harsh Environments Initiative initiated by the European Space Agency in August 1997, with the aim of transferring relevant space technologies to the resource sector (*CIM Bulletin*, February 2001). A number of other projects are also under development.

Brandrill Ltd, based in Western Australia, made some important progress in developing and implementing its Penetrating Cone Fracture (PCF) rock-breaking technology. The original PCF technology was acquired from Sunburst Excavation Inc., in June 1998. Brandrill has invested A$17 million in acquiring and developing PCF, including a new cartridge system. PCF is considered to offer major benefits to South Africa's underground mines, and extensive trials were undertaken at Impala Platinum's operations (www.rockbreakingsolutions.com.au). A co-operative agreement between Brandrill and Impala was agreed mid-year, for joint R&D of a PCF-based continuous stope-mining system. PCF trials were also in progress at AngloGold's Joel operation, which was also evaluating a local alternative – the Swartklip rocksplitter, owned by South-African company Denel Ltd.

World Mining Equipment (October, 2000) reported that Atlas Copco unveiled its Superdrifter COP 1838 HF high-frequency rockdrill at *MINExpo 2000* in Las Vegas. Featuring a percussion frequency of 73 Hz, a 20% increase in frequency compared with the popular COP 1838 ME, the COP 1838HF out performs the ME-version while using nearly the same energy in each blow. The unit is designed for drifting and tunnelling using R38 or T38 drifter rods for hole diameters between 43-51 mm and for reaming of cut holes between 89-127 mm.

MINExpo 2000 also saw the latest jumbo addition from Sandvik Tamrock – the Axera D05 jumbo. This unit can turn right-angled corners in 2.9x2.9 m drifts, and is claimed to be surprisingly powerful for its size.

Loading and Haulage Equipment

Year 2000 saw yet more developments in all equipment sectors, and underground trucking was no exception. Each change in truck technology also changes the parameters which limit the economic viability of trucking from underground, when compared with shaft systems. Trucking tonnages of 1.5 Mt/y economically from depths of up to 1,000 m is now possible (*Mining Magazine*, September 2000).

Australia's leading mining equipment manufacturer, Caterpillar Elphinstone, dominates the local market for LHD's. The three most popular loaders (R2900, R2800,

and R1700) occupy 47% of the Australian market (*Mining Monthly*, October). The group's display at *MINExpo 2000* included the Elphinstone R1700G 14-t capacity LHD, and the new 988G loader.

Sandvik Tamrock's new Toro Supra truck was released during the year, and a 0012R model completed a successful trial at Normandy Mining's Golden Grove operation in Western Australia. In the trial, with an average load of 78 t the unit hauled up the 1:7 ramp at 12 km/h. Thanks to its unique multi-axle design, the Supra truck is capable of operating in much smaller openings than normal trucks. Toro claims the unit offers the best ratio of payload capacity (approximately 80 t) to gross vehicle weight of specialised underground trucks (*Mining Magazine*, September 2000).

Sandvik Tamrock also released its new Toro 006 LHD, designed for drifts of 3x3 m, with a tramming capacity of 6.7 t. At the other end of the scale, Toro also announced the new 0011 LHD with a capacity of 21 t, which can fit into drifts of 5.5x5.5 m.

As one would expect, large underground trucks also featured at *MINExpo 2000* in Las Vegas. Those on display included the MT5010 from Atlas Copco Wagner, with a 50 t payload and a powerful clean-running 485 kW Detroit Diesel engine. The MT2000 truck is also new, with a 20 t payload, 224 kW Detroit Diesel engine, and capable of travelling loaded at 12 km/h on a 10% grade, and 26 km/h on level ground. A range of other new machines from Wagner includes the ST-8C Scooptram (14.5 t capacity), the ST-2G Scooptram (4.0 t) and the ST700 (6.5 t). The ST-2G's engine delivers 67% more power and 60% more speed on a 1:7 grade than its predecessor (ST-2D), yet with the same ventilation requirements. There are also a number of other important new features.

The largest load carrier for underground coal mines was put into operation at the Daw Mill colliery in the UK (*Mining Magazine*, June 2000). Developed by Voest-Alpine Eimco, the powerful Eimco 942 carrier has been developed for handling the latest generation of powered roof supports, weighing up to 40 t each. The unit measures 10.5 m long and 3.6 m wide, and travels fully loaded on level ground at 6 km/h.

