

FUELLING GROWTH

The mining and metals industry supplies the feedstock for a large part of everyday life—from coal for power, to iron ore for steel girders, to the minerals and metals that are processed into our everyday necessities.

16% Share of mining sector in national GDP
25% Share of mining in national exports
\$5bn Mining production value in 2012
\$67.2bn Expected production value by 2016
4.8% Expected growth rate during 2012-16



Brazil

20% Share of M&M industries in industrial output
15% Share of minerals in national exports
\$158.7bn Mining production value in 2011
\$173bn Estimated production value by 2017
3% Expected growth rate from 2012 levels



Russia

2.2- 2.5% Share of mining industry in GDP
10-11% Share in total industrial output
700,000 Jobs provided by mining industry
\$41.79bn Production value in 2011
\$51.9bn Expected production value by 2017



India

\$340bn Value of mining production in 2012
\$432bn Estimated production value by 2017
5.6% Expected growth rate from 2013
50% Share of China in global supply and demand of coal

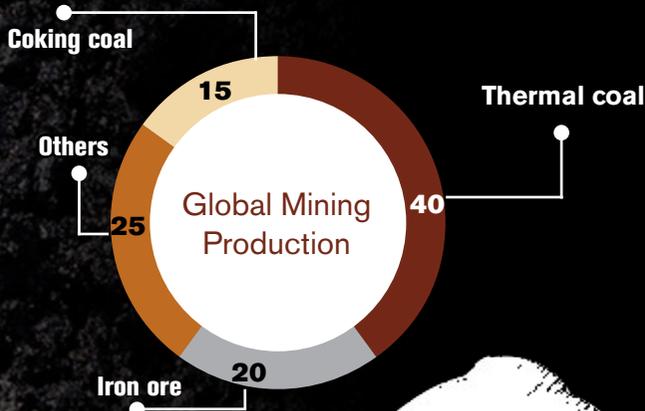


China

6% Share of mining sector in national GDP
18% Share of mining in total industrial output
60% Share of mining sector in exports
\$32.4bn Size of mining industry in 2013
\$34.0bn Estimated production value by 2017



South Africa

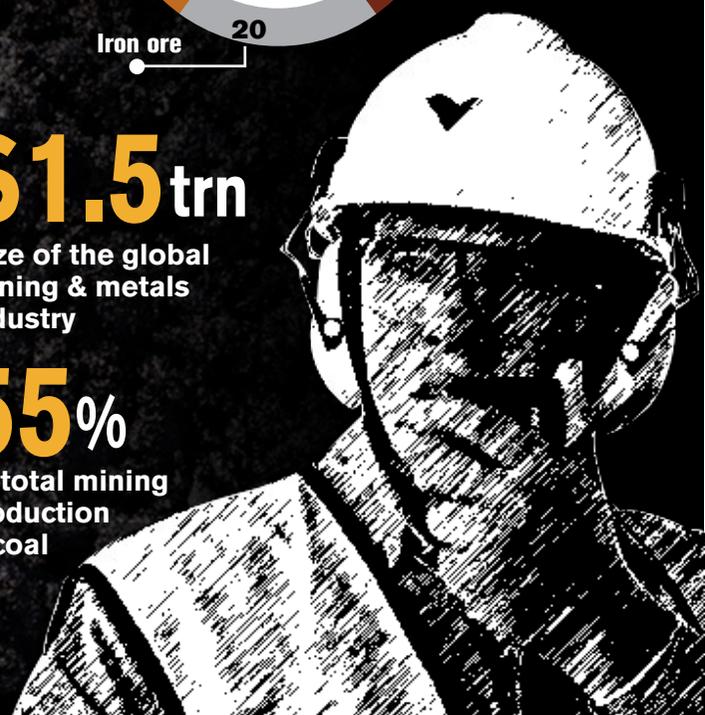


\$1.5trn

Size of the global mining & metals industry

55%

Of total mining production is coal



Source: ICMM, Business Monitor International, PwC, IBRAM, E&MJ, Infomine, ThomasWhite

Digging Deep to Development

Geospatial technology is expanding the bottom line for mining companies in the BRICS countries and could go a long way addressing the sector's current confidence crisis.

