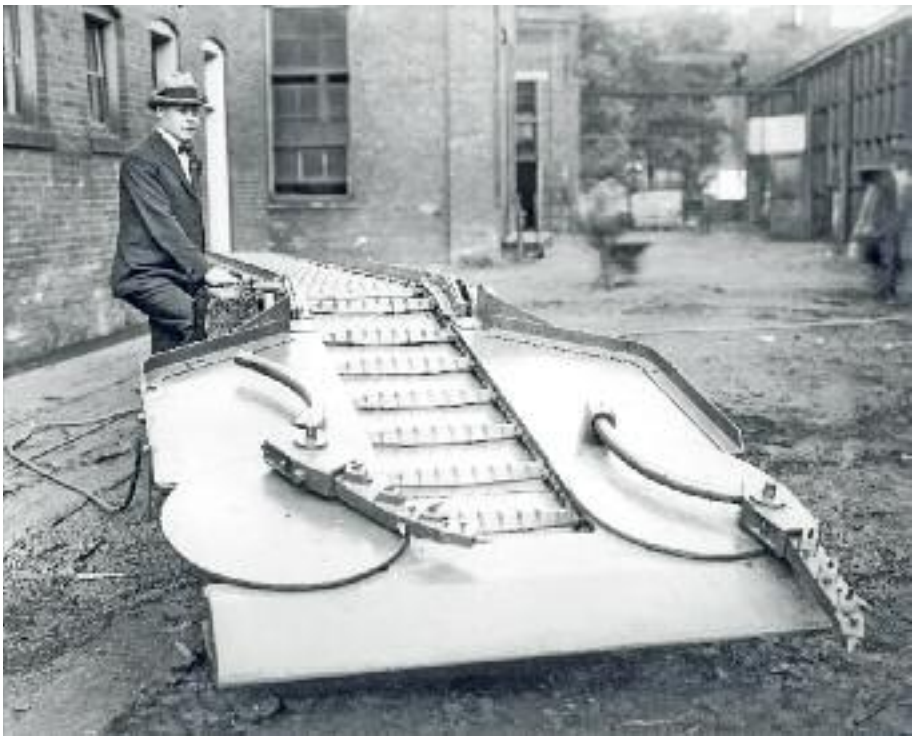
The nominations are...

The shortlisted nominations to the International Mining Technology Hall of Fame – here are some extracts from the nominations



Joe Joy and his loader

Since May this year, readers have been sending in nominations and these have been shortlisted to those covered here. Any not shortlisted will be carried forward to the 2014 inductee nominations, for presentation early in 2015. There is to be a gala dinner in Salt Lake City next February (http://www.im-mining.com/im-hall-of-fame/ and www.im-halloffame.com), when those voted for induction into the IM Technology Hall of Fame will be presented.

There are many names in this article besides the nominees. The nominees are identified by bold type for their first mention. The electoral college of judges around the world – mining company management, senior personnel in engineering and consulting companies, mining professors and others are concluding their deliberations and the winners will be announced shortly.

Beginning with exploration, INPUT is **Tony Barringer's** best known and most commercially successful legacy, with the discoveries of more than 25 orebodies collectively worth over $100 billion attributed to it. The majority of modern-day airborne systems owe all or part of their inheritance to the design of the INPUT system. Few individuals can rival the impact he made on mineral exploration technology, in the illustrious 50 years he spent pursuing scientific discovery and invention in the industry.

Rio Tinto Exploration has nominated **Nikolai V. Sobolev, Bob Loucks** and **Doug Oldenburg. Sobolev's** contribution was the study and development of Cr-Ca systematics in garnet concentrates, xenoliths and diamond inclusions, with focus on their use in exploration. His seminal publication is *Chrome-rich garnets from the kimberlites of Yakutia and their paragenesis*, Contributions to Mineralogy and Petrology, 1973.

Over more than a decade of research Loucks has developed whole rock trace element ratios which reflect the presence or absence of magmatic differentiation processes directly associated with the potential to form porphyry Cu-(Au-Mo) mineralisation. He successfully demonstrated that these processes can be related to specific tectonic stress regimes which are both geographically and temporally transient. This brought about a step change in understanding of the processes necessary to potentially form a porphyry Cu deposit.

Oldenburg revolutionised the way geophysicists use potential field (magnetics and gravity), direct current (resistivity and induced polarisation) and electromagnetic data through development of the UBC-Geophysical Inversion Facility inversion codes. Prior to the 1990s the standard means of interpreting data was to forward model a preconceived simple body until a suitable fit was found. This was time intensive and interpretation success relied heavily on the correct body shape being selected. The UBC Geophysical Inversion Facility code is based on the simple proposition that inversion is an optimisation problem between minimising the misfit between the observed and predicted data whilst minimising the misfit between the final model and the reference or starting model.

Edmund J. Longyear has been nominated for his influence in contract diamond drilling, geological services and shaft sinking in the early part of the 20th century, serving the rapidly growing U.S. iron ore mining and steel industry. In 1890, Longyear drilled the first diamond core hole in the Mesabi Iron Range in northern Minnesota. He later formed the E.J. Longyear Company, which would eventually become Boart Longyear. The company developed the wireline-retrieved Q core barrel, which revolutionised the exploration business in the 1960s and is still the standard used for exploration drilling.

Following diamond drilling, it is interesting that Ray Roussy, President of Sonic Drilling and the Sonic Drill Corp has been nominated. He is the patent holder and the developer of modern day sonic drilling technology. Today, seven out of 10 sonic rigs are purchased for mining exploration. Sonic drilling overcomes certain shortcomings of diamond core drilling. Using Roussy's innovative sonic drill head, samples, ranging from 3" to 8" in diameter, can be obtained from a wide variety of mineral deposits including hard-to-extract oil sands, slag piles, mine tailings and heap leach pads.

Around the mines, three nominations from Rio Tinto are: **David George,** Chief Advisor, Processing, Mineral Technology Services for Outstanding Innovator; **Peter Chittleborough**, Supervisor of the Mine of The Future™, Autonomous Haulage Deployment (AHD) team in Surface Load and Haul, and Northparkes Mines Mechanical Engineer, **Matthew Betts**. It would be nice in future years to see other mining companies recognising their personnel in this way.

Betts has led the implementation of the automated LHD operation at Northparkes Mines working with Sandvik to deliver a robust and reliable system that is changing how Rio Tinto plans large underground block cave mines

Northparkes Mines nominates mechanical engineer, Matthew Betts

worldwide. This loader automation system (AutoMine) has improved safety for the underground production team by reducing exposure in the underground environment; improved utilisation of the loader fleet as the machines can operate continuously across shift change and improved maintenance as the machines are operated within their design envelope. According to Sandvik Mining, thanks to Matthew's vision and leadership, Northparkes has the most advanced automated LHD system in the world. Also, a Robotic Idler change out system (RIC) was Matthew's vision for the future of a common and ergonomically difficult task around maintaining conveyors: changing idlers.

