Comminution has long been known as an energy intensive and inefficient process. The Coalition for Eco-Efficient Comminution (CEEC) is well known to IM readers as the global non-for-profit industry funded organisation which aims to raise awareness of comminution research findings, alternative mineral processing strategies and installed outcomes in order to address this problem. CEEC aims “to accelerate information, knowledge and technology transfer with the objective of lowering processing costs and improved shareholder returns as a result of improved comminution energy utilisation.”

The 2012 CEEC Roadmap, freely available on CEEC’s website, recommended that the mineral processing sector develop clear benchmarks and standards for use by process designers, equipment manufacturers and project operators. This allows performance to be compared with industry standards and with others operating in similar circumstances so that strategies can be devised to achieve best practice. Best practice needs to be viewed as a full system initiative, and include strong leadership from executive level; overall operational efficiency; planning systems; equipment efficiency; maintenance systems; control systems; and technical support systems. The Roadmap recognised that an important part of any change process is to identify and implement appropriate business drivers and KPIs, and communicate the benefits to stakeholders.

Sarah Boucaut, CEEC Executive Officer told IM: “The first step toward realising that large or small efficiency improvements are possible is through an understanding of best practice and the use of industry benchmarks. In fact, the 2012 CEEC Roadmap identified best practice and benchmarking as immediate actions to achieve efficiency in mineral processing. Examples of best practice need more publicity, supported by evidence of their impact on financial outcomes. Delegates at the 2014 CEEC Workshop identified a number of examples of current best practice. For example, technologies such as high intensity blasting can improve comminution; and the use of integrated sensors and data analytics can optimise pre-concentration adding 15-50% to a project’s NPV.”

Achieving standardisation in comminution
Guidelines for measuring standardised industrial comminution throughout are in development by the Global Mining Standards group. The adoption of these standards will form a common platform on which comparisons of efficiency may be made. Using energy efficiently helps organisations save money as well as helping to conserve resources and tackle climate change. ISO 50001 supports organisations in all sectors to use energy more efficiently, through the development of an energy management system (EnMS). ISO 50001 has been awarded to New Gold’s New Afton mine in Canada. In order to achieve accreditation, the site had to establish comprehensive energy measuring systems for the entire mineral processing operation. Benefits from this achievement include the ability to forecast energy requirements with more accuracy, more accurate cost allocation and improved budget planning.

Multiple benefits will result from the measurement of current practice using a standardised set of measurements tools and common comparison tool. They include internal team building; internal data analysis; comprehensive monitoring of energy use; improved budget planning; more appropriate KPI measures; team building across production silos; optimised equipment performance on site; improved risk tolerance for trials of different processes; accurate cost analysis to support business case development; improved collaboration with business partners and communities; improved energy efficiency in mineral processing; more efficient energy use on site; and improved shareholder satisfaction. Processes for measuring optimal operation at each site have evolved.

Paul Moore reviews developments in comminution, from standardisation of measurement tools, to further HPGR application and grinding media
regionally, based on proximal expert knowledge. Therefore, a range of measurement processes exist. This adds to the complexities of comparing operations across different sites.

Dr Grant Ballantyne from the University of Queensland’s JKMRC presented a survey of the comminution energy requirements of gold and copper producing mines at the 2014 Mill Operators’ conference in Townsville. His work provides reliable benchmarking data that can be used to compare comminution energy consumption across different minesites. The total gold and copper production of the mines included in the study equated to 15% and 24% respectively of global production and all of Australian production.

The comminution energy per unit metal product is presented in a graphical form similar to a cost curve. This simple technique allows individual mines to be ranked with respect to energy consumption and clearly displays the potential energy and cost benefits of moving down the graph into more efficient operating regimes. The anonymity of the comprehensive, mine-specific data is maintained and the variability is visualised by constructing an ‘energy curve’. Since these types of curves are well known in the mining industry, this format is easily recognised and can then motivate behaviours to move an operation down the curve. This approach also allows flexibility in the way comminution energy intensity is displayed (such as energy per rock milled or metal produced) thus providing a fairer comparison between sites.

**CEEC hosts secure database**

In 2015, CEEC will host the use of the easily interpreted energy curve format to visualise energy use in mineral processing. Using a secure log in, operators will be able to enter specific performance parameters, and view their current operating efficiency on the curve format, relative to other operators. The applications of energy curves are many and varied. They can be used to map the position of the mine as production progresses with year-on-year analysis. Circuit design proposals can be compared to assess the position of the mine on the energy curve when operational. Operational efficiency improvements can be mapped on the curves to visually assess the magnitude of reductions achievable through various strategies. The efficiency with which the various comminution devices achieve size reduction can be mapped down a circuit to identify opportunities for improvement and the magnitude of achievable gains. CEEC will hold an industry review in September 2015 for gold processing; it is anticipated that up to 75% of the world’s gold production data will be included in the resulting report. The same format will be used for comparison of copper, nickel and platinum production efficiency in the future.

**Evolution at Weir Minerals**

Trio Engineered Products was acquired by The Weir Group PLC in October 2014. The acquisition of the Trio Engineered Products business enhances Weir’s portfolio as a supplier of mineral processing equipment, including primary gyratory and secondary jaw crushers, cone crushers, HPGRs, scalping screens, incline vibrating screens, conveyors and feeders as well as a full suite of washing equipment. Due to the extensive brand recognition in the sand and aggregate industry, the Trio® brand name will continue to be used, in the same way that other brands such as Warman® centrifugal slurry pumps were retained after they became part of the Weir Minerals portfolio.

Weir Minerals stated to *IM*: “The expertise of the Trio Engineered Products team strengthens Weir Minerals’ ability to be able to offer full processing plant design and commissioning services to EPC and EPCM companies. Weir Minerals’ value proposition is to supply premium quality, long wear life products and spare parts into the minerals processing market. The global coverage that Weir Minerals provides through its extensive network of manufacturing and service facilities increases the support available to the large existing Trio customer base in the mining industry with aftermarket service and support. This includes the future supply of retrofit high wear parts with new materials and designs to improve efficiency and wear life. The flip side also applies, as Weir Minerals already has an extensive installed base of mining customers currently using its pumps, cyclones and valves, as well as service capability just to name a few. This customer base will now also have access to the extensive range of Trio comminution products, thus reinforcing Weir Minerals’ capacity as a ‘one stop shop’ for the customer.”

The product range will also be expanded beyond the current range provided through the Trio acquisition. Weir Minerals plans to continue its investment in crusher technology, including expanding its range of crushing equipment. In products, Weir Minerals has a high pressure grinding roll (HPGR) in its offering.