By Anusuya Datta, Deputy Executive Editor

In the midst of the worst recession ever to hit the world in 2008, the mining industry surprisingly experienced a commodity boom. The surge, largely fuelled by economic growth and development in the BRICS, particularly in China, created an unprecedented demand for coal and mineral resources.

In the years to follow, the BRICS nations emerged as the new global powerhouses in more ways than one. Along with their increasing political influence on global issues, these rapidly growing economies are building up an industrial base fast closing the gap with the developed nations — in some cases, like China, even surpassing them.

No other sector illustrates this global trend better than mining, which had the immediate job of constantly fuelling the chugging growth engines. The coal production figures highlight this aspect the best. As World Coal Association Chief Executive Milton Catelin puts it, the BRICS' demand for coal by 2035 is set to rise by around 1,350 million tonnes of oil equivalent, which is about three-fourths of China's demand for coal today. Much of this demand will be from India and China.

In many ways, the story of mining and metals (M&M) sector is that of China's. Valued at \$1.5 trillion currently, the sector grew more or less in sync with the global GDP for years. Turn of the millennium saw the sector outsmart global growth, even during and after 2008 crisis. The main reason for this can be attributed to the takeoff in the Chinese economy. At present, 40- 60% of any mineral extracted anywhere in the world ends up in China.

But for over a year now, the mining industry is facing confidence crisis. Mining scrips have stopped outperforming the broader equity markets. Low confidence in cost controls, return on capital and volatile commodity prices are giving sleepless nights to industry leaders, reveals a PwC report.

So what changed the storyline?

The current slowdown in the Chinese economy and not-so-encouraging trends in other BRICS partners hold the key to this riddle. In trying to rebuild the market's confidence, miners are moving towards maximising returns from existing operations from improved productivity and efficiencies, underlines PwC.

In such a situation, the geospatial industry sees the mining challenges in the BRICS as similar to the global challenges — improving operational efficiency, managing capital budgets, mine valuation strategies, miner safety, environmental and regulatory compliance, and developing a skilled workforce, says Nathan Pugh, Business Area Director for Mining, Trimble.

Remote sensing and GIS have long played a key role in the mining sector but evolving geospatial technologies and integration of the geo-element in mainstream IT are bringing up new solutions. Geo applications are widely adopted in larger mining operations, including mine planning and productivity management systems, while emerging areas are mine valuation and safety. Mining companies buying or selling properties can also use geoinformation more effectively to evaluate mineral resources, assets, and infrastructure of a property in the scope of their entire portfolio.

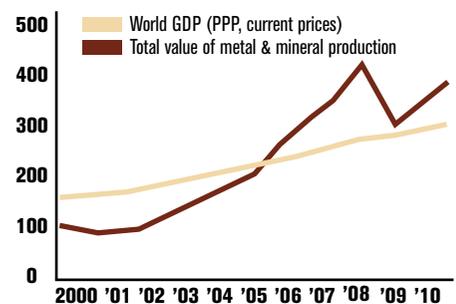
Mining Management Systems (MMS) are today widespread for optimised resource management, ie, exploration, reserve estimation, production optimisation and environmental remediation. As in GIS, a combination of vector- and grid-based modelling and a relational database management system comprises the core of current MMS, explains Robert Marschallinger, a geoinformatic expert.

Maximising production, minimising costs

Mining practices and application of geospatial technology varies across regions and mine operators. However, they all share a common requirement — that this technology should help increase efficiency of operations, improve safety and optimise productivity, points out Matt Desmond, General Manager, Product Management and Marketing, Leica Geosystems.