Separately, Sandvik Mining's Vice President of Mine Automation **Riku Pulli**, engineer **Janne Kallio** from the Turku plant and **Hannu Mäkelä** from Navitec have been nominated for AutoMine. AutoMine is an automated loading and hauling system for underground hard rock mining which has succeeded in transforming mining practices for the 21st century. It is a flexible modular system that can successfully be adapted to small scale operations, as well as massive block caving applications. Moreover, the system incorporates functions and applications that allow it to interface with other third party IT systems at the mine site.

Chittleborough "has been an incredible leader on all fronts when it has come to educating new people about the AHD. He has an amazing understanding of the system, which is second to none, he fully understands all its advantages and disadvantages, how to get the best from the system from an efficiency, safety and production point of view. He has always led by example and is greatly respected by those who work with him. Peter has pushed for change, encouraged, insisted professionalism, and always been willing to share his experiences and discoveries with his colleagues, and other stakeholders to improve their knowledge, the system and everyone's working experience. Without him the AHS system would not be what it is today and would not have managed to achieve what it has."

Outstanding innovators

George is nominated in the Outstanding Innovator category for his contribution to the Double-flash copper smelting technology. "This technology has revolutionised copper smelting; setting the standard for sulphur dioxide capture, improving safety by eliminating molten matte transfer, and reducing the labour required to produce copper. This technology is recognised by the US Environmental Protection Agency as the best available current technology (BACT) in copper smelting. The technology was developed by combining Outotec's flash-smelting with the Kennecott Utah Copper (KUC) flash-converting intellectual property, to which David was an instrumental contributor.

Between 1985 -1987 **Sverker Hartwig** was responsible for all Atlas Copco underground drill rigs, trucks and loaders. He initiated a large number of projects for new rock drills and rock drill control systems, including what today has become the well known RCS system, a Can bus based rig control system, today used on most of its underground drill rigs and LHD equipment and also used on surface products. This project was called Rig 90 and was outlined by Hartwig. For the next 10 years, he was first Technical responsible and later also Business responsible for all Atlas Copco's all TBM and raise boring machine activities. A large number of patents were filled in his name during these years, for new machine concepts, cutters, control systems and VSD drives of TBMS and RBMs.

After returning to Sweden from the President position at Atlas Copco Robbins in USA 1996, Hartwig was Vice President Technology, for everything related to rock drills, surface and underground drill rigs in Örebro, Sweden. During these years "rig 90" was finally introduced and first was the Boomer L2 C rig, now available in many different sizes and types. He also invented a new boom system, the BUT 40, "which is an unmatched boom in reach, stability and versatility now used on premium rigs, Atlas Copco's nomination reads. "Sverker also initiated a large number of new products like the Scaletec etc.

"In 2005, Sverker moved to a new position to become the Vice President Technology for all Atlas Copco Construction and Mining products. Even though his primary task was not to invent products in this position, he kept pushing the boundaries for inventing systems for energy management, LHD control, new rock drill concepts and such."

Nick Hazen is President and CEO of Hazen Research, a company that was founded by his father and grandfather in 1961. The company has grown from a single-building laboratory to the largest private metallurgical and processing R&D facility in the US and serves clients around the world. Hazen and his team have worked for many of the world's major mining companies on projects spanning the range of mineral and metal commodities and unit operations, initiating processing solutions and developing treatment routes and flowsheets, which is evidenced by his résumé, list of publications and the 30 patents to his name. An area in which he has been successfully involved has been the development of multi-unit operation methods for the efficient, economic and environmentally sound extraction of contained metals from ores, concentrates and wastes. In recognition of his service to the industry, the US SME awarded him the 2008 Arthur F. Taggart Award and IOM3 awarded him the Futers Gold medal for 2012.

Mineral core samples need to be stored, without degradation, for the entirety of the mine they were used to prospect. **Greg Owens** and **Damien Blyth** – Owens is the Managing Director of Intercept Australia. Owens saw the potential to apply a technology from one field of business to another, and in doing so came up with the idea for the INTERCEPT® Mineral Preservation System (IMPS). Blyth was responsible for mechanising the process. He knew the potential of the INTERCEPT material, but used his background to capitalise on the idea of evacuating the air from the packaging and replacing it with nitrogen or low dew-point filtered air. The goal of these processes was to further reduce the need to refrigerate the samples. Additionally, Blyth realised that every core that went through this machine represented a chance to label and log the sample to comply with QA/QC requirements. These two shared the goal of maximising the quality of sample preservation and efficiency while minimising costs. In using this technique samples can be quickly and safely packaged on site, the material is easily used and applied providing an environmentally friendly effective alternative to freezing or waxing, with the simplicity of use and the speed of application.

Mining software

You know you have made a difference in the world when your family name becomes a verb. That name is Whittle and the man who has had a revolutionary impact on the mining industry is pioneering strategic mine planning expert **Jeff**

Whittle. For well over three decades, his innovative thinking has made an impact on the vast majority of mining companies and mining professionals involved in the evaluation of mining deposits and the planning of mining operations.

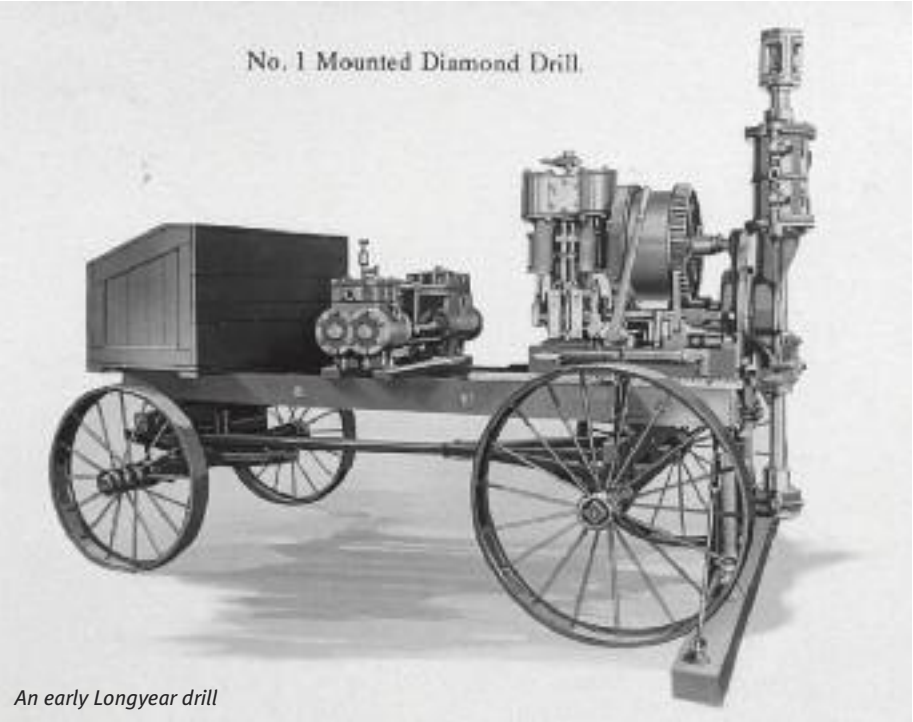
Several years after his first foray into the industry in 1979, Jeff and his wife Ruth founded Whittle Programming, and soon wrote the Whittle software strategic mine planning software. Over the next sixteen years he developed a series of mining optimisation packages, including Whittle Four-X, Opti-cut (inspired by Ken Lane's theories on cutoff grade optimisation) and the Milawa algorithm (a creative solution to the difficult non-linear mine scheduling problem). Whittle Programming was sold in January 2002 to Gemcom Software International, which is now known as GEOVIA following its acquisition by the ninth largest software applications company in the world, Dassault Systèmes.