Of a more novel nature, also featuring at *MINExpo 2000,* was the patented Maglev 4 Mining system, a new surface and underground haulage system that utilises magnetic levitation and propulsion, created by super-conducting magnets, to carry material (*Mining Magazine*, January 2001). It is claimed the system can haul 100 t containers at speeds up to 160 km/h, is fully automatic, low cost, low maintenance and environmentally safe. Maglev is a high-speed ground transportation alternative to rail and airline travel that has been tested in Germany and Japan at speeds of over 300 mph. There is, however, no commercially operating maglev system, yet. In the US, MAGLEV 2000 is a partnership between Florida Corporation, Florida Department of Transportation and other agencies to validate the technology at Titusville's Space Coastal regional Airport (http://faculty.washington.edu/jbs/itrans/fmaglev.htm), and in Southern California a Maglev project is being examined which would run from Los Angeles International Airport to Union Station in downtown Los Angeles, proceeding eastward through the San Gabriel Valley and the Inland Empire (http://www.calmaglev.org). Maglev development also continues in Japan.

Automation

The development and commercialisation of automated underground mining equipment took some major steps forward in the past 12-18 months. According to *Mining Monthly*, 'enabling technologies' was one of the buzz phrases in use at the *MassMin 2000* conference in Brisbane, Australia, in October. This encompasses automated systems for equipment, explosives detonation,

maintenance, ventilation and communications. As noted in the preface to this review, the industry is now seeing some very exciting developments in the implementation of automation and advanced communications technologies.

Manufacturer Sandvik-Tamrock commercially released its *AutoMine* LHD auto-steering system (*Mining Magazine*, July 2000), following nearly a decade of development in Sweden, Canada, and Finland. Sandvik Tamrock has been involved in major automation projects for some time, including the Mine Automation Project at Inco's 175 Orebody in Canada, Finland's Intelligent Mine Implementation project, and the development of four semi-autonomous Toro 2500E LHDs operating at Kiruna in Sweden. Interestingly, forecast labour productivities from some of the northern hemisphere automation programmes have long since been exceeded in non-automated Australian operations.

AutoMine is a control system for automated underground machines, and was developed by Sandvik Tamrock in partnership with Pronyx (*Mining Magazine*, July 2000). AutoMine uses the Infrafree system for navigation, which relies on dead reckoning to calculate its position, using an on-board gyroscope and an articulation angle sensor. There are also two scanning lasers. Semi-autonomous machines are already operating in Finland (at Tamrock's test mine at Tampere) and at Kiruna in Sweden. It is claimed the technology also has the potential to be used to guide underground trucks.

Two systems for LHD navigation were also developed and trialled in Australia in 2000. One system developed by the Cooperative Research Centre for Mining Technology and Equipment (CMTE) in Brisbane (with sponsorship organised by AMIRA International) was convincingly demonstrated, with an LHD navigating autonomously at the Northparkes mine in New South Wales, Australia. It is noteworthy that Northparkes mine, although originally set up for tele-remote loading, later reverted to manual LHD operation to improve productivity.

In parallel, a 'smart loader', with fully automated tramming capability, was successfully trialled by WMC Resources Ltd and Australian company Lateral Dynamics at the former's Leinster nickel operations in Western Australia, and is currently under trial at WMC Resources' Olympic Dam operation in South Australia, using an Elphinstone R2900 LHD.

The successful trials have led to the formation of a joint venture company Dynamic Automation Systems (DAS), with partners Lateral Dynamics and Caterpillar Elphinstone, to develop and market the automated LHD. The CMTE has licensed its technology to Caterpillar Elphinstone. DAS, based in Melbourne, is blending these two systems to produce what may be the most advanced underground vehicle control system in the world. The LHD uses on-board scanning lasers for autonomous guidance, building a map of the underground workings as it moves. The system also combines the AutoDig system from Caterpillar Elphinstone, and is fully self-contained.

Systems which manage mining cycle logistics and information, in real time, such as those developed by Modular Mining Systems (MMS) of Tucson, US, are now widely available, and in use at major operations such as Olympic Dam (WMC), Sudbury (Falconbridge), El Teniente (Codelco) and Finsch Mine (De Beers). MMS's Intellimine system (developed with Komatsu Mining Systems) featured at *MINExpo International 2000* in Las Vegas, and was introduced for the first time in underground mines in 2000, at Falconbridge's Kidd Creek and Craig mines in Canada, and at WMC Resources' Olympic Dam mine in Australia. At the latter, 50 field computer systems were installed on mobile equipment, whose movements are tracked via the mine's 170 km leaky feeder radio system. Further illustrating Olympic Dam's commitment to utilising the latest

appropriate technology, the leaky feeder system at the mine comprises a new generation of the technology supplied by MineCom Australia. The cable is suitable for both VHF and UHF signals, and there's also a digital version (MineCom 2000D) which can integrate analogue and digital systems. An early version of the technology at Olympic Dam has been upgraded to accommodate the mine's initiatives in equipment automation.