Several years ago, a study by Brazil-based Vale found that the use of the advanced technologies reduces cost and increases productivity manifold. The world's second largest mining company uses the most advanced technology in all

World GDP and mineral production



Source: Raw Materials Group; World Bank



Brazil: All is not 'Vale'

Brazil, a mining powerhouse in the world, has been ranked top among the BRICS nations in its use of most advanced technologies. Besides Vale, most other mining majors like Kinross Gold, Votorantim and Petrobras use modern technologies, says Juarez Milmann, Executive Secretary, Brazilian Association of Mineral Research Companies. Even government departments like those under the Geological Survey of Brazil are increasingly taking the help of such technologies for their work. According to Diogo Martins of Topcon Positioning, mining companies were the first ones to start using RTK systems in Brazil. The use of such advanced technologies is not common in many others industries in Brazil; but the mining sector is leading in terms of investments. GPS systems, robotic total stations and laser scanners, as well as satellite imaging, can be easily found in this market. Most of these companies use specialised applications — some developed specifically for mining

— seeking the integration of geological, geophysical and geochemical data, and data from surveys, remote sensing and laser scanners, using a GIS to integrate information shared between different company departments, says Sérgio Augusto Dâmaso de Sousa, General Director of DNPM. “The newest technologies also guarantee compliance with environmental regulations and shorten times to complete projects,” adds Martins. The mining sector in Brazil is currently mired in a new controversial mining Bill, which seeks to increase taxes but also aims to make the licensing process more transparent. Whatever the outcome, the undefined direction of the rules that will regulate the sector is hurting it at the moment as companies stall investments into new technology. Besides, with only about 30% of its territory systematically explored using geological mapping, there is a clear need for better control of land property and environmental indicators, which again demand growing investment on high-end technologies. The problems of mining are also attached to issues of infrastructure: roads, railways, ports and energy as well as environmental issues, especially in the Amazon region.

its mines, and reviews of survey jobs, for example, have shown that productivity has increased 10 times in 10 years. “The immediate RoI timeframe is very short. This is why progressive companies continue investing in emergent products. This investment in solutions is easily justified when costs can be dramatically reduced and profit increased,” says Diogo Martins, Regional Survey Sales Manager (Latin America), Topcon Positioning.

Like in developed countries, remote sensing and GIS are extensively used in the BRICS during the exploration and development phases. In

these early stages, GIS is probably the most utilised of all technical software in the industry, points out says Dan Haigh, Natural Resources Industry Manager, Pitney Bowes. As a company progresses into the construction and production phases, use of GIS reduces (but does not disappear) and a 3D resource modelling package becomes primary.

“We also have geospatial technology, including satellite imagery, digital photos, geophysics, surface geology, cross-section borehole data — the so-called ‘big data’ — playing a key role,” adds Louis Morasse, Industry Solutions Manager, Autodesk. The more information you can gather and provide, and combine, the more it will help for site development and infrastructure site selection, waste dump, tailing ponds etc.

Construction is a critical phase and technologies for engineering design, 3D modelling and information management have taken off well with BRICS mining majors, says John Sanins, Solutions Executive, Bentley Systems. The use of geospatial software tools, coupled with advanced 3D design and modelling systems, permits rapid development of mine infrastructure. This can be validated to take into

account the local environment and communities. Adoption of Building Information Modelling (BIM) is picking up too and is seen as crucial in data recovery, or reuse for new projects or expanding existing ones. BIM also facilitates 3D visualisation to communicate design intent and environmental impact for technical and non-technical stakeholders; and helps coordinate with engineering, procurement and construction firms.

Another technology fast picking up is laser scanning, which allows for very precise measurements for speedy and accurate decisions. Some companies are using laser scans of open pit mines to calculate the volume of material removed each day. Others are using such scans to measure ground movement in order to pre-empt landslides or other disasters at mine sites. Also, with different modules of a mining facility being designed and built across the world, construction crews can take 3D laser scans of sites, which can then be compared to a module being built in another part of the world to ensure exact fit, explains David Canady, Global Director (Metals & Mining), Intergraph Process, Power & Marine (PP&M).

Mining is an asset-intrinsic sector.



