



BESTECH

The Whole Mine™ Approach

The **New Face** of Mining

BESTECH is proud to share our vision of the mining operation of 2030.

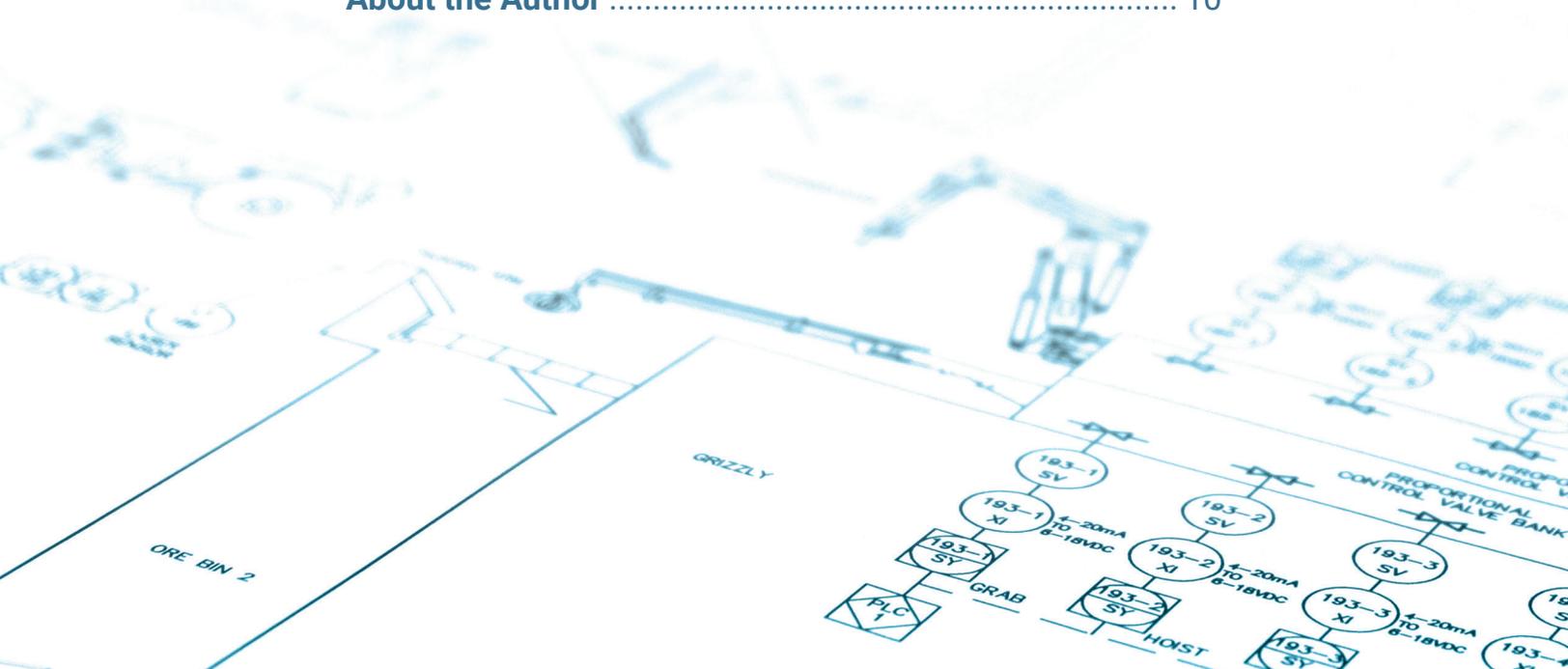
bestech.com

© 2020, INOVINTA Group of Companies. All rights reserved.

INOVINTA
GROUP OF COMPANIES

Table of Contents

The Whole Mine™	3
Modernized Mining Methods & Engineering.....	4
Ore Body Characterization.....	4
Mineral Beneficiation & Extraction	5
Electrification.....	5
Continuous Processes	6
Real-Time Knowledge.....	6
Remote Operation.....	7
Waste Reduction.....	8
Community Involvement & Project Financing.....	8-9
About BESTECH.....	10
About the Author	10





The Whole Mine™

This thought piece takes a Whole Mine view and covers the technical aspects of designs as well as the social and financial considerations. We welcome your comments.

There is a need to drive the transformation of the mining industry with technical solutions that address the key challenges in the industry. Compared to 2020, the future challenges include declining grades, deeper deposits, stricter legislation, more complex metallurgy, and ever-increasing expectations of companies to continuously earn and maintain their license to operate. Indeed, solutions are needed to address the growing demand for responsible, effective operations with low risk to people, communities, and the environment.