Fred Banfield started Mintec from his Tucson apartment in 1970. As a Colorado School of Mines student in the early 1960s, he applied his passion for mine engineering and computers to solving mine modelling and design challenges. Now Banfield presides over a global network of dedicated mining professionals. Through offices in eight countries, Mintec helps clients solve problems with MineSight. MineSight is Mintec's comprehensive modelling and mine planning software platform, offering integrated solutions for exploration, modelling, design, scheduling and operations. Mintec won this year's President's E-Award for Exports – the highest recognition any US company may receive for making a significant contribution to the expansion of US exports.

Micromine Founder and Managing Director, **Graeme Tuder**, has significantly contributed to the advancement of the international mining sector over the past 27 years. Tuder's pioneering efforts have resulted in Micromine's reputation as a leading provider of innovative software solutions and services to the international exploration and mining sector, offering companies worldwide the tools to operate productively and cost efficiently.

"There are countless individuals at Caterpillar that have contributed to the Cat mining technology systems of today, but a key group of people have been involved for literally decades, bringing early thoughts and brainstormed ideas that began on paper to life in mining applications. Caterpillar is proud to nominate this group for the International Mining Hall of Fame Award: Software Category – **Craig Koehrsen, Michael Murphy, Chuck Sahm, Carl Hendricks, Claude Aboujaoude, Jason Gough, Josh Bynon** and **Chuck Boen**.

"This group of individuals has been involved with technology at Caterpillar for well over 20 years and continues to work on state-of-the art Cat technology systems today. From the early days of GPS and data collection systems, these people revolutionised the machine control and guidance sector with the advent of the VIMS and Terrain systems (formerly known as Computer Aided Earthmoving System (CAES) and AQUILA Drill & Dragline). These early technologies provided a foundation for Cat technology systems today, including comprehensive surface and underground automation technologies at work in mine sites around the globe. These systems have now joined forces make up Cat MineStar system, the mining industries broadest and most comprehensive suite of technology products on the market today."



An early Longyear drill

Paul Anthony Higgins is an innovative visionary who has moved the mining industry from a machine repair culture in the 1980s to a modern Asset Wellness™ approach. He founded Dingo as a software company in 1991 to support the needs at an Australian Rio Tinto mine to organise and effectively use oil analysis results. Over the years, Dingo's Trakka® software tool grew into an independent data and work process platform to care for mining machinery around the globe. The methodologies he developed, deployed through Dingo, are today improving performance, lowering cost and boosting production of mining machinery worldwide.

Surface mining

Dr Jonathan Peck was a co-founder and CEO of Aquila Mining System, which was subsequently sold to Caterpillar. In this role, he led the development effort that pioneered the use and development of real-time high precision GPS (HPGPS) guidance products for both blasthole drills and cable shovels in the mid-1990s. These developments set the standards for this technology, which is still in use 20 years later. In the mid 1990s production grade, ruggised PC-based mobile computers were deployed for use on a wide range of blasthole drill makes and models. Besides production monitoring, the applications included rock recognition, based on data collected by drill monitors, and retrofit drill control systems. Peck and his team delivered the first full integrated production and diggability monitoring, load weighing, health, and HPGPS guidance products for cable shovels in the mid 1990s.

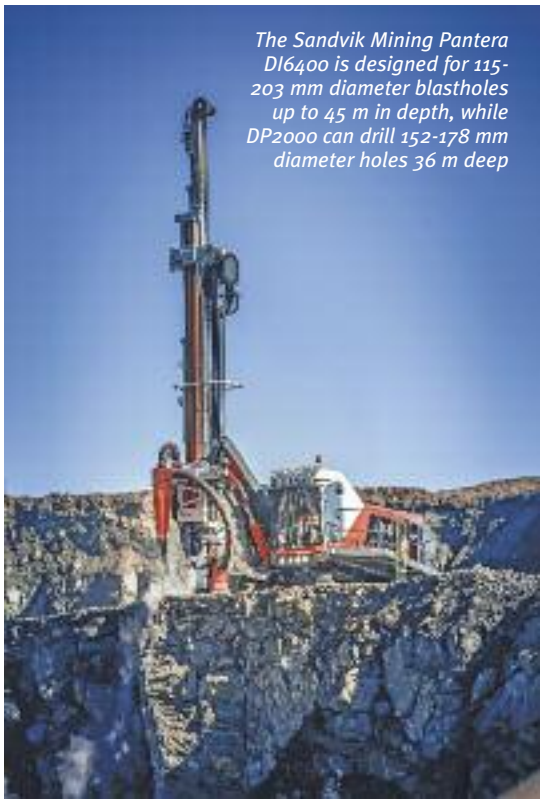
Dr Sean Dessureault, Associate Professor, Director, Mine Intelligence Research Group at the University of Arizona wrote: "I would like to submit a nomination for some true 'game changers' in the industry, the folks that revolutionised mine production control, the guys who created Modular Mining Systems: **Mark Baker, Dr Jim White**, and **Michael Arnold**. "Few technologies have sparked such a deep and pervasive change in mining." Separately, John McGagh, Head of Innovation, Technology and Innovation, Rio Tinto, also nominated Jim White.

Since 1950, arguably, no single person has had a greater influence and impact on the off-highway truck industry than **Ralph Kress**. He was the driving force behind the off-road hauler businesses of Dart, LeTourneau-Westinghouse (Wabco), Caterpillar, and Kress Corp. From 1950 to 1955, Kress was General Manager of Dart Truck Co. In 1951, he designed and built the Dart 75-TA, a 75-t tandem drive, rear-dump truck powered by two 300-hp Buda diesel engines. It was the largest truck in the world, and was sold to the Bagdad copper mine in Arizona. In 1955,

Ralph Kress worked for LeTourneau Westinghouse (Wabco) as a consultant. His task was to design a truck to put Wabco in the truck business. The outcome was a prototype 30-t rear-dump truck of radical design. It featured a triangular box shape to lower the centre of gravity, an offset cab, forward-sloping windshield, oleo-pneumatic suspension, short wheelbase and high payload-to-weight ratio. These features set the standard for off-highway truck design for the next four decades.