Vale has set up an advanced decision making centre which uses spatial data and high degree of immersion and interaction with geoinformation to create virtual reality environments for better planning.

And “knowing the position of assets, be they people, equipment or ore bodies, is fundamental to the mining process,” underlines Jason Nitz, a fleet automation expert from Australia. “More importantly, knowing the exact location of these increases their value, and in the current times we are experiencing this value is amplified,” adds Nitz, who works with US gold mining major Newmont Mining.

Vale indeed showed the way in using innovative technologies in Brazil. It invested \$8 billion for a GPS-enabled ‘truck-less’ system of conveyor belts by automating part of the world’s largest iron ore mine in the Amazon. The solution also enables automation of the recovery and piling through satellite positioning and 3D scanning. This process takes about 100 trucks off the site, reducing diesel consumption by 77%. In 2011, Vale’s production was 109.8 million metric tonne (mmt), which is likely to more than double following full automation in 2016.

Another interesting example is Coal India Ltd (CIL). Among its many technological innovations is its plan to introduce GPS-based vehicle tracking systems by March 2014 after an internal study showed that any of its 170-tonne capacity trucks remaining idle for half an hour translates to losses worth \$84. This would double if the truck was of 240-tonne capacity.

The geospatial industry has seen significant investments from big mining companies in the past 10 years. Anthony Fraser, Sales Manager (Asia-Pacific), Leica Geosystems, says such advanced technologies were unaffordable for many in the BRICS region as recent as five years ago. Since then, development push has been upping their usage.

Environment & Sustainability

The mining industry is increasingly under pressure to consider environmental concerns while evaluating economic viability of a project. In addition, communicating and engaging with local governments and community stakeholders are also becoming imperative. As it is in India, every major mining project in the past few years has faced opposition from local communities or environment activists. “A company’s licence to explore or mine can be severely compromised without first gaining a ‘social licence’ to operate. Geospatial technology can assist in pulling together baseline studies on the chosen community. Also, by leveraging the power of Web mapping, companies can engage with and communicate with communities, investors or authorities,” explains Haigh.

Again, Brazil shows the way in using geotechnology for clean mining. Since many of its new mines are located in or near the Amazon, the government has spelt out environmental responsibilities. “The environmental impacts of mining are tracked using multispectral satellite images with high spatial resolution,” says Antonio Machado e Siva, President, AMSKepler, a local geospatial player. Spatial analysis allows observation of the consequences of mineral exploration in areas of permanent

preservation and environmental preservation, among others. GIS even allows simulation scenarios, thus mitigating environmental accidents before they occur.

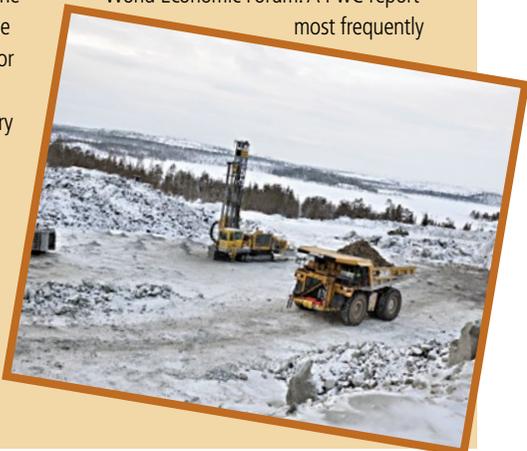
The Russian mining industry is notorious for environmental pollution. The Arctic in particular has suffered due to waste discharges during offshore oil and gas activity, and smelting of ore deposits. Recently, the Russian government began using satellite remote sensing to monitor mining activities in the Far East region. Outlining the advantages of remote sensing over traditional checks due to “continuity and objectivity”, Sergey Donskoy, the Russian Minister of Natural Resources and Ecology, had said: “It (remote sensing) can detect previously unregistered land and eliminate the damage caused by illegal activities.”