Application dependent, the HPGR can effectively reduce the energy consumption required to create the final product for the next milling stage or in some technologies such as dry fine grinding with air classification, eliminate the final mill completely. For example, an HPGR, in combination with an air classifier, can replace a tertiary cone and regrind mill.

A key move in the mining market by Weir Minerals is to introduce the Enduron® HPGR for dry grinding which enables a feed F80 of 32 mm of crushed material to be reduced to P80 of around 170 micron. This is achieved by having a closed circuit in combination with a dry air classification, removing the desired product and recycling the larger particles back to the HPGR feed. The final product can be made even finer by lowering the product cut so that more material will be recirculated.

This technology is potentially applicable to any type of grinding circuit as long the moisture of the feed is low enough that air can classify the HPGR product. Weir Minerals told *IM*: “This makes the HPGR ideal for projects in those parts of the world with arid environmental conditions that force the operator to use as little water as possible. In addition to the advantages associated with the reduction of water usage, transport and treatment, space and energy savings are achieved through the elimination of the large geared drives used on SAG and ball mills.” A further major benefit, in either dry applications or in a ball mill circuit, is its extended wear life. The rolls on Weir Minerals’ HPGR equipment can last for 10,000 or 12,000 hours, depending on the material being ground. In some pellet applications wear life can extend up to 35,000 hours. Weir Minerals’ Enduron HPGRs are manufactured in Venlo in The Netherlands. This is also the location where the group
manufactures Geho® PD slurry pumps and Warman axial flow pumps. The site has the advantage of being able to handle large equipment such as Enduron HPGRs which can weigh as much as 400 t. There is also some commonality between the positive displacement pump and HPGR production such as in relation to the hydraulics and drive train, the engineer to order process, supply chain and the safe handling of heavy components, resulting in high efficiency production.

Weir Minerals told IM that there are five main areas where it sees its Enduron HPGR as having a competitive advantage versus others in the market. Firstly are the studded rolls. The unique pattern and density of the studs on the rolls used in Enduron HPGRs makes for a very long life, meaning Weir Minerals can offer some of the longest HPGR warranties in the mining industry. The company has also designed the frame around the Enduron HPGR to enable very quick change out of HPGR rolls, therefore achieving higher operating availabilities.

The Enduron HPGR also has a low diameter to width ratio which means that it has a smaller diameter but greater width compared to others in the industry. This enables a greater throughput and smaller operating gap, resulting in a lower wear rate based on the final product.

The model also utilises cylindrical roller bearings, which allows the Weir Minerals machine to have a smaller bearing housing. These bearings are grease packed via a closed oil lubrication system, making them one of the longest lasting in the industry (around 30,000 to 50,000 hours), “proven on site in HPGR machines operating around the globe.”

Finally, additional to the advantages of closed oil lubrication, including environmental benefits, is a proven anti-skewing system which also helps to achieve the long wear life in the operating machines.

**Mill lubrication and gearing**

Lubrication of bearings in mills is important in maintaining uptime. A Peruvian mining company was operating a Metso 32 ft x 34 ft SAG mill for gold ore processing. One recommendation was to lubricate the mill bearings with a standard mineral oil, and set oil drain intervals at one year. However, with hopes of increasing productivity and reducing the total cost of ownership, company managers approached ExxonMobil to determine a lubricant solution capable of safely extending oil drain intervals beyond the one year mark.

ExxonMobil recommended transitioning to Mobil SHC™ 630 bearing oil. Formulated with high viscosity base fluids and a unique, proprietary additive system, the company states that it is “scientifically designed to provide outstanding performance in extreme service applications. Mobil SHC 630 is also laboratory proven to provide significant efficiency improvements over standard mineral oils.”

Complemented by good maintenance practices and routine oil analysis, Mobil SHC 630 bearing oil helped the mining company extend oil drain intervals from one year to three years on the SAG mill without any identified concerns. ExxonMobil states: “Maintenance personnel were so impressed by the lubricant performance, they’ve considered extending drain intervals even further to five years. By tripling oil drain intervals, the company has reduced oil consumption, decreased labour costs, increased plant availability and conserved energy resources, generating an estimated savings of $1,112,000 over three years.”

Since the development of its fabricated girth gear in 2013, David Brown says it has had “an unprecedented level of success” manufacturing gears for major grinding mill OEMs, not only across Africa but in Europe and the Americas. As a key part of the comminution process, girth gears drive processing equipment such as AG and SAG mills, often in arduous environments where strength and robustness is imperative. As previously covered in IM, David Brown girth gears are manufactured at its Mining Centre of Excellence in Benoni, South Africa, which has developed a global supply chain to ensure cost effective, high quality gearing. For decades, David Brown in Benoni has delivered gears to the comminution process, including mill drives, pinions and its largest girth gear at 12.5 m diameter.

Henk du Preez, Engineering Manager and Girth Gears Lead told IM: “Our customers can choose to operate both cast and fabricated girth gears and we are proud to be a leading engineer of both. We recommend the best manufacturing method based on key factors such as the customer’s technical specification, their application and lead time. We are currently experiencing an even split of cast and fabricated girth gear orders – arguably cast gearing is the more traditional method and possibly perceived to be lower risk. However, it is important to stress that fabricated gearing has excellent material properties, especially when manufactured using the unique hot forming method David Brown is known for. It is also a cost effective, speedier option for the customer.”

David Brown’s first fabricated girth gear was delivered in June 2014 to drive a SAG mill at a platinum mine. Since then, David Brown has developed key girth gear business from the mining majors, which it will continue to deliver over the course of 2015.

**Grinding media Americas growth**

Arun is a global leader in the supply of forged grinding media through its Newcastle, Australia-headquartered subsidiary Moly-Cop. In a recent presentation, the company says it aims to capture market share based on growth in demand for grinding media in North and South America, as well as maintain existing its strong market position in Australasia. Moly-Cop is completing capacity expansions in Canada and Peru (equivalent to 295,000 t/y) on time and budget. At Kamloops, Canada commissioning is planned for mid-2015 (120,000 t/y), while in La Joya, Peru, completion is scheduled for mid-2016 (175,000 t/y). The company is also working on the market roll out of its new generation SAG ball, the Moly-Cop NG, which it says is progressing well with strong customer support by virtually eliminating large diameter ball breakage in SAG mills. The group says it is continuing its long-term supply contracts approach with strategic customers, with the industry dominated by a top list of about 20 customers that account for about 80% of grinding media sales; and basically equate to the key global copper, gold and iron ore mining companies. Customer contracts and supply agreements are typically 10,000-50,000 t/y and are two to five years duration with Moly-Cop having some supply relationships with certain customers that have lasted for over 30 years.