When Motion Metrics International started out in 1999, **Dr Shahram Tafazoli** led a team of just three engineers who had the goal of solving some of the mining industry's most challenging problems. In 2003, a big break came when an oil sands mine in Alberta asked for a solution to a serious problem it was having: the bucket teeth on the shovels were breaking off and ending up in the crusher, which would end up blocking the crusher for hours, each incident costing hundreds of thousands of dollars, and creating a very dangerous situation for the mine. This had been a serious problem plaguing the mining industry for years without a good solution. According to MSHA, "When a broken tooth from a mining shovel or loader gets caught in the mine's crushing or processing equipment, there is a potential for the tooth to be shot from the equipment at very high speeds potentially creating a lethal situation." Motion Metrics developed an advanced vision-based system to monitor the teeth, ToothMetrics™. When a broken tooth is detected, it alerts the equipment operator and the mine is then able to take the appropriate measures to prevent the tooth from reaching the crusher.

The old Tamrock model name of Pantera (first used in the late 1990s) has been revived with two new Pantera drill rigs. Described by Gary Hughes, Sandvik Mining's President, as "game changers", they are quite a step forward in blasthole drilling. The new Pantera percussive drill platform, designed by **Markus Reinikka and his team** is available for both DTH (down-the-hole) and TH (top hammer) applications – delivers increased drilling capacity, lower fuel consumption and improved safety. And they come with equally impressive new drilling tool packages. Featuring a distinctive new-look, stylish design, the new Panteras have been developed to take advantage of industry trends towards fully autonomous operation – with options allowing owners to take advantage of automation technology as their needs and mining operations change. The two new models are the Pantera DI6400 (DTH) and Pantera DP2000 (TH). The new Pantera platform combines an innovative approach to surface drilling with proven and intelligent SICA (Sandvik Integrated Control Architecture) control system technology. The Pantera DTH configuration will offer the industry's highest operating pressures for faster, more efficient drilling. Another industry first is the introduction of 7.5 m drill pipes, in diameters from 89-140 mm, for boom-based operation. "Compared with other DTH solutions, Pantera DI6400 with 25-ft drill pipes delivers higher productivity and lower operating costs, through higher penetration rates, reduced time spent in tool changes, better stability, faster maintenance, and an optimized powerpack," says Jan-Olaf Petzold, Vice President for Product Line Surface DTH/TH drills.



The Sandvik Mining Pantera DI6400 is designed for 115-203 mm diameter blastholes up to 45 m in depth, while DP2000 can drill 152-178 mm diameter holes 36 m deep

Karl-Axel Stjernström, Kurt Andersson and **Jörgen Rodert** developed the COPROD system, a patented innovation, which provides an important increase in drilling productivity for large hole sizes. Secoroc COPROD is Atlas Copco's patented system for fast, straight drilling in demanding rock - a system that combines the high penetration rates of tophammer drilling with the hole straightness and the hole quality of DTH drilling. In short - combining the best of two worlds. Benefits include high penetration rates and excellent flushing, straightness and hole quality.

Joy Global has nominated **Alonzo Pawling** and **Henry Harnischfeger**, the co-founders of a company in 1884 which became known as P&H Mining, now part of Joy Global. P&H Mining celebrated 125 years of industry service in 2009. Today, the company designs, manufactures, sells and services P&H branded surface mining equipment including electric shovels, draglines, and drilling equipment. This equipment can be found on 90% of today's global surface mines. In 1920, Harnischfeger, having bought out Pawling whose health was failing, unveiled the highly successful P&H Model 206 – a crawler-propelled power shovel. This led to the innovative 300-Series machines, which were the first convertible configuration units used as a shovel, backhoe, clamshell, dragline, crane, auger, and backfill machine. The popularity of these machines led to Harnischfeger's leadership in both the mining and construction industries.

The most popular and well-developed approach to the ultimate pit limit problem is the **Lerchs Grossman** algorithm (Lerchs and Grossman, 1965), primarily based on graph theory. Almost all algorithms use a block model of the orebody, i.e. a three-dimensional array of identically sized blocks that covers the entire orebody and sufficient surrounding waste to allow access to the deepest ore blocks. "Of these, the Lerchs-Grossmann algorithm, based on graph theory, is the only method that is guaranteed always to yield the true optimum pit. However, the original algorithm assumes fixed slope angles that are governed by the block dimensions. None of the subsequent attempts to incorporate variable slope angles provides an adequate solution in cases where there are variable slopes controlled by complex structures and geology."

Tamrock (now Sandvik) Ranger's revolving superstructure, developed by **Juha Piipponen & team** was very revolutionary at the time it was launched. It greatly simplified the drilling of blastholes since they could be drilled anywhere around the circumference of the circle provided by the revolving superstructure. Ranger was trademarked in 1996. The Ranger 5002 is a hydraulic, self-propelled, self-contained, crawler-based surface drilling rig equipped with a cabin (FOPS and ROPS) and rod handling system. It drills vertical, inclined or horizontal holes with a diameter of 51 - 89 mm using 32, 38 or 45 mm extension rods.

Underground mining

It was in the 1970s that **Dennis Laubscher** developed the rock mass classification system for which he has become famous. His mining rock mass rating (MRMR) system is now very widely used in the industry worldwide. There is not a block caving mine anywhere in the world that has not used his empirical correlation, or stability graph, to evaluate the cavability of its deposit. The system is also used for the determination of caving angles and hence the occurrence of cave cracks and extent of cave craters. It is also used for the estimation of slope angles in open pit

mines. He is a man who has made an enormous technical contribution to the world of block caving.

By the start of the 1980s the limits for conventional cemented carbide in rock drilling tools were reached due to the fact that an increase in wear resistance by using less binder phase or finer grained tungsten carbide always resulted in an unacceptable loss of toughness for the demanding application. Udo Fischer and his co-workers **Torbjörn Hartzell** and **Jan Åkerman** tested several new concepts and between 1988 and 1995 their four US patents were approved covering the new Dual Property (DP) cemented carbide, which still is the most well-known cemented carbide using macro- gradients. In the DP concept the wear resistance and the toughness can be improved independently of each other in the product. Controlled re-distribution of cobalt binder phase several millimetres inside the buttons gives components which contains three distinct microstructural zones. These gradients, together with their differences in thermal expansion, redistribute the internal stresses. It is for example possible to create a very hard and wear-resistant surface layer which is simultaneously pre-loaded with compressive stresses to prevent the initiation and propagation of cracks. Carbide having such a distribution of properties has high wear resistance at the surface combined with a tough underlying region. The new type of tools often has double life-length compared to conventional tools.