China too faces environmental issues due to use of outdated technologies and equipment by smaller firms. Now, there is an emphasis on environment protection partly because of the unprecedented haze around the country,

Russia: Battling the Soviet Ghost

With its coal and iron ore deposits believed to represent around 20% of the total global reserves, Russia is currently a global leader in several minerals. However, since the dissolution of the Soviet Union, the Russian mineral industry has been struggling. Many of the primary minerals are now located in other CIS states. The reciprocal also applies, as Russia was the main producer of oil and gas to the CIS. “This places a huge strain on trade and import/export agreements, and resulting in almost 50% fall in production for most commodities,” explains Arthur Poliakov, Managing Director and Chairman of MINEX Russia Mining and Exploration Forum. Although Russia accounts for about 14% of global mining, apart from a few large steel companies and oil & gas giants, most large Russian mining firms are unknown. A challenge for the sector will be to upgrade its ageing equipment and increase productivity, which currently lags 72% behind the average for OECD countries, according to the World Economic Forum. A PwC report most frequently

quoted risks for the Russian mining industry is “the use of outdated, inefficient and unsafe techniques in constructing and operating mines”.





The Arctic hosts Russia's massive raw materials base, with reserves estimated at approximately 20 years for iron ore and 10-30 years for other non-ferrous metals. The Arctic holds 15% of the world's oil & gas reserves.

points out Singer Chang of the China Mining Association. This could be reduced by closing smaller mines and shifting smelting plants.

Even in South Africa, sustainability concerns provide a potential for geospatial industry through assessment and remediation projects, says Stephane Chevrel, a senior scientist with the French geological survey authority (BRGM), who, however, sees a lack of coordinated action in this area.

Safe & Secure

Mining operations are generally risky business. "There is a huge risk since you don't know what's underneath.

With mine-planning software, you can minimise that risk and the RoI will be immediate," says Dinakar Devireddy, Senior Project Manager, Infotech Enterprises, an Indian geospatial solutions provider. Visualisation of complex designs that make up a large mining facility enhances better design and allows mining companies to easily factor safety into the designs. The use of UAVs keeps surveyors out of hazardous areas and the positioning technology used in proximity detection for mobile mining equipment vulnerable to blind spots can prevent accidents.

Knowing accurately where a person is located is vital to keeping them safe. "Think of the incident in Chile a few years ago when miners were trapped underground and geospatial technology helped the rescue team find and extract the miners. They brought a camera down one of the bore holes and located the miners underground with exact coordinates," points out Morasse. This level of visibility is what many companies are now offering as part of the proximity awareness systems. Some of these use GPS to position people in and around the equipment.

For instance in China, because most coal deposits are located deeper, it has

to be mined underground, which results in a high number of casualties. This has been coming down in the recent times with the takeoff in technology adoption. In South Africa, 3D laser scanning is a huge hit in open cast mining for slope stability monitoring and survey of dangerous and inaccessible areas due to safety risks. Canady adds that 3D modelling of mining facilities greatly enhances visualisation, which allows mining companies to plan for safe evacuations or maintenance procedures.

Utility & Maturity

The mining industry has traditionally been behind other engineering industries in adopting technology, but that is changing and the sector in developing nations is anxious to learn new techniques, maintains Canady.

Mining powerhouses Brazil and South Africa, for instance, are on a par with developed nations in terms of technology adoption. While the use of an emerging technology like geospatial is not common in many others industries in Brazil, mining is leading in terms of investments, says Martins, who also points out that private mining companies were the first ones to start using RTK systems in Brazil. Besides Vale,



India: Caught in Regulatory Maze

India hosts a wide range of globally significant mineral resources, ranking among the world's top five nations for its

core competency commodity reserves of coal and iron ore. India has a number of giant, mostly state-owned mines that have an outsized impact on total output, in addition to the existence of a large number of small and inefficient mines operating illegally. A total of 5% of operating mines in India produce about 50% of the country's mineral output. However, only 10% of the country's landmass has been explored, primarily due to significant regulatory and bureaucratic hurdles. Despite the potential passage of a new mining Bill on the horizon, which seeks to improve transparency and introduce better legislative environment, analysts are wary of calling for a sea change. And they have reasons to. Environmental concerns and land acquisition hurdles have dealt a major blow to the once-booming sector in India, with almost all activities coming to a halt in recent years. Coupled with that, corruption and vital regulatory and bureaucratic obstacles remain major obstacles. There is lack of transparency — starting from tenement lease to excavation details.

most other mining majors like Kinross Gold, Votorantim and Petrobras use modern technologies. Now, even government departments like those under the Geological Survey of Brazil are increasingly adopting such technologies.