Grinding media consumption is expected to grow in direct proportion to tonnages of copper, gold and iron ore being milled worldwide. Moly-
Moly-Cop sees its strengths as being located close to its customers, “assuring timely and flexible delivery of products” and minimising risk of interruption to operations. “Regular on-site technical customer support allows for deep understanding of customers’ business operations and requirements”, while targeted product development activities with tailored solutions aim to “deliver high quality value-in-use outcomes to customers.” With the specific purpose of providing effective customer technical support to its customers, Moly-Cop has developed the comminution simulation software package Moly-Cop Tools®, now in its third version, made available free-of-charge to all interested parties. Moly-Cop is recognised for its superior product quality and performance, helping customers maximise throughput and yield. The company says it has a strategy of building capacity ahead of forecast market demand, to secure a ‘first mover’ advantage with current expansion projects securing a longer-term “in-region position.” The company has also developed the so-called Drop Ball Testing (DBT) methodology which can provide reliable off-line estimates of the expected breakage performance of any given type of media; particularly in the case of modern high-impact SAG mills.

Barbagallo told IM on the market: “Grinding media demand is about 80% from copper and gold mines and 20% other, the majority being iron ore. In the medium term, head grades of copper and gold are expected to continue deteriorating over next 10 years which should increase grinding media demand.

Strong growth is predicted in global copper ore milled, expected to increase 45% from 2014 to 2019, with the most significant growth anticipated in North and South America. There is a stable outlook for existing mines with low numbers of closures expected with a good pipeline of new projects and expansions.

Equally, strong growth in gold is expected, with global gold ore milled expected to increase 32% from 2014 to 2019, again with the most significant growth anticipated in South America and North America.

John Barbagallo, Chief Executive, Mining Consumables at Moly-Cop estimates additional grinding media demand of some 460,000 t/yr in 2018 in North and South America alone.

Expansions aside, key projects in Chile include Codelco MMH, Caserones and Sierra Gorda, all of which have already commenced operations in 2014. In Peru, Toromocho has commenced operations, and Constancia and Las Bambas are under construction. In Canada, Mt Milligan is up and running, Red Chris is being commissioned and Goldcorp Eleonore is under construction.

Moly-Cop has manufacturing facilities in the same region as any given type of media; particularly in the case of high-impact SAG mills. However, the group is also seeing new customers around the world, in both established mining districts and in new mining districts such as Asia and Africa.

ME Elecmetal manufactures grinding media for both SAG and ball mill customers. Greg Schick, Director Milling Solutions - Grinding Media Division told IM: “We offer three basic grades of SAG balls which are designed to work in a variety of SAG milling conditions. Our ‘S’ series, or standard balls, have proven to work in a wide range of SAG mill operations, with the near elimination of ball breakage – which was widely accepted in the industry as ‘normal’ before the ME Elecmetal product – and excellent resistance to media consumption caused by abrasive wear. We offer ‘HH’ or High Hardness series media with high resistance to wear for mills with low impact. We offer ‘T’ or Tough series media with high toughness for mills with aggressive impact conditions. We also offer two grades of ball mill balls, the Ultragrind and Performa II balls. In a wider sense, we are committed to continuously improving our product quality and customising our products to meet our strategic customers’ changing mill dynamics. Such efforts often times lead to optimised grinding results and lower grinding media consumption. In some cases, the optimised gains achieved through collaboration between our customers and us are so significant that they more than offset the increased consumption need from ore grade decreases.”

Chile and Peru are the countries with the highest concentration of copper ore processors and represent a large market for ME Elecmetal. However, the group is also seeing new customers around the world, in both established mining districts and in new mining districts such as Asia and Africa.

ME Elecmetal says it actively engages with the customer in monitoring media consumption and grinding process performance. “Before our products are used in any major milling operations, we conduct a mill operation survey and make an initial media recommendation based on a number of factors provided by the customer, and then make additional recommendations based on the actual performance encountered once our balls are in the mill. We also help study grinding efficiency performance and can make recommendations based on testing to change media size for improved grinding efficiency.” There are two basic types of grinding media commonly used in ore grinding applications: forged carbon steel and cast white iron. ME Elecmetal makes forged carbon steel media from 22 mm to 165 mm.
Forged media are made from steel rods which are heated, cut, forged into spherical shapes, and then heat treated for the designed hardness and toughness characteristics. ME Elecmetal uses high quality steel bars manufactured with proprietary technology that produces a premium quality. “We have a brand new, state-of-the-art ball production facility in China, which has was commissioned in 2011 and has recently completed its third expansion project. At this plant, both forging and heat treatment are controlled to the most stringent requirements in the industry. Our ball plant is certified to ISO 9001-2008, OSHAS 18001 and ISO 14001 standards.” The plant is located in Changshu, China, a joint venture with Long Teng Special Steel.

On the process of choosing the right media, Schick told *IM*: “The ore being processed at any one mining operation is always the major determinant at that operation in all aspects of mill performance, including media consumption. The choice of grinding media should be based on cost per tonne of ore ground, which is the product of the media consumption in terms of g of media/tonne of ore times the price of the media in $/g of media. When using this approach, a higher quality, higher priced media can be proven cost effective by having a lower rate of consumption. There are also other factors to be considered as well. Many of our SAG customers have realised improved production when using our balls. The improved productivity comes from better impact kinetics, reduced ball breakage, and better shape characteristics of the worn balls, which also lower the occurrence of liner grades plugging.”

With the slump in metal prices and the high cost of doing business, mining customers are examining all costs. Electric power and grinding media are the two largest costs in a mining operation with grinding circuits, often accounting for two thirds of costs. “Our goal is to work with customers and take steps towards reducing cost per tonne of ore ground by using high performing media such as ours, carefully controlling media additions to avoid waste, and improving grinding efficiency to reduce specific power consumption. We feel that we work well with customers that take a holistic approach and analyse the entire cost of grinding. We have introduced the ME FIT system to bring all the tools and products that ME Elecmetal have to offer to bring improved mining solutions to the customer.”

**Wear studies in grinding media**

Specialist in high chromium grinding media, Magotteaux, which is based in Chaudfontaine, Belgium but since 2011 part of the Chilean Group Sigdo Koppers, recently presented an in-depth paper entitled *The use of high chromium content grinding media in the mining industry*, authored by Christopher Greet - Manager Metallurgy/ Minerals Processing Research; and Alfred Van den Bosch, Manager Technical Development Department.