Jack de la Vergne is a Canadian civil engineer who specializes in underground mining and was a recipient of the Professional Engineers Ontario Engineering Medal in 2005. De la Vergne is the author of the *Hard Rock Miner's Handbook* and the *Hard Rock Miners Technical Spanish Dictionary* and is recognised as an industry expert in mine shafts and mine hoists. Scott McIntosh wrote in an introduction to the book in May 2003: “Jack de la Vergne's *Hard Rock Miner’s Handbook* is a work of the heart. Originally published in June of 2000 as a compilation of Jack’s continuing 35++ year mining industry career, I personally knew the lifetime of effort that Jack put into the original. Although I helped Jack with sponsorship and encouragement, Jack did all of the real work and I never believed we would consider publishing an update. But, having received significant encouragement from the many readers of the book, and many new Rules of Thumb, Jack made the decision that a complete update was warranted and I was on board.

“Mining industry response to the book is incredible. Thanks in large part to the efforts by John Chadwick, the Infomine website and many others; the *Hard Rock Miner’s Handbook* has

been distributed to over 113 countries worldwide. Daily website hits and downloads continue as students and professors, miners, engineers and mining executives embrace the *Hard Rock Miner’s Handbook* as an invaluable source of practical mining information.

As one of the original inventors of rough-terrain machinery, Manitou has steadily grown its involvement in the global mining industry. Its subsidiary, Manitou South Africa, has adapted its telescopic handlers to feature a much lower risk of sparking or over-heating in dangerous environments, where finally dispersed coal dust or gases can fuel explosions or fires under certain conditions. “ The company’s Project Engineer, **Jannie Smith**, has developed a series of similarly practical and dependable flameproofing technologies that have seen the rise of a range of flameproof mining utility vehicles (MUVs) and skid steer loaders. “Some of our technologies have included breakthroughs in flameproof diesel engine designs, radiators, header tanks, cowls, cooling fans, exhausts, dry and wet system and intake manifolds,” says Smith.

In parallel with the manufacture of hand-powered drills, a lightweight, ratchet-rotating machine was constructed by Atlas Copco in 1913 that would be suitable for porous rock types, such as limestone. This machine type, the BOB, was still in production until the 1930s when it was replaced by a lightweight, ratchet-rotating drill of the RH type. A type that would have major significance for the company's continued development. The RH Series was designed by engineer Gustaf Andersson and entered production in 1930 with the RH-70, a drill intended for hard rock. The most important of these lightweight, handheld drills was the RH-65 from 1932. The machine came to constitute the most important link in the successful Swedish Method: a lightweight drill on a pusher leg and equipped with hardened metal bits.

As a field technician for the local Caterpillar® dealer in Tasmania in the late seventies, **Dale Elphinstone** recognised that there was no ‘new technology’, which was in constant change on surface mining equipment (trucks and loaders), being applied to hard rock underground equipment of the same purpose. He therefore embarked on a new direction by opening his own business to correct this with the prime driver being, to reduce the operating and maintenance cost plus improved operator ergonomics. His business started by modifying standard Cat trucks and loaders to suit the rigors of the harsh underground environment, this later led to the development of purpose built LHDs and articulated haul trucks. The key to the success of the product and company as it grew from the late 1980s through to current times was the fact that Elphinstone’s motivation was to always use Caterpillar components and systems, such that new technology developed by Cat® could, wherever possible, be used for the betterment of the industry as a key cost reduction driver to the end user. This also fostered high productivity and mechanical reliability.

Joe Joy was hired as an engineer for Jeffery Manufacturing, where he spent his days in Pocahontas, Virginia, as a team member developing cutting and loading equipment. At night, he continued to develop his gathering arm loader which he eventually presented to Jeffery management. He tried to sell

Jeffery the rights to his machine, but his offer was declined. So he took his invention to senior officer, John A. Donaldson, at Pittsburgh Coal. He demonstrated his model on Donaldson’s desk using dry dog food as the loaded material to be conveyed. Donaldson was so impressed that he requested Jeffery to manufacture this machine. The first gathering arm loader was shipped to Pittsburgh Coal’s Sommer

Number 2 Mine on September 27, 1916. Joy applied for a patent for this gathering arm loader, and continued to work on its testing and development underground. He was awarded a patent, in his name, for the machine in 1919. The machine proved to be so successful that Jeffery Manufacturing tried to claim rights to Joy’s invention. This resulted in him leaving his position with Jeffery Manufacturing and ultimately led to a patent lawsuit (which Joy successfully won in 1924).

Jacques Melkonian is an engineer with a unique sense of mechanics. His reputation became so strong that the Mines de Potasse d’Alsace decided to contact him to find a solution on their Joy Mining loaders. “Melkonian went to Mulhouse, met the managers, and accepted to go underground and see the problem. Fascinated by the underground mine, he decided to work on the

problem. This was the revolution: Melkonian designed an axle that would solve the problem, had it manufactured as a sample, tested by the mine: the problem was solved! The solution was found! Joy contacted Melkonian and ordered the MJ AXLE 1301, as he named it, by the 100s!" His success led to the establishment of Continental Industrie, from which his children founded Groupe Melkonian and Aramine.

In 1922, Eddie Wagner moved to Oregon and with his brothers started a company called Mixermobile. The brothers began to experiment with four-wheel-drive wheel loaders, which led to the start of Wagner Tractor and the manufacture of construction equipment. In 1949 Eddie's brother, Elmer invented the four-wheel drive articulated vehicle. In 1958, Hidden Splendor Mining Co in Moab, Utah, asked Wagner to build a front-end loader for underground mining. At that time, rail loaders were widely used but Hidden Splendor management was looking for a more manoeuvrable vehicle that could successfully travel the narrow and twisting drifts in underground mines. After hearing about Hidden Splendor's new trackless loader, Phillips Petroleum approached Wagner, then Vice President of Wagner Tractor, to build a similar vehicle for its mine in New Mexico. Working nights and weekends, he completed and shipped the first articulated, rubber-tyred, front-end loader mining scoop, the MS-1, in the summer of 1958. In October that year, Wagner, his wife Mary and their son Richard founded Wagner Mining Scoop Co.

Burt Royle was the principal inventor of the mucking machine, which greatly eased the job of removing the broken muck by hand shovelling by moving to operating a powered machine, doing the job in less time and with much less exertion and back strain. Many unsuccessful attempts had been made to improve the mucking cycle, but the revolutionary design conceived by Burt Royle, with improvements by **John Spence Finlay** made possible the removal of muck faster and easier than ever thought possible.

Royle's idea for the mucking machine came partly from observing the arc motion of the shovel while mucking out a round. His design also permitted a smaller cross-section drift to be driven than those employing hand mucking or the mechanical devices then available.