In South Africa, most large and medium mining companies today use GIS for integration of exploration datasets while applying for mining leases or even financial assistance, says Dr Siva Subramanian, Head (Agriculture & Natural Resources), RMSI, an India-based geospatial player which operates in that country. While the annual planned production and pit head costs for mining are also linked to geospatial technology, the country has also picked up on the global trend of mapping large area mineral potential and corridors. The initiatives though are said to be too dispersed and needs to be harmonised.

Further, managing resources in the remote parts of Africa remains a challenge, and this makes geotechnologies well worth investing in to keep a handle on resources and optimise revenues, points out Francois Stroh of HORTS Geo-Solutions, a local distribution partner of Riegl.

For Russia, one bright spot is the high competency and potential of geological survey agencies/companies engaged in exploring. Even though surveying technologies, long-range laser scanners, satellite imagery and GPS-GLONASS integrated solutions are also coming up, it is mostly limited to gas and oil majors. There are some M&M companies like Phosagro, Uralkali, but the rate of uptake is very slow, says Mikhail Zimin, Head of Geodesy and Cartography, ScanEx.

But the major problem in Russia is extraction. Vast uninhabited territories in a harsh climate and an undeveloped transport infrastructure combine to make the Russian Far East and Arctic even more remote. Additional investment required for basic assets due to climate and permafrost, higher labour, transpor-

tation, energy costs and costs for many supplies and commodities present other obstacles, underlines Arthur Poliakov, Managing Director and Chairman of MINEX Russia Mining and Exploration Forum. Because of Russia's difficult terrains, almost 70% of the massive explored reserves are not exploitable using existing Soviet-era technologies.

Technology adoption greatly varies across China, from very low-level to use of some of the world-class equipment because of lack of awareness on sustainable development and inadequate supervision, says Singer. Most mining majors have their own teams for acquisition of geospatial data and now a majority of them use GNSS for daily surveying, says Sam Chen of Red China Geosystems, a local distribution partner of Riegl. Further, more and more miners are using multi-sensor land slide monitoring system with GNSS, laser scanning and ground-base InSAR technology. A few of the more-established ones are using CAD, automation and monitoring software. Another encouraging trend is the recent focus on the combination of geology and integrated applications, such as ground, underground, 2D or 3D integrated analysis of spatial visualisation, geological modelling of volume stereo profile, says Zhuo Wei Jie, Director, SuperMap, a local GIS player.

Interestingly, the Indian mining industry, widely regarded as a laggard among its BRICS counterparts, has seen great strides being taken by its state-owned miners led by CIL. Some claim the level of penetration of geospatial technology in coal mining at least is on a par with the developed world. Former CIL Chairman M.P. Narayanan points out that remote sensing was used as far back as 1985 to delineate the fire areas in Jharia Coalfields. Today the world's largest coal miner is using this technology for pre-mining, surveying, exploration, and compiling baseline data of environmental and land-use patterns; as also real-time trip counting at opencast

China: Nailing the Dragon

China is the leading producer of around half of the over 70 minerals contained in the World Minerals Statistics database. It is also the leader in Rare Earth minerals. But coal remains the overriding focus in a sector dominated by large state-owned enterprises. Mining is facing pressure both from the falling prices of commodities and energy, as well as environment and sustainability issues. China's growth rate is slowing down, leading to a slump in commodities consumption.