A range of media alloys with different chromium content has been developed by the group for different milling applications but when selecting the grinding media alloy for a specific application, Magotteaux emphasises that “consideration must be given to the mineralogy of the ore as well as the water chemistry and mill operating conditions.”

The paper describes the influence of the microstructure of the alloy on the wear resistance and the influence of the chrome content on the pulp chemistry and downstream processing. It also provides information about the in-house tools which Magotteaux has developed to predict the media wear rate with different chromium content alloys and predict their flotation efficiencies that can be expected when the right alloy is selected for a particular application.

The range of grinding media produced by Magotteaux consists of high carbon steel balls (forged and cast balls) as well as an extensive range of high chromium content media. The percentages of chrome in the high chrome balls vary from 11% to 30%. The high chrome balls are produced by casting the liquid metal into moulds, followed by different heat treatment cycles to obtain the desired properties. These balls’ structure consists of a matrix in which chromium carbides are distributed. These chromium carbides are much harder than the iron carbides in steel balls giving the high chromium balls a better wear resistance.

Wear in a grinding mill can be attributed to abrasion, corrosion and impact. The overall wear is generally a combination of all three wear mechanisms, and each wear mechanism can also influence the other ones. For instance, in cases of high abrasive wear the influence of corrosion becomes less important. Wear due to abrasion, in extreme cases, can be observed by the removal of ball material due to the scratching of hard constituents in the ore on the ball surface and thus removing part of the surface. The main factors influencing the abrasive wear are the type of the minerals in the ore, their percentage and their hardness; the granulometry of the feed and ball size; and the mill diameter. For abrasive cases, the solution is to maximise the hardness of the matrix and the percentage of chromium carbides.

Corrosive wear can result in the typical golf ball-effect where corrosion pits are formed. The main factors influencing the wear by corrosion are the water composition: pH, aggressive ions like Cl⁻ and S²⁻ ; and the ore composition, especially conductive minerals such as sulphides, magnetite and haematite. For corrosive cases, the solution is to maximise the chromium content in the matrix.

Repetitive high impacts will lead to small metal pieces coming off the ball surface due to stresses being built up in the ball. In case of extreme impact conditions the media can even break. The main factors to be considered in impact wear are the size of grinding media and mill diameter; the type of discharge, whether by overflow or grate discharge mill; the influence of the liner design and mill speed defining eventual ball trajectories; and the total filling degree in the mill, as well as the grind-out procedure in grate discharge mills. A high impact case will require a higher toughness usually obtained through a tempering heat treatment. Magotteaux states: “By analysing the above mentioned factors, we determine the importance of each wear mechanism which enables us to define the required ball specifications and properties for the specific milling application. In case of corrosive conditions it is possible to carry out some additional test work to be able to better judge the influence of corrosion on the wear rate. Using the pulp from the mill the polarisation curves are recorded for different ball alloys. The polarisation curve is established by imposing a potential over the ball alloy and measuring the resulting current. High levels of current indicate a higher risk of corrosion.”
In order to test different alloys (including new developments) in the industrial mill at the same time, a marked ball test is carried out. The test consists of loading drilled balls into the mill and to retrieve them from the mill during a mill stop. Each alloy in the test is drilled with a different pattern of holes (two holes of 4 mm diameter at ±80°, two holes of 6 mm at 90°, etc.) to allow easy recognition. The main advantages are that different alloys can be tested under the same operating conditions without having to do a full scale industrial test. Results are obtained quickly and the cost is far lower than an industrial test. The loss of weight for the different alloys is then extrapolated to obtain a wear rate expressed in grams per tonne milled for each alloy.

In its databank, Magotteaux has information on more than 2,000 plants and the results of in excess of 900 marked ball tests with on average five alloys per test or 4,500 test results with different ball alloys. On the basis of these data a mathematical model has been developed to calculate the wear rate of the different alloys in ball mill applications. The inputs into the model are factors mentioned above as well as the throughput of the mill and mill absorbed power. The foreseen wear rate for the different alloys is expressed in grams per tonne milled or grams per KWh.

Depending on the specific case, the use of high chromium balls can reduce the wear rate by between 26% and 67% compared with standard steel balls.

**Pulp chemistry and grinding media**

One of the most significant differences between the various geological ore types is the pyrite content, which has a major influence on the mineralogical character of the ore. To investigate the pyrite influence on the pulp chemistry of the system, it was monitored during grinding using the Magotteaux Mill®. In the first instance the Eh of the laboratory mill discharge was plotted against the pyrite content when the various ores were ground with steel grinding media. Broadly, as the pyrite content increased the Eh of the system becomes more reducing, suggesting that the grinding environment became more corrosive with increasing pyrite feed grades.

Interestingly, for the steel media system the porphyry copper ores recorded laboratory mill discharge Eh values around 95 mV (SHE), and comparatively low EDTA levels (0.05 m²). The sedimentary copper deposits tended to behave in a similar fashion to the porphyry ores. However, the iron oxide copper/gold and VMS style deposits exhibited more reducing pulp potentials and higher EDTA extractable iron values – so higher corrosion rates.

The application of a more chemically inert grinding media should have an impact on the pulp chemistry of the system, particularly if the alternate media is a high chrome white iron which has inherent corrosion resistance. Within an alloy, as the pyrite content of the ore increased, the Eh of the mill discharge became more reducing, the oxygen content of the pulp decreased, the oxygen demand increased and the EDTA extractable iron increased. This suggests that as the pyrite content increased the ore became more reactive. However, for the same geological ore type, as the chrome content of the grinding media increased, the Eh of the system shifted to more oxidising pulp potentials, the dissolved oxygen content increased, the oxygen demand was reduced and the corrosion rate (EDTA extractable iron) decreased.

Magotteaux states: "It is apparent from this data that the porphyry copper ores, with their low pyrite feed grades, produce ball mill discharges that have comparatively oxidising pulp chemistry when grinding with steel balls. Changing to high chrome white iron grinding media does shift the pulp chemistry to more oxidising Eh values, higher dissolved oxygen contents, lower oxygen demands and produces less EDTA extractable iron. The difference between high chrome alloys is relatively minor."

At the other end of the geological ore type spectrum the VMS ores with their high pyrite content are very reactive, and produce ball mill discharges with very reducing pulp chemical conditions. These ores have very high oxygen demands and exhibit high corrosion rates. The conversion to high chrome grinding media does shift the Eh to less reducing values, but the dissolved oxygen remains very low, with high demand for oxygen, but the corrosion rate is reduced (ie lower EDTA extractable iron). The variation in pulp chemical parameters, particularly EDTA extractable iron is marked.

