Michel Serres, ABB, North America, highlights three trends that are transforming global mining operations: digitalisation, electrification and automation.

The Industrial Internet of Things (IIoT) and artificial intelligence (AI) - driven analytics now provide both real time and predictive data to operators, helping them make informed decisions that reduce ore variability and OPEX, while providing visibility across the mine to market value chain.

Electrification, particularly the transition to electric vehicles, will eliminate the need for many diesel machines, improving the working environment and boosting companies' sustainability credentials. Like digitalisation, automation has the potential to future-proof mining operations by increasing productivity...
and promoting the more sustainable use of resources, while simultaneously lowering input costs.

The future of mining will be characterised by horizontal integration, remote operation centres, the mine to port value chain, electrification of assets, data management for a continuous improvement process, and increased collaboration.

Horizontal integration across the value chain should be a step-by-step approach, with the target being to remove silos and build a collaborative approach across the company and the entire value chain, which is key to the transformation process.

ABB is focusing on analytics, AI and machine learning to orchestrate and predict autonomous-based activities in mines. Autonomous fleet co-ordination, predicting time to perform a task and being able to take a holistic approach with different vendors - these are the ultimate goals.

Five levels of automation
ABB has identified five potential levels of automation, from those that are currently present in the industry, to those that are feasible moving forward, in order to understand the challenges that the mining sector must overcome on its journey to automation, and better tailor its suite of digital solutions in response.

On Level 1, systems provide operational assistance by decision support or remote assistance. Examples include software that helps localise underground mine vehicles. Level 2 edges into occasional autonomy in certain situations, with the automation system taking control in specific circumstances and for limited time periods, as and when requested by a human operator. In this scenario, personnel are still heavily involved, monitoring the state of operations and specifying the targets for limited control situations.

On Level 3, automated systems take control in certain situations, otherwise known as ‘limited autonomy’. A prerequisite is a complete and automated monitoring of the environment, with human workers on hand to confirm proposed solutions or act as fall-backs. An example would be autonomous charging of explosives in an underground mine. In such a set-up, the (remote) operator can still be alerted in exceptional situations and can take over or confirm a strategy to resolve the issue.

On Level 4, the system is in full control in certain situations, and learns from its past actions in order to better predict and resolve issues by itself, for example. Finally, Level 5 involves total autonomous operations in all situations. No user interaction is required and humans may be completely absent. At present, this is merely aspirational, but an example would be an electric self-driving vehicle for fully-autonomous ore loading, which would offer significant advantages in terms of safety and productivity.

A tailor-made automation solution
The ABB Ability™ System 800xA Minerals Process Control Library is a tailor-made automation solution for the mining and cement industries that comprises an extensive set of software modules designed to achieve the highest plant productivity, availability and safety, as well as the best operator efficiency.

Successfully operating in more than 400 cement and mining sites worldwide, the solution increases standardisation, functionality and quality of process control software over the complete lifecycle of a production facility, minimising downtime and optimising both the production process and mine assets.

The library forms part of the ABB Ability System 800xA Extended Automation Platform, which manages more than 10,000 industrial plants worldwide using parameterised process control. Advancements in data network technology will allow such complex data to be processed even quicker.

Long-term evolution (LTE) or 5G networks for underground or open cast projects will debottleneck data usage and increase data bandwidth. Teleoperation, video, autonomous equipment and telemetry: underground mining automation is evolving fast.
**Electrifying innovation**

The drive to electrify mines by taking energy-intensive facilities off the grid in favour of battery energy storage and renewables is underway, with many progressive companies investing in fully electric or hybrid electric vehicles in order to eliminate the use of diesel, and cut both costs and emissions.

However, electric mines also present challenges for operators in terms of infrastructure, maintenance and operating constraints. As such, solutions are being developed that prioritise total cost of ownership.

ABB is well-versed in the arguments about decreasing such things as ventilation costs, but there is another argument that should be considered when looking at electrification: namely that not all mines are equal. Some use heavy fuel oil (HFO) while others require Arctic diesel, but the one constant here is cost volatility. While electricity costs are fairly stable year after year, the oil price can go from US$25/bbl to US$160/bbl.

ABB is working on battery equipped vehicles (BEVs) in partnership with mining mobile fleet OEMs, and collaborating with companies to transform diesel fleets into BEVs with its ‘OppCharge’ solution.

For opencast mines, the company demonstrates trolley usage in Arctic conditions, and combines trolley and batteries for haulage. ABB is also developing a simulation tool to position chargers and charging solutions at the most efficient location according to fleet models, and mine design and topology.

The transition from diesel to battery equipped mining vehicles is the subject of a collaboration between ABB, GMG and CMIC, and the company is also working with LKAB, Epiroc, Combitech and Volvo Group on the Sustainable Underground Mining (SUM) project, which aims to test smart, autonomous BEVs by 2020.

**Case studies: Canada and Sweden**

ABB collaborated with resources company NMG to develop the first all-electric, carbon neutral mine in the province of Quebec at Saint Michel des Saints (Canada). The project employed data collection and analytics to optimise loading and dumping cycle times.

The task force committee brought different experts around the table and promoted an all-electrical with some technological maturity solutions to turn the conventional mining methods into all-electrical mining applications. Innovation can only come through collaboration.

Swedish company Boliden and ABB took part in a two year pilot project examining the possibility of replacing elements of the transport system at its Aitik opencast mine with electrified trucks. Trialling the world’s first electric trolley in an Arctic climate, the ultimate objective is to move the majority of the approximately 70 million t of rock transported at the pit each year entirely without the use of fossil fuel.

The lane is 700 m long and is expected to save 830 m³/yr of diesel, enabling Boliden to reduce its greenhouse gas emissions by up to 80% along those routes where the technology can be implemented.

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Ability System 800xA migrated all of the control and drive installations to the latest technology.

The portal scrapers and stacker at Schleenheim are also operated autonomously, and the scope of the project also encompassed drives, instrumentation, auxiliaries, CCTV and communication infrastructure.

MIBRAG wanted highly accurate material handling for lignite, in addition to material tracking for quality management. The ABB Ability Stockyard Management System provided maximum availability and reliability, accurate, optimised and cost-effective material handling, quality management and material tracking, as well as 24 hr/d service support.

**Collaboration is key**

Today, every mining company, from a single asset to a multinational organisation, has a vision of the future and what would constitute an ideal mining project. Operators currently face multiple challenges, including deeper mines, the end of combustion engines, new commodity trends, fleet electrification, the impact of greenhouse emissions and additional taxation on fossil fuels.

To meet these challenges and reap the rewards offered by a new generation of digital solutions in terms of productivity and cost efficiency, the present and future mining workforce must understand and engage with new technologies, and do away with siloed working practises in favour of collaboration.

Processes, people and technology are the drivers of change, and the key to transformation and future success. The mining industry is conservative and not automated, and people should be at the centre, meaning prior to introducing innovations. We need to adapt internal processes in order to adopt this technology.

Integrated remote operation centres (IROCs) are an example of how everything from drill control to the dispatch of trucks in a pit can be monitored and controlled thousands of miles away from where physical assets are located, and remote working is an important factor in generation change.

The baby boomer generation will soon be at pensionable age and the young generation prioritises remote working, so having an IROC in a city centre is key to bringing efficiency and attracting talent to the industry. IROCs are only possible with technology and connectivity, and the gains are substantial. Some are measurable – continuous improvement, for example – while others are more complex, such as talent acquisition and retention.

But again, the most important one is collaboration.