Industry experts like Singer Chang of the China Mining Association is of the view that much of the issues are related to the fact that the government takes the mining sector merely as a tool for supporting infrastructure rather than a growth pole of the economy. Many laws and statutes are incomplete and there is a serious lack in terms of long-term mining strategies.



mines, vehicle monitoring etc. CIL is also updating topographical maps of all coalfields and has also initiated satellite surveillance of all the 162 open coal mines for assessing land reclamation status on an annual basis, a first of its kind in the world.

CMPDI, a CIL subsidiary and a consultant in mine planning and design, uses a wide range of remote sensing technology for exploration, infrastructure development, land-use mapping,

environmental management plan; thermal infrared for mine fire mapping; DInSAR for subsidence monitoring; LiDAR for excavation measurement etc. It has also started surveying of mine lease areas using DGPS. Meanwhile, the rest of the sector, especially private miners, is lagging behind, largely owing to high costs and lack of awareness. Sanins, however, sees a huge opportunity in this void.

Bridging the Talent Gap

The advanced level of geospatial technologies is pretty new to mining. As Devireddy explains, what happens inside the earth is basically in the domain of geologists and the knowledge they have is in 2D environment. “People trained with geospatial technology do not know how to mine and do not understand the structural aspects of a mine. So you need to have the best of both worlds.”

In South Africa, for instance, mining companies earlier had GIS experts supporting them with management of datasets. But now there is an increased focus on having GIS experts who combine their domain expertise with hybrid technologies for advanced modelling and analysis outputs, says Subramanian.

Operating mining management systems involves a range of skills — a thorough knowledge of the geological processes that lead to the resource to be modelled, an in-depth knowledge of the used modelling and simulation al-

gorithms and their pitfalls, the production process and the social context of a mine location, underlines Marschallinger, who sees trained resources as not being a problem for big companies.

The key to implementing technology found in other industries within the mining industry is to have an understanding of how and where the technology has a role to play, says Nitz, who has a background in IT, combined with practical mining experience with some of the leading global miners, and then again backed up with postgraduate engineering studies. A resource like Nitz is unusual but not impossible in the developed countries, but in BRICS mining engineering courses are yet to marry this kind of technology with basics of the subject.

While such a culture is almost non-existent in India, trained labour is a big problem even in Brazil and Russia. “This deficiency is very high in Brazil because even big miners do not have a post of Surveyor Engineer or Cartographer,” points out Neves. In China, though there are enough number of geographic information technology graduates, they still require specialised training in mining. In South Africa, however, there is a growing trend among large mining conglomerates to undertake local capacity development and training, which stems from the government mandate to develop mining skills of local resources, explains Subramanian.

In such a situation, both mining and geospatial organisations are learning fast and customising solutions to make it easier. Leica, for instance, is moving from optimising the flow of trucks and shovels to optimising the knowledge worker by providing access to geospatial tools and analysis. Bentley supports and encourages proactive local education advancement through a series of structured learning programmes — Bentley Learning Paths — as part of the Bentley LEARN program, an on-demand programme tailored to meet the education demands of those involved in M&M engineering and design.

Awareness and Regulatory Hurdles

There is a feeling that today that mining companies in the BRICS are more progressive than the governments about the significance of geospatial technology. Companies typically go faster than governments because they are motivated by a need to have RoI as quickly as possible, says Morasse.

Major miners and regulators, particularly in developing nations, have an eye on the best practices across the globe. There is often a reluctance to implement these demands across the entire industry due the nature of pre-existing small-scale operations, but major miners do not solely rely on legislations to

South Africa: A Land of Hidden Treasures

South Africa's total reserves, estimated to be worth \$2.5-trillion, is the world's fifth-largest mining sector in terms of GDP value. It is the world's leading producer of platinum, as well as a major player in the production of gold, diamonds, base metals and coal. The potential for further discoveries in huge yet-to-be explored regions means that mining could contribute even more to national GDP than the current 8.8%. Given its history and mineral wealth, it is no surprise that the country's mining companies are key players in the global industry.