"It is expected such changes in pulp chemistry would have a bearing on the metallurgical performance on the various ores. Further, the variations in pulp chemistry also suggest that the grinding media best suited for a porphyry copper ore is unlikely to be optimal for a VMS style of deposit."

Finally, laboratory copper rougher rate flotation tests were then completed on each of the samples for each alloy in triplicate. The data suggests for all alloys tested that the copper recovery decreases as the pyrite content increased. The second and probably the more important point, is that the high chrome alloys produced markedly different copper recoveries depending on the alloy and the pyrite content.

For low grade pyrite ores (porphyry copper deposits) the low chrome alloy produced superior maximum copper recoveries to steel and the two higher chrome content alloys. As the pyrite content of the ore increased the metallurgical performance of the low chrome alloy deteriorated to below that of steel. The reasons for this behaviour are related to this alloys poor corrosion resistance. The vast majority of the chrome in this alloy is present as chromium carbides that give this media excellent abrasion resistance but poor corrosion resistance. Consequently, these low chrome alloys work well in low pyrite (low corrosion) systems but do not survive in highly corrosive environments (VMS ore types).

"As the pyrite content increases there appears to be a transition from low chrome to medium and high chrome alloys at around 10 to 15% pyrite. At the intermediate pyrite feed grades (10 to 25%) it is probably that the medium chrome alloys produce the best pulp chemistry for copper flotation and this ultimately results in improved copper recoveries when compared with tests where steel grinding media is used. For VMS ore types the high chrome alloys tend to produce the optimum pulp chemistry and yield the best copper recoveries."

**Siemens largest mill drive development**

Like in all other industries mining projects are forced to generate an expected profitability over a long period of time, but in contradiction to other industries mining projects are facing extraordinary challenges. New mines will be more and more in remote and challenging areas of high altitudes or extreme climate conditions. Moreover new projects are facing lower ore grades compared to past projects. These challenges have always been a strong motivation to gain profitability by increasing the throughput with bigger and higher efficiency and availability equipment. The demand for grinding mills beyond today’s standards of 40 ft is just a natural market law and will challenge the key suppliers soon. Past experience guided Siemens to establish a new culture in designing bigger and more powerful Gearless Mill Drive for the expected demand for 42 ft and 44 ft mills.

The evolutionary design methodology is to reuse proven design elements and a detailed risk assessment and root cause analysis is the basis of the Siemens 42 ft ring motor design. The company adds: "But as the first installations of the 40 ft GMDs at Cadia and Collahuasi have shown, evolution is not enough. The Finite Element modelling has to give a look beyond experience. Simulation can reduce the remaining risk of a new design only if we ensure a computer model as a realistic image of the reality." Siemens tuned and evaluated their ring motor FE-Model with the 20 MW GMD at the Peñasquito site in Mexico. Up to forty acceleration sensors have been placed inside the motor to measure the impact of two shakers attached at the top and the bottom of the motor housing. These tests
provided a detailed frequency response and structural stress analysis of the motor during different situations: stability of the motor construction as built; structural stress impact of the magnetic pull to the stator after energising; and motor behaviour during normal operation with mill loaded. The result is the design of a GMD motor for a 4.2 ft grinding mill providing up to 35 MW of power.

As the present mining industry environment is still in a downturn Siemens is focusing on brownfield projects and highlighted to IM as a key part of its offering its ability to support its customers to achieve maximum availability of their assets, including through modernisation of their mill drive systems. “Many Siemens mill drives have been in operation for decades. While motors easily achieve this lifetime, the situation with electronic controls can be different. Rapid advancements in electronics and computer technologies have allowed significant progress in the control technology of mill drive systems. For long-term operation of your mine, the only comprehensive solution to the challenges of aging devices is the stepwise modernisation of the old control systems. Of course there is no single modernisation concept or one-size-fits-all. Rather, for each individual customer and each specific installed system, the most suitable modernisation solution has to be determined based on the customer’s prioritised criteria. Siemens has been successfully implementing modernisation of selected equipment at installed systems for many years. However, the introduction of the SINAMICS SL 150 drive control system for cycloconverters triggered an extensive engineering development with the specific aim of evaluating the complete electrical components of the older systems, defining adequate substitute solutions and developing alternative modernisation concepts. The result of this development is a variety of innovative approaches, based on standard modules, to modernise the existing mill drive to a state-of-the-art system to prepare it for many further years of continuous and reliable operation.”

**ROM particle size distribution and comminution**

A recent paper from Split Engineering and Rocha Blast Engineers, presented at the recent New Orleans ISEE conference and at SME 2015, tackled the impact of ROM PSD on crushing and grinding circuit throughput. The run-of-mine size distributions due to blasting have a great influence on the performance of a SAG mill. In this paper, a mine case study was conducted where there are four primary geologic units and the material properties between the four units vary considerably. Also, the mixture of the four units that will be mined at any given time also varies considerably. This presents a challenge in terms of optimising the blasting for mill production throughout the mine life. As part of the case study, field rock mass characterisation, laboratory rock mechanics tests, and laboratory breakage tests were conducted. The field characterisation and rock mechanics tests provide material properties used to simulate the effect of different blast designs on run of mine particle size distributions (ROM PSD). The rock breakage tests provide material properties used to simulate crushing and grinding performance. The JKSimMet software was used for these simulations.

The goal of the mine is a mill throughput of 95,000 t/d. Based on this goal, run-of-mine fragmentation analysis was conducted for four blasting designs resulting in powder factors of 0.44, 0.54, 0.64, and 0.94 kg/t. The powder factor of 0.44 represents a standard blasting design, while the 0.54 and 0.64 kg/t designs are high-energy blasts specifically to assist with mill production. The 0.94 kg/t design was investigated for the one geologic unit with very high strength. The results of the run-of-mine fragmentation analysis were then inputted into a crushing and grinding simulation model to predict the mill throughput for the time periods of 1-5 years and 5-10 years. The results indicated that certain blast designs are able to achieve the 95,000 t/d goal, while other blast designs were not. A standard blast design with a 0.44 kg/t powder factor, for example, was not able to achieve the throughput goal, while a design with a 0.64 kg/t powder factor was able to achieve the goal in both the 1-5 and 5-10 year time periods.