Wilhelm Löbbe invented and refined the coal plough in an attempt to modernise and mechanise underground coal mining. The invention of the 'Loebbe Plow' in the early days laid the foundation for establishing ploughing as the preferred high-productivity longwall mining method for seam heights below 1.8 m. Ploughing is a long-known coal mining method invented in the early 1940s. Many different plow models were designed and trialled underground until in the mid-1990s only two models remained: the Reisshakenhobel® or base plate plow and the Gleithobel® or gliding plow. Power and plough speed have increased steadily over time; however it wasn't until 1989 when the biggest weakness of plough systems was overcome: automated ploughing, using electrohydraulic controls, with defined cutting depths finally allowed ploughing to become the most productive mining method for seams below 1.8 m seam thickness.

Anderson Boyes manufactured this shearer coal cutting machine between 1960 and 1985

The **Anderson Boyes design group** responsible for the first coal shearer has also been nominated – though no names have been made available. The first attempts to mechanise mines with coal cutting machines happened as early as 1860. Simple machines were built, similar to circular saws, with picks around their edges instead of teeth. However, it was not until the middle of the next century that they had developed sufficiently for men to be able to put down their hand tools and rely on machines. Anderson Boyes became Anderson Strathclyde (via Anderson Mavor), then Anderson Longwall (after the controversial 1983 takeover by Charter International), Long-Airdox (after its 1995 sale by Charter, with the Motherwell manufacturing plant closed in 1997), DBT Deutsche Bergbau-Technik (2001), Bucyrus International (2007) and Caterpillar.

Don Maclean of MacLean Engineering is a mining engineer who once worked at Inco in Sudbury and brought the ideas that could be turned into useful products. He spearheaded the drawpoint obstruction clearance machines, known as 'blockhole jumbos', in the late 1970s that, although a very simple concept initially, became dependable and irreplaceable tools for underground bulk mining. In the late 1990s, Palabora went in search of a machine that would ensure that drawpoints and drawbells at the conceptual Palabora block cave mine could and would be kept free of obstructions. MacLean stepped up and developed the High Reach Rig. It was a diesel-powered mobile unit that could reach up 20 m, drill multiple 75 mm holes, charge them with emulsion explosives and arm the holes with a detonator. The operator controlled the machine via radio-remote from outside the drawpoint, sitting in a detachable track-mounted unit that docked with the mother rig for transport around the mine. Palabora purchased two such rigs. MacLean subsequently developed the 'Ro-Bust' rig which was implemented to break drawpoint boulders below the brow by using high-pressure water impulses, a technique that licensed a technology from South Africa munitions manufacturer Denel.

John Wood is a man of vision. Back in the early 1980s when a plethora of manufacturers in Australia dabbled in the production of roof bolters for the underground coal mining industry, he and his team came up with a bold new concept – a roof bolter design which took the industry by storm. Then he set about establishing a presence in the UK. At that time, UK coal mining used arch bars for roof support, so extraction costs were very high. Wood recognised that if he could convert British miners to roof bolting (using Hydramatic bolters) then some pits could survive. His foresight paid off and the UK operation flourished and paved the way for a burgeoning export market to open up in many other countries around the globe, including China, Austria, Norway, the USA and even Germany. One of the primary reasons for the company's success was its willingness to work closely with clients and to solve their problems – to engineer tailored solutions exactly fulfilling their needs. Hydramatic developed many world-first innovations, conceptualising, designing and making the first Longwall Face Bolter in the world. A machine which replaced the hazardous operation of hand-bolting the last three to four shears of a longwall block enabling removal of the longwall infrastructure. This innovation alone

significantly reduced the number of injuries sustained during longwall moves.

Split Set stabilisers were originally developed by **Dr James J. Scott** and were manufactured and distributed by Ingersoll-Rand for many years. The system consists of a slotted high strength steel tube and a face plate. It is installed by pushing it into a slightly undersized hole and the radial spring force generated, by the compression of the C shaped tube, provides the frictional anchorage along the entire length of the hole. Because the system is quick and simple to install, it gained massive acceptance by miners throughout the world. The device is particularly useful in mild rockburst environments, because it will slip rather than rupture and, when used with mesh, will retain the broken rock generated by a mild burst. Provided that the demand imposed on Split Sets stabilisers does not exceed their capacity, the system works well and can be considered for many mining applications.

Safety

Fittingly, there have been more nominations for the Safety category, sponsored by Redpath, than any other.

Glen Barton's passion changed the mining industry. His leadership made Caterpillar the world's leading provider of mining equipment by creating the roots that support the organisation today. Barton's vision led to the creation of a new breed of mining haul truck – a truck with greater than 100 t of capacity that operated using mechanical drive. Within three years, this new technology helped Caterpillar become the leading supplier to the industry. But that was just the beginning. Customers needed more production – and needed it at the lowest possible cost per tonne. He spearheaded the development of the Cat 797 Truck (400-t payload) as well as large loading tools like the Cat 994 Wheel Loader. His vision for Caterpillar in mining went beyond equipment. He spearheaded innovative agreements that created a successful partnership between Caterpillar, Caterpillar dealers, and mining companies. However, it is for his leading Caterpillar to focus on safety that he is being nominated. He brought together producers and other manufacturers to work on a single goal – how to mine more safely. This led to innovations such as improved visibility on haul trucks. Caterpillar continues this focus on safety today – it as a core value of the company. Barton sponsored The Human Element, a comprehensive program focused on personal responsibility and safety on the mine site – translated into eight languages and still in use at mines around the world.

John T. Ryan, Sr., contributed immeasurably to the development of coal mine safety during the first half of the 20th Century. He was instrumental in developing the Edison Electric Cap Lamp, which eliminated the open-flame lamps that caused methane explosions, and in instituting procedures for the use of rock dust in coal mines to prevent dust explosions. In 1914, Ryan and **George H. Deike, Sr.**, formed the Mine Safety Appliances Co (MSA) in Pittsburgh, which began vigorously to develop methods of avoiding methane and dust explosions in mines. Their company would become the largest mine safety equipment supplier in the world.

Optalert recently received validation for its real-time operator alertness monitoring system by academics from one of the most prestigious research institutions, Harvard in the US. A cross-institutional study concluding the Optalert fatigue detection product as setting the 'gold standard' in early fatigue detection – a key component of workplace safety. Optalert's fatigue detection products have been developed with more than 20 years of research by a team including current General Manager of Scientific Research Dr Andrew Tucker. Tucker said over the years the team developed new methods of measuring eye and eyelid movements. This then led to the world's first validated scale of drowsiness – the Johns Drowsiness Scale – after Optalert founder and Chief Scientist **Dr Murray Johns**.