Its strengths include a high level of technical and production expertise, and comprehensive R&D activities. South African mining companies are under severe pressure in their local operations from labour unions on the one side and investors on the other. A few have refocused on operations in the rest of Africa as South Africa remains the gateway into the rest of Africa. The labour unrest throughout 2013, uncertainties over the regulatory climate as local authorities dispute over jurisdictions over mining sites, and increasing resource nationalism are considered big hurdles.



ensure best practices, adds Desmond.

In Brazil, for instance, there is no awareness on the part of lawmakers of the importance of systematic mapping, given that today Brazil does not have all its territory mapped even at 1:100,000 scale, points out Roger Neves, Director with CPE Equipamentos Topograficos, Riegl's local distributor. But that didn't stop Vale. As for mapping, the task has now been taken up by the private sector but in such cases the information generated is not shared with other companies, resulting in duplication of efforts.

Brazil has an active and progressive regulatory system in place, but it is a long way from being implemented throughout the entire country. "While big mining companies adhere to regulations, there are innumerable small, clandestine operations in remote areas, which are impossible to inspect," says Martins, pointing out satellite imaging solutions are a big help towards this.

In China, mining companies have been asking for information transparency and open data, and the government too is clear that geospatial technology should be widely used in this sector, says Ma Wei Feng, General Manager, InfoEarth, a local player. Various government departments have for long used spatial information for exploration, macro-industry management, production, safety et al and the first national geographic census being conducted includes mineral resources. Digital mining is currently a hot topic in China and the government has made it one of the State 863 projects (a programme intended to stimulate technological development in a wide range of fields), but the situation regarding mining data is still not satisfactory since issues such as transition to information security controls act as barriers.

Also, China's political and business environment is difficult and costly to navigate and multinational technology providers are cautious to enter China due to these reasons as well as

the lack of IP protection there, says Pugh. Similarly, he finds the political and business environment in Russia to be complex, challenging and thus prohibitively expensive for leading foreign geospatial players.

Even though the level of understanding is high among the government and mining companies in South Africa, local authorities and regulatory bodies need further awareness and training. For instance, the rigid rules for surveying laid down under the existing laws could be the single biggest challenge for the acceptance of laser scanning technology. To make changes to the law could take years and the fact that mine surveyors are legal appointments further complicates the issue, points out Stroh. Labour unrest throughout 2013, uncertainties over the regulatory climate, and increasing resource nationalism are other hurdles. In such a situation, geospatial mapping software will be crucial to create an overall view of the complex interrelationships in areas where high natural resources are found, underlines Sanins.

What Lies Ahead

The industry thinks the future is in autonomous mines. And accurate geospatial information is the key to this. "Technology today is evolving so fast, and being used in areas that nobody thought it would be used for — eg, driverless trucks," says Morasse. Other areas are reality capture for ground control and stockpile verification; laser scanning (which has already made good inroads) is a great tool for height analysis and blasting taking advantage of point cloud terrain mapping and modelling safety; tailing dam control etc. Haigh also recommends making government data available via WMS



China has the potential to become a global innovator in clean coal technologies. It recognises underground coal gasification as important and has dedicated government support to develop own resources.

or through a web mapping portal to assist the adoption of GIS in mining initiatives.

Nitz thinks remote sensing and visualisation

is where the future is headed to. Many mining companies are moving towards remote operations centres where all types of mining data are displayed, often thousands of kilometres away from the mine sites. Radar interferometry has been widely recognised in monitoring mining-induced subsidence. Hyperspectral imagery is a proven remote sensing technique to monitor environmental impacts of mining as it enables mapping minerals responsible for pollution and their extension around mining sites, points out Chevrel.

For now, the biggest challenge is in convincing people about the cost and RoI that these technologies offer. "Historically, technology has not been in the 'must-have' list for mining but this is slowly changing. Economic credit crunches don't help with this, but we will see a return to technology uptake once the situation improves," says Nitz.

For years mining has been seen as dirty, dangerous and environmentally contentious. But emerging markets, innovative technologies and a dynamic workforce are steering the modern miner to become smarter. 🌐

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