**Increasing roller mill outputs**

Requirements in the mining and cement industries for mill output continue to increase, with the result that Loesche has adapted its well-proven module concept to this greater mill output. Now, alongside the mill types with 2+2 and 3+3 rollers, the customer can also use a mill with 4+4 rollers. Loesche has already been building on this patented technology for over two decades. In the early 1990s, the 2+2 concept was patented, and later extended to the 3+3 module design. Now, a few years later, the development of the 4+4 grinding concept follows, which offers the customer outstanding flexibility. “On the one hand, this allows the desired high throughput capacity to be achieved, and on the other hand, it offers the possibility of running just as well in 2+2 roller operation, thereby generating a mill output of 60%.”

The success of having sold over 300 mills for grinding clinker and slag on the market allows Loesche “to use this experience to further develop the trusted concept and to continue to provide customers with the well-known technology.” The innovative development in the Loesche mill type LM 4+4 is not only the expanded module concept but also the drive. The increasing performance requirements of cement producers led Loesche to rethink further developments in drive technology but the mills also have applicability in mining. Particularly for larger mill outputs, Loesche favours a drive system with multiple motors and gearboxes with milling force decoupling.

In order to meet these demands, Loesche will use the COPE gearbox developed in cooperation with Renk, which offers a redundancy of up to eight motors at the motor end. With all eight motors in operation, a capacity totalling 8.8 MW is achieved. The new COPE gearbox contributes the feature of working without variable speed drive and also operating with a reduced number of motors. This means the new drive concept allows for operation with, for example, 7, 6 or only 4 of the available motors. Even in operation with only 7 motors, 100% mill output can be attained.

Because this drive train works with the normal dimensions, the system is also suitable for retrofit gearboxes in existing mills. With this drive concept, “Loesche can put a highly redundant, innovative drive system for the new Loesche mill type LM 70.4+4 & LM 75.4+4 on the market with short delivery times and low investment and construction costs.”

The recently sold Loesche mill type LM 70.4+4 will be used with an output of 370 t/h; 4,700 Blaine in UNICEM Nigeria’s new line in Calabar, Nigeria. The delivery period is 14 months with commissioning due in 2015.

**Stirred media mill development from CITIC HIC**

A high proportion of new base metal resources are tending to be relatively fine grained which ultimately require grinding below 45 microns. As grinding gets finer the surface area increases exponentially as does the power requirement. Rajiv Kalra, General Manager at CITIC HIC told IM:
“The traditional tumbling mills have become inefficient with the development of stirred media mills in recent times, which have become the preferred option for regrind and fine grinding applications. There are only a few manufacturers producing stirred media mills in either vertical or horizontal design. CITIC Heavy Industries is one of the major equipment suppliers in the mineral processing industry with the largest manufacturing facility in the world for grinding mills. CITIC has developed a range of vertical stirred mills with advanced features to handle wide range of regrind and fine grinding applications.”

The range includes the 800 KW CSM800 up to the 4,000 kW CSM4000, with six models in all. Grinding power efficiencies are achieved by 100% filling of charge and smaller steel media (balls) used for fine grinding. Typically, stirred media mills use 25 mm make-up balls, where conventional ball mills are using much larger grinding media.

“The popularity of stirred media mills has risen in recent times. CITIC HIC has developed our own range of stirred media mills to complement our conventional grinding milling range, we have research and development team in Australia and China constantly working on improving the technology and efficiency of our equipment.”

Cited design features/advantages of using CITIC Stirred Mills include a two stage planetary main gearbox design instead of two helical plus one planetary gearbox design. Two stage planetary gearboxes offer 2% more efficiency. Also a better design digging shoe for reduced scrap metal and easy replacement; high efficiency/high starting soft start motor; solid main screw shaft; magnetic shell liners; complete in-house FEA on drive screw and main body; hydraulic jacks to crack the main door for opening; high availability with low maintenance; and optional control panel with PLC touch screen and with MCC.

Three units of the model CSM1200 are currently under manufacture for a project in South America, there units will replace the existing conventional regrind mills in a copper mine. Kalra states: “Almost all components are being manufactured in-house at our factory in Luoyang. In fact, CITIC Heavy Industries has the ability to manufacture every component other than the electric motors in-house. Having a large manufacturing facility in one location we are able fully assembled and test run machines in factory prior to dispatch, which is an option no other mill vendor offers.”

Additionally, CITIC HIC says it has recently developed a new range of Auto JAW crushers for mining industry. The CITIC-HIC AJ) range of single toggle jaw crushers incorporates the use of a hybrid cylinder (patent pending) toggle system. “The new design of toggle system has made the operation and maintenance of the jaw crusher is simpler and safer than other jaw crushers currently available in the market. The traditional tension rod system has been eliminated and replaced by a hybrid cylinder, the toggle arrangement no only allows for the equipment to be easily adjusted. This design also provides tram relief for the equipment which adds another level of protection to the machine and minimises potential damage to the crusher when tramp material enters the crushing chamber.” Models include the CITIC HIC AJ1317 jaw crusher. “An added advantage of this system, the crusher is able to be adjusted while the machine is running reducing which improves the availability and productivity of the crusher. The toggle system has also been designed with maintenance in mind, the toggle system pivots outward to create easy access to the toggle area for maintenance purposes.”

Metso maximises capacity and value

Metso says it reduces the total cost of ownership by maximising the capacity of a single unit to reduce the number of production lines. Metso’s MP2500 cone crusher, HRC3000 HPGR, and Vertimill VTM-4500-C are the largest machines of their kind in the industry. King Lim, Vice President, Gridding at Metso told IM: “By creating a single circuit, we can reduce the need for ancillary equipment such as feeders and conveyors. This consolidation can reduce the structure costs, foundations, and maintenance requirements.”

Ultimately, a line must have the highest availability to achieve maximum capacity. This requires reliable machines that minimise downtime. Metso’s MP2500 cone crusher, HRC3000 HPGR, and Vertimill VTM-4500-C have similar maintenance intervals to smaller units, but with much greater capacity. Since this capacity allows the number of lines to be reduced, overall downtime is minimised since there are less machines and ultimately less wear parts to replace.

Lim adds: “While all of this sounds good on paper, it does not come without its challenges. Larger components can make manufacturing, transportation and maintenance difficult if designed incorrectly. With over 100 years of experience, Metso has the expertise in house to account for all of these challenges. Nowhere is this better emphasised than with the these three large machines which maximise circuit efficiency, availability and reliability due to their higher capacities and innovative designs.”