Slope stability radar creation and market application - **Dr David Noon and his team** are nominated for "GroundProbe SSR and WAM inteferometric monitoring devices that created a whole new sector and have added value and saved lives worldwide. The idea to use radar to measure the movement of walls in open pit mines originated at The University of Queensland, Australia as part of a Research Project, commencing in 1997. As the research and development took shape, it became clear that the idea was sound and the technology would revolutionise safety in mining."

Jim Joy is nominated for the Global Mining Industry Risk Management (G-MIRM) education and training package. "Joy is a highly experienced and qualified risk manager who is well-recognised in the global mining industry. As the Director of the Minerals Industry Safety and Health Centre (MISHC) in the University of Queensland (UQ), he was contracted by Anglo American to develop an internal training program to enable employees at all levels (executive to operator) to better understand safety risk and make better decisions both in day to day operations and major engineering decisions where these impact safety. In essence, Anglo American was looking for a cultural change to safety risk management within the organisation. What he produced was unexpected – a truly remarkable program that far exceeded the expectations of Anglo American as, for the first time, a structured process became available that challenged the mindset and tolerance of company executives and line leaders to risk, based on the principle of 'care'. Notwithstanding the well-known and accepted duty of care in the mining industry, the approach developed in the G-MIRM program was confronting, challenging and almost life-changing for those leading Anglo American. The technical content of the program is based on a journey model from basic to resilient across four layers of risk (critical risk down to daily task risk). But it was the ability of the program and Jim's approach to permanently change mindsets and behaviour across a global multinational that was truly unique."

John Pierce-Jones has been at the forefront of mining safety for more than half a century. As the Founder and Chairman of British-based Trolex, a leading name in hazardous gas detection and environmental condition monitoring, he has led the development of a number of systems that have revolutionised mine safety around the world, saving thousands of lives. They include a ground-breaking vibration monitoring system for mine ventilation systems developed in the 1960s. Known in the industry simply as MAVIS, the system was renowned for its user-friendly method of operation, reliability and was depended on for predictive maintenance and system failure indication of vital mine ventilation systems. Working with the Mining Research and Development Establishment in the 1980s, Trolex under his leadership developed an improved mining smoke detector, the Trolex P3270, which was less sensitive to dust and moisture than previous devices and could respond to fires in wind speeds of up to 7 m/s. In the 1990s, he pioneered the TX9042 which quickly established itself as an iconic product in safety. The eight-way programmable sensor controller is hugely versatile and used for sensing gas, flow, pressure, temperature as well as vibration. More recently he has led the development of Trolex's popular Sentro 1 (TX6351) intelligent universal gas detector, and the award-winning Sentro 8, the very latest generation of multi-gas and environmental monitoring systems.

Andy O'Brien and **Andy Cecala** have worked together developing several new innovations including the dust booth and the Helmet Cam (& Evade software). Andy O'Brien is VP of Safety & Health for Unimin Corp in Virginia and Andy Cecala works with NIOSH out of Pittsburg. SK Bowling, the parent company of Clothes Cleaning Systems (CCS), teamed up with NIOSH and Unimin to develop a dust removal system suitable for industrial applications. Today, SK Bowling's clothes cleaning system remains the only personal dust removal method tested and accepted by NIOSH, approved by MSHA and accepted by OSHA. Operators can use the NIOSH-

developed Helmet-CAM in the fight against silicosis. It is a lightweight video recording system that integrates easily into a mine worker's gear and takes advantage of other proven dust control technology. Information is downloaded to a computer and merged through a new NIOSH-developed software program called EVADE (Enhanced Video Analysis of Dust Exposure). The result is a single integrated display of the recorded video above a graph, depicting the worker's dust concentrations as measured by the aerosol monitor in real time.

SmartCap inventor **Dr Daniel Bongers** - Hans Hayes, General Manager - Opencut Mining Excellence at Anglo American Metallurgical Coal: "Anglo American's Metallurgical Coal business has been involved in the development of the SmartCap since it's completion as an ACARP research project in 2008, both through provision of operational advice as well as financial assistance in the commercial development of the product. It is fundamentally important to Anglo American that our employees are safe and are working in safe environments. Incidents involving impact between heavy equipment and light vehicles (whether as a result of fatigue or otherwise) can have disastrous consequences, which is why introducing a new control to monitor fatigue was so important to us as a business. For decades the mining industry has relied on subjective measures to manage fatigue, or more recently, reactive systems that alert the operator once fatigue has set in. While Anglo American has used these subjective systems and trialled the reactive system approach in the past, we wanted to be more proactive. We saw the potential of the SmartCap in delivering a factual based system that measures brain activity, through sensors embedded in a simple baseball style cap, to allow our operators to identify their level of alertness visually and in real-time. By doing it this way, operators can take action in managing their own fatigue and assess different approaches individually in maintaining alertness.

Bulk handling

Sverker Hartwig, Chris Lybaert and **Ludo Van Nederkassel** for the development of Atlas Copco's VSD (variable speed drive) compressor technology, which drastically reduces energy consumption. They have already won Atlas Copco's John Munck Award, presented for excellence in innovative technical thinking resulting in products with a proven commercial success.

At that time they were Sverker Hartwig, Research and Development Manager at Atlas Copco Rock Drilling Equipment; Chris Lybaert, General Manager of Quality Air at Atlas Copco Airpower; and Ludo Van Nederkassel, Engineering Manager at Atlas Copco Industrial Air, and participated in the different project phases of developing and launching a series of VSD compressors that perfectly match compressor capacity to air demand by varying the speed of the drive motor. As air demand is reduced, the VSD compressor lowers the delivered flow and consequently the power consumption. This is its key feature, reducing energy consumption to a minimum by avoiding completely unloaded power consumption and saving up to 35% of energy, or up to 22% on the total life cycle cost.

John S. Frater was nominated by Patrick A. Turner, President - FLSmidth Krebs for his "internationally renowned pump designs [that] have made an extraordinary contribution to the mining industry worldwide. He started the Orion Pump Company in 1981. The patented pump pioneered the design to allow adjustment of running clearances at both the front and back of the impeller. The company was subsequently purchased by Denver Equipment. This acquisition would lead to his position as Pump Product Manager at Denver Equipment, which soon after would be purchased by Metso.

In 1996 he invented "what to this day remains a revolutionary pump, the millMAX pump. The patented suction side sealing has changed the way the industry looks at wear on the suction side liner and pump adjustment overall. The design uses a wear ring to seal between the suction liner and impeller. Further it allows the adjustment of the wear ring to maintain the sealing while the pump is operating. This was a first for any slurry pump. John sold his company to FLSmidth Krebs in 1999 and since that time has served as Pump Technical Director."