The use of 'dirty water' pumping systems with positive displacement pumps enables trouble-free automation of the mine dewatering system. Despite this, some new underground mines continued to install vertical settlers with clear-water pumps, requiring separate mud-handling systems and a much greater need for maintenance and manual intervention. This is a particular problem where rail operations are converted to trackless, resulting in much higher mud loadings in the mine drainage circuit.

Ground Control Systems

At *MINExpo 2000* in Las Vegas, Master Builders presented its new robotic shotcrete MSV2100 Spraymobile. This completely self-contained unit can spray up to 27 m^3/h of wet shotcrete, using an automatic swing-tube concrete pump.

Also at *MINExpo 2000*, Fletcher Mining Equipment presented its Feedback system, which it claims is a world first. The computerised sensing system, used on Fletcher's mobile roof bolters, reads strata hardness while it drills, and adjusts drill speed, feed pressure, thrust, torque and vacuum automatically. It also installs resin bolts consistently to the manufacturer's specification.

Australia's Strata Control Systems (support@stratacontrol.com.au) released the new 'Jumbolt' rockbolting system, which is arguably the first truly one-pass grouted rockbolt system for underground hardrock mines. The system is designed for installation by a jumbo in a single pass and comprises a specially designed, tubular high-tensile steel rolled steel bolt and a multi-aperture polypropylene tube. The bolt incorporates a castellated ring welded to one end and is crimped at the other. The ring retains the dome plate, and engages with a drive tool during bolt installation. The crimped end of the bolt aids in resin mixing and bonding. According to Strata Control, the Jumbolt provides greater shear and elongation capacities under load than conventional bolts. The system has been successfully trialled at the Cannington and Black Swan mines in Australia, and a trial at Tara Mine in Ireland is to occur in early 2001.

Health, Safety and Training

The past year has continued the steady reduction in lost time injuries (LTIs) in all sectors of the industry. Practically all major companies and mining contractors in the major mining nations now have in place a comprehensive safety management system that includes effective workplace hazard identification and control strategies. These are usually supplemented by rehabilitation plans that minimise the time lost when injuries do occur.

Safety legislation continues to evolve, with less prescription and more emphasis on risk management. Accountability for safety performance is now clearly focused on senior management, with increasing potential for criminal charges where the 'duty of care' has not been provided. In some areas the 'presumption of innocence' no longer applies; the very occurrence of an incident being *prima facie* evidence of system failure, or negligence.

However, the continuing success in reducing injuries is not reflected in the frequency of serious incidents with potential for major loss of life. The frequency of fatalities (FIFR) shows no signs of reducing. Indeed, but for 'good luck', several major incidents could have been disasters. There is an increasing recognition by the regulators and the industry

that the systems and processes that are successfully addressing day-to-day safety performance have little impact on preventing the low frequency, high consequence events which continue to plague the industry.

On the training front, company 5DT demonstrated what is claimed to be the world's first Virtual Reality Miner Training Simulator, 5DT VR COAL, at *MINExpo 2000* in Las Vegas. The trainee controls the miner in a virtual coal (or potash) mine in a series of scenarios of increasing complexity (*Mining Magazine*, January 2001). The product was developed in partnership with Sasol Coal, one of the leading coal suppliers in South Africa.

In Australia, MineWise Pty Ltd released a beta version of their new, interactive multimedia ground control training software for underground mines (www.minewise.com.au). The software features modules on rockfall hazard recognition, ground conditions assessments, rock scaling and ground support technology. Other modules on mine ventilation, mine backfill and other topics are also scheduled.

Simlog (www.simlog.com) completed development of the world's first drill jumbo operator training simulator, in late 2000. The system was developed in collaboration with Atlas Copco Construction and Mining (North America), and an advanced version was shown at *MINExpo 2000* in Las Vegas in October. The Simlog simulator recreates essential aspects of an actual drill jumbo control interface, using industrial components (joysticks, levers etc). The simulation software features 3D models of a twin boom jumbo in an underground mining tunnel. The trainee is led through a series of modules, and performance criteria assess their performance continuously. The new unit was tested in June 2000 in Sudbury, and was apparently very well received.