Metso’s MP2500 cone crusher is the world’s largest cone crusher, weighing more than 450 t and doubling the capacity of its next largest unit, the MP1250. With the largest available feed opening, greater top size capability allows for wider settings at the primary station which could reduce the number of primary crushers. In one current installation, two MP2500s perform as pre-crushers in a 250,000 t/d SABC circuit. In a typical 75,000 t/d HPGR circuit, one MP2500 can feed a single HRC3000. “In terms of maintenance, new features on the MP2500 cone cruscher such as hydraulic socket removal and an improved locknut design ensure that maintenance is simpler, reducing human error and streamlining the process. Lifting features have been designed for many of the MP2500 components to facilitate simple maintenance operations.”

Next in Metso’s portfolio, the HRC3000 includes 3 m diameter by 2 m wide tyres and a drivetrain with a total installed power of 11.4 MW. This single unit can replace two 2.4 m HPGRs, simplifying circuits and improving profitability. “In one current installation, an HRC3000 is operating as a tertiary crusher in a 65,000 t/d circuit.” The large size HPGRs inherently have a larger operating gap, which allows for a larger top size and increases the size of tramp material that can safely pass between the tyres. The HRC3000 includes features unique to the HPGR market such as the patented anti-skewing arch frame and flanges. These features increase the efficiency of the HPGR and its circuit by increasing the amount of ore crushed at the edges of the tyre. In closed circuit testing the arch-frame and flanges were shown to increase the circuit capacity by over 20% and decrease specific energy by over 10%.

Finally, the VTM-4500-C from Metso is the world’s largest gravity induced stirred mill. “Because of its innovative design, Metso was able to reproduce the footprint of a 3,000 hp Vertimill and use it for its largest current iteration, a 4,500 hp device. With this newest offering, Metso has made it practical to use Vertimills in high capacity secondary grinding applications. In one soon to be operating
installation two VTM-4500-Cs are situated in parallel in a primary grinding gold application. The Vertimills are in closed circuit with multiple stages of high frequency screens, and are accepting a feed of 90% passing 3 mm and grinding to a specification of 85% passing 74 microns at 400 t/h."

As with Metso’s other offerings, Vertimills are optimised to be maintenance friendly with maintenance intervals typically exceeding nine months and availabilities exceeding 98%. “These benefits, coupled with their high energy efficiency, low media consumption, small footprints, and process flexibility make them ideal pieces of equipment for any fine grinding duty. Even in instances where many Vertimills are required, Metso has the process capabilities and engineering expertise to design for the most intensive duties. At a Brazilian mining operation, 16 VTM-1500-WBs are currently being commissioned in an iron ore regrind application with a design throughput of 3,040 t/h. With the VTM-7000-C in its final stages of development, Metso has the ability to simplify the most complicated grinding duties and to truly minimise the total cost of ownership for the end user.”

Outotec – integrated functionality
Outotec’s comminution portfolio encompasses a wide range of equipment as well as a large technical workforce that have enabled the company to address market needs through customised offerings from individual grinding mill equipment to entire EPC/EPCM processing plant solutions. This covers traditional but where needed also cutting edge technologies such as vertical fine grinding through its HIG mill, HPGR size reduction through a partnership with Köppern, or ore sorting through a partnership with Tomra Sorting Solutions. Harri Lehto, Outotec Technology Manager - Grinding Processes told IM: “Outotec’s dominant position in downstream technologies such as flotation or enabling technologies such as particle size or elemental analysers contribute to efficient plant design that doesn’t just look at individual stages in isolation, but ensures best possible integrated comminution functionality. Outotec has the in-house knowledge and is continuously working on a better understanding and utilisation of ore data used for prediction of ore amenability to sorting or other processes which have significant impact on comminution and downstream process operation.”

The High Intensity Grinding (HIG) mill has been a recent addition to the portfolio. It is based on existing, well proven stirred milling technology for white minerals processing. After launching this new fine grinding approach for the metalliferous mineral processing industry, Outotec started an intensive testing campaign with several pilot size units. Based on pilot scale testwork results, the company strongly believes that it has the best available technology to offer in this area, especially regarding regrinding and tertiary grinding applications. “First to market HIG mill installations and commissioning are ongoing and there is more to come. Although it has taken some time to ensure technical maturity, the future looks very bright indeed for this product.”

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Outotec has a large comminution specific workforce dedicated to grinding mills from sales to service. About 40 of these are in-house engineers working exclusively on grinding mill design which equates to over 350 years of accumulated experience in this field. Over the last decade or so, Outotec has established itself as a leader in high quality large SAG and AG mills. Lehto states: “Customers value Outotec’s attention to technical detail and focus on quality as is evident in its market leading Finite Element Analysis (FEA) of grinding mill assemblies, which distinguishes it from traditional approaches that often neglect such engineering integrity assurance. Mechanical failures of key fundamental components such as mill head shells that are reported by mill operators are entirely preventable by Outotec’s approach, which has been well received by industry.”

On mills he adds: “It is a common misconception that Ball, SAG and AG milling is a mature technology, with little scope for further refinement. Interestingly, Outotec is reporting that just the opposite is true. Advances in numerical analysis and increasingly powerful computing hardware have provided the company with the means to overcome previously accepted structural or process limitations. These need no longer be accepted as the state of the art. For example, structural failures experienced in previously supplied equipment from any other manufacturer can be shown to have fundamental flaws in the design that contributed to the failure when studied. As grinding mills design tools are refined, Outotec has found that mills are getting heavier if designed to comply with traditionally accepted design specifications. Competent mill buyers typically associate a numerically optimised mill as one that is lighter than a non-optimised mill of a past design. Along with the advances in structural design, the use of advanced control systems and the integration of advanced materials are resulting in mill equipment that is more robust and subject to less downtime than has been the norm of the past.”

Similar advances are being experienced in process technology for grinding mills. When it comes to grinding mills, small improvements in process can provide large dividends in increased production or reduced cost of production. For example, AG milling has historically been difficult to control, so even in situations where AG milling is possible, the uptake has been relatively low. Recent improvements in advanced control have provided the potential of simpler AG mill control. This improvement along with reduced iron in the slurry through the elimination of steel grinding media has the potential for very significant returns for mines willing to explore AG milling or other new process technologies more generally.

“What may have been viewed as a trending toward the limits of fundamental design in the past should really be considered a trending toward the state of the art of the time. Outotec’s message is that there are many opportunities in grinding mills for future advancement and the company is confident that opportunities for further advancement will continue for some time to come.”

Tailored service offerings have seen very strong demand and have been a major success story for Outotec. From an owner or operator point of view it makes sense to source such services from the OEM, who is always best placed to ensure that the installations meet or even exceed the targeted return of investment over their life cycle. “So since its early Outokumpu days that focused primarily on hardware sales, Outotec has now evolved to generate a large portion of its revenue from highly efficient and successful individual process or equipment services, all the way up to plant wide Operation and Maintenance (O&M) contracts, an expanding area for the company that has become increasingly popular for locations and owners requiring expertise not otherwise available locally. Recent acquisitions of Scanalyse Holdings and TME Group in the comminution sector have fast tracked this expansion and have enabled Outotec to now offer holistic integrated mill reline services on a global scale for example.”