Born in 1917 in Chicago, **DeWitt Buchanan**, Jr. succeeded his father, DeWitt (Buck) Buchanan, Sr., as President and CEO of Old Ben Coal Co, one of America's largest coal producers. He eliminated entirely the use of black blasting powder in all of Old Ben's mines and promoted the use of permissible explosives and eventually even replaced those when he introduced the first continuous mining machine. He developed this machine with Robbins and Goodman Equipment to perfect the first type of successful continuous miner, the Goodman boring machine. He also introduced continuous belt haulage and thus made Old Ben one of the first mining companies in the country to completely eliminate track haulage for coal.

Comminution

This category received the highest number of nominations which were shortlisted to Elizabeth Lewis-Gray (CEEC), Joe Pease (IsaMill), John Russell (Mill Relining System), John Starkey (SAGDesign test), Samuel Calvin McLanahan (1842-1928; Log Washer and the Single Roll Crusher) and Prof Alban Lynch.

"**Alban Lynch's** achievements in mineral processing over 50 years have been made in two different but related fields: research and education. Both of these have had a global impact on mineral processing technology itself, on the people who practice the profession, and in the modus operandi of much mineral processing research to-day."

Joe Pease, COO, Xstrata Technology, has been in the mining industry for over 30 years, in a range of technical and managerial roles. A large part of his career has been at Glencore Xstrata's Mount Isa Mines (MIM), and more specifically, in the lead/zinc concentrator at that site. During this time, the 'spark' of using small scale industrial fine grinding in mineral processing was initiated in the labs at MIM to combat the company's deteriorating ore quality, which lead to the birth of IsaMill™ comminution technology.

Then there is the RME mill relining technology. Leaving MIM in 1985, **Dr John Russell** formed Russell Mineral Equipment. Before RME entered this market, a large SAG mill commonly required 160 hours for a standard reline. RME's goal was to halve this. In 2012, the RME RUSSELL Twin 8 Mill Relining System relined a 38' SAG Mill in Chile in less than 40 hours.

In 2011, **Elizabeth Lewis-Gray** chaired the inaugural Board meeting of CEEC International. She had identified a significant gap in accessing data on energy efficient comminution processes. While comminution is known to be the highest energy consuming step in mineral processing, she discovered it was challenging to source published documentation to support this hypothesis. Crushing and grinding steps in mineral processing represent a substantial proportion of total electrical energy in mining up to 3% of the world's electrical energy. For some mine sites the energy usage by crushing and grinding processes represents up to 70-90% of total energy consumption.

It is claimed that **John Starkey's** SAGDesign™ test "is the most accurate grindability test available." It measures the pinion energy to grind ore from 80% passing 152 mm to 80% passing 1.7 mm (WSAG). The second stage of the test measures the Bond Ball Mill Work Index on SAG ground ore, Sd-BWI.

Samuel Calvin McLanahan changed the direction of his family's company (today's McLanahan Corp) from that of a foundry to a leading manufacturer of mineral processing equipment. His most important inventions - the Log Washer and the Single Roll Crusher - remain in use worldwide in a wide range of minerals processing plants.

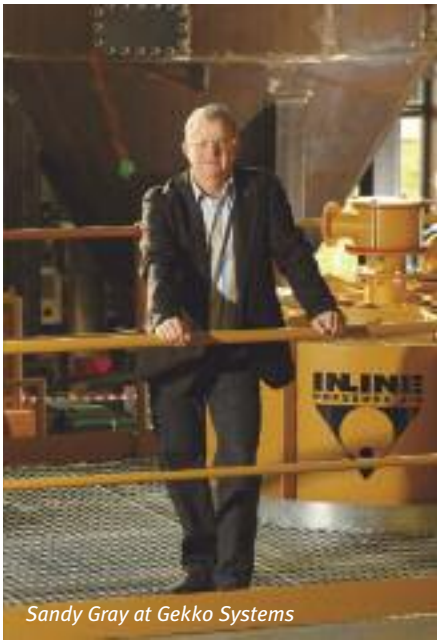
Concentration

Bob Moorhead is another Patrick A. Turner nomination. His "inventive cyclone designs have made a remarkable contribution to the mining

industry. {He} has been a major contributor to the design of the current line of Krebs Heavy Media Cyclones. Unique to this design is the use of a removable ceramic acceleration wedge within the inlet; this allows the end-user to alter performance and/or capacity without having to change required flow split. The new design provides greater capacity and is more efficient than previous designs due to careful correlation between the open area of the inlet, vortex finder and apex orifices."

Philip Thompson from FLSmidth Dawson Metallurgical Labs has been a 35+ year leader and innovator in concentrator-related flotation - specifically in copper moly operations. He is currently the most outstanding flotation expert for copper-moly separation in plant optimisation. Further, he is currently mentoring the next generation of flotation engineers.

Sandy Gray, Technical Director at Gekko Systems, has made a significant and unique contribution with equipment offering a



Sandy Gray at Gekko Systems

conceptual platform that maximises the recovery of minerals by creating a high-grade stream of concentrate from which minerals are extracted by gravity separation, or from which waste is eliminated. In either case, the method provides a simple, economical, and environmentally-responsible means of recovering minerals. He joins his expertise in gold mineral processing with an ability to design a range of innovative, state-of-the-art, step-change mineral processing units or flowsheets. This range of equipment includes; pressure jigs, leach reactors, modular units, and resin columns.

In 1976 **Byron Knelson** tested the first crudely built fluid-bed prototype centrifugal concentrator at an aggregate plant. The first unit lacked the mechanical refinement of today's carefully engineered units, but the metallurgical performance of the unit set Knelson on what would become an exciting and passionate 25 year journey that resulted in the commercialisation of what has become an icon in the mineral processing industry – the Knelson Concentrator. Over the 30+ years since the first crudely manufactured Knelson Concentrator was produced, the machine has become a fixture in many of the world's most prominent gold mines.

Prof Graeme Jameson of University of Newcastle, Australia, is a true pioneer in innovative flotation research, and the inventor of the Jameson Cell which bear his name. This was first introduced 25 years ago at Mt. Isa and is now installed in over 320 operations worldwide. Jameson, now in his 70s, continues to publish innovative work on the fundamental nature of flotation, and this year was awarded the Gaudin Memorial Award at the SME Meeting in Denver. Jameson was nominated twice; by Dr Barry Wills founder of MEI and by John McGagh, Head of Innovation, Technology and Innovation, Rio Tinto.

Maxie Anderson, Joe House, Don Agers and **Ronald Swanson** are nominated for the development of copper SX-EW. The reagent LIX 64, containing the ketoxime LIX 65 and a catalytic amount of LIX 63, was introduced in 1965 and in March 1968 the first commercial copper L/SX/EW operation, the Bluebird plan of Ranchers Exploration and Development Corp, came on line. Bluebird proved that L/SX/EW technology could produce large quantities of good quality cathode copper on a consistent day to day basis at a profit. This raised the awareness and sparked the interest of the industry in copper L/SX/EW. ***IM***