As far as functionally superior liner offerings are concerned, Outotec has established an associated track record with its Turbo Pulp Lifter (TPL)
product, which ensures uninhibited and therefore efficient flow through the SAG/AG mill. From an energy efficiency point of view reported savings have been up to 20%. Process operability is also improved, because the response time to any changes in ore grindability, or other process parameters is shorter.

Comminution islands from FLSmidth

FLSmith not only supplies to large mineral processing plants but also uses its expertise to develop smaller flowsheets and equipment for all crushing, grinding and sizing applications. FLSmidth’s capabilities currently extend from large fixed plants, to mobile/semi-mobile and also portable plants, with equipment made available as a standard design or customized for a specific application or location.

FLSmith is a worldwide supplier of high pressure grinding rolls with numerous installations dating back nearly 30 years. Today the company continues to expand this legacy product’s utilisation by focusing on optimising HPGR technology specifically for minerals applications. HPGR technology has undergone significant development since its cement-based origins with refinements made to the machine roll wear surfaces and control philosophy. The F-Series HPGR developed by FLSmidth features the new “Express Frame” with split rail design. This along with hinged hydraulic rams, integrated roll extraction system - both patent pending - and oil lubricated bearings reduces the overall footprint of the machine, reduces the required steel content, and facilitates a quicker roll replacement while placing special emphasis on health and safety aspects.

To further support these developments, FLSmidth has designed and commissioned an HPGR especially for the large-scale laboratory environment. This unit is in operation at FLSmidth’s Minerals Technology Center located in Midvale, Utah. “We feel that our HPGR test unit combined with our mineralogy and metallurgical laboratories truly differentiates FLSmidth from other equipment suppliers,” commented Joe Dziedzina, FLSmidth’s Global Product Manager for HPGR.

Lower ore grades and complex mineralogy are continually creating demand for more efficient fine grinding solutions. FLSmidth’s VXPMill™ vertical stirred mill is designed as an efficient option for fine and ultra-fine grinding applications. FLSmidth states that it outperforms similar technologies in capital cost and ease of maintenance. FLSmidth VXPMills operate at a power intensity that is higher than low-speed mills and overlaps that of high speed mills. This allows the VXPMill to be customised to a wide range of grinding applications.

A row of installed FLSmidth’s VXPMill™ vertical stirred mills. This machine is designed as an efficient option for fine and ultra-fine grinding applications

“Our VXPMill stirred milling technology has allowed us to provide regrind solutions that benefit our customers in ways that could not be done with conventional grinding equipment. We are particularly enjoying success in utilizing the stirred mill for gold treatment applications in both floation regrind and tailings retreatment,” said David Rahal, FLSmidth Manager of Fine Grinding. “Our ability to ship nearly fully assembled VXPMills (up to the VXPMill2500 size) has led to steady demand in the industry. This demand is driven by short manufacturing and delivery times and the ability to install these units quickly once they arrive at site.”

Grinding mills supplied by FLSmidth have their origins dating back to the Fuller Company and under the Traylor brand name since 1902. Many of the largest plants operating today have these world-renowned SAG and Ball Mills installed. Anthony Filidore, FLSmidth’s Director of Grinding Mills stated: “FLSmith has long been a leader in the industry providing a full range of mills that can be delivered and custom designed to suit various conditions as well as client preferences. We continue to innovate our designs including the accommodation of a variety of drive arrangements, bearing types and common spares.”

Recent successes include engineering and constructing one of the largest operating mills ever commissioned. Installed at the Toromocho copper mine in Peru, the SAG mill has a 40 ft diameter with a 28 MW ABB gearless mill drive that is designed for 5,250 t/h of throughput. The two ball mills are 28 ft in diameter each with 22 MW ABB GMDs. They are each designed for 1,575 t/h of throughput. The shell diameter, motor power and throughput of these ball mills are all the largest in the world.

FLSmidth sees as a major advantage its being able to secure orders by offering comminution ‘islands’, combining its Fuller-Traylor mills, Ludowici vibrating screens, Krebs hydrocyclone clusters and slurry pumps all from one source to ensure the best possible comminution equipment combination and to optimise process efficiencies.

FLSmith’s Raptor cone crusher line has also been proven worldwide in all sorts of aggregate, minerals, and pebble applications. Sizes range from the Raptor 200 (well suited for small and medium-tier operations and the aggregate market), up to the Raptor 2000 with maximum capacity for the most demanding high tonnage applications.

FLSmith’s legacy of quality crushers dates back to the Fuller-Traylor gyratory crushers of the early 1900s. Machines continue to be engineered and designed for any process requirement for surface or underground installations (in standard or split-shell configurations), and for stationary, mobile or semi-mobile operations. “Through constant and continual improvements in engineering and to meet customer needs, the company supplies both the bottom service (NT) crusher design; and for now more than eight years, the top service (TS) crusher design. In fact, FLSmidth is still the only manufacturer of a fourth generation, fully top-serviced gyratory model; whereas other companies are only able to provide third generation crushers.”

“We developed the ‘Top-Service’ gyratory crusher to help alleviate safety concerns and improve maintenance downtime. It can be maintained completely from the top, with the aid of an overhead crane,” said Bill Malone, FLSmidth’s Global Director of Crushing. “This unique design translates into more cost-effective and more flexible foundation designs and allows maintenance personnel to swap out the entire assembly in a single shift.” The world’s largest installed model is FLSmidth’s 1600 x 3000 TSU gyratory crusher that boasts a 1,200 KW capacity and was recently commissioned and is fully operational in a copper plant in Peru.

FLSmith’s history with the design and manufacture of jaw crushers dates back more than 100 years with the Traylor and Fuller-Traylor double toggle jaw crushers. FLSmidth more recently added a line of single toggle jaw crushers, the TST, to the heritage the double toggle crushers established. The TST is equipped with an efficient crushing motion, modular bolted frame and a simple, low maintenance design to handle increasingly hard ores and remote site locations.

The ABON sizer range and superior performance is well recognised in the industry and with the further integration of FLSmidth product companies in 2010, ABON sizers have been able to enter new markets and enable other FLSmidth solutions to be bundled into cross-complimentary package offerings. Successful endeavours include combining the sizer into IPCC solutions.