The optimal future designs must include leading-edge solutions for the mines, the processing plants, and all the ancillary infrastructure systems and processes.

The solutions will address social responsibility, environmental

responsibility, governance, and human resources aspects, as follows, where stakeholder expectations are met:

1. Investors and shareholders receive a threshold return on investment;
2. Mine owners achieve reduced costs, improved safety, and increased productivity;
3. Communities enjoy clean water, air, and soils;
4. Workers are paid well, are kept safe from harm to body and mind, and are fully engaged in their work.

**At BESTECH, we believe
this is all possible,
as described through
10 key elements.**



BESTECH



Modernized Mining Methods & Engineering

Maximizing Mechanization with a Step Change in Productivity

Traditional mining methods are re-designed to take advantage of the latest in technology and equipment, with remote control rooms and fewer people in the operations. All processes are mechanized and automated including advanced machine health and diagnostics, and algorithms for high reliability. Automation and tracking of supplies delivery (fuels, ground support, tools, etc.) allow management and control of goods while minimizing idle and downtime – this, in turn, enables optimal planning and scheduling of work. All inventories are logged and tracked with advanced analytics to improve processes and eliminate bottlenecks.



Ore Body Characterization

Know Your Ore Geometries and Value Distribution

Geophysical tools and techniques, such as real time assaying and sensors, eliminate the high cost and time associated with diamond drilling. Designs use 3D accurate ore outlines and value distributions including geostatistical assessments. Hill of value estimates are automated for trades-off between production tonnages, ore values, and mining costs. Designs automatically incorporate real-time bottlenecks in the mine and processing plants to make use of available capacities with mineable incremental ores. All data is integrated in a 3D geospatial database to enable rapid mine design alternatives, with optimized sequencing and scenario analyses.



Mineral Beneficiation & Extraction

Maximize Recoveries from Mine to Mill

Geometallurgical models link with mine planning software to determine stope sequences and optimized ore blending. Crushing is eliminated by improved drilling and blast fragmentation. Screening and preferential processing of fines is used with ores that are high-grade and exhibit high-oxidization rates. On-line analyzers allow for automated adjustments of grinding and flotation, along with intermediate cleaning of process water and/or removal of deleterious elements. Digital twins are used to assess opportunities to adjust the mine to mill process flows.



Electrification

Power Your Site with Clean, Green Energy & Reduce Energy Usage

Underground and surface mines use high capacity battery vehicles and trolley-electric fleets and limited diesel units. Next generation hydrogen engines emerge. Renewable energy via wind, tidal, and hydro electric generation is in place with battery storage to manage energy peaks. Ventilation control systems reduce energy usage while the tracking technology delivers productivity data for analysis. Small Modular Reactors (SMRs) offer a safe, economic alternative to diesel generation for remote locations. The SMRs provide post-operation energy support to communities.



Continuous Processes

*Transforming How We Move Material,
Without Delays & With No Inventories*

In underground mines, mechanical rock excavation and remote processes are used for development access, vent raises and shafts, and in ore production, particularly in high heat and high stress areas. Precision-cut profiles and uniform cuttings allow for continuous transportation with conveyor systems and automated material handling systems. Rail-veyors will access the ore body and other technologies such as Maglev will replace hoisting plants for a massive improvement in shaft utilization, for movement of material and supplies, as well as for the movement of personnel to strategic operations centres underground. Sorters allow for waste and ore to be segregated at the source, on surface and underground, with re-direction of material to either the processing plant or into open voids as fill.



Real-Time Knowledge

Leveraging the Power of Industry 4.0

Next generation operations use backbone infrastructure, cloud platforms, wireless communications, edge computing, artificial intelligence, and robotics. Real time optimization, analytics, and autonomous decisions are employed. Plug and play capabilities are the norm. Short interval control allows operations to pivot and manage resources for an integrated operation. Workers access virtual data and digital information to perform work and to capture new routines for continuous improvement. All ground response and process data are captured and analyzed with a feed back into designs.



Remote Operation

Taking Control to a New Level with Strategy Centres

Cloud technologies will host business data and process control platforms. Geographically, operations are controlled via distributed operations centres for strategic oversight and decision-making, such as product-to-customer interactions, inventory management, and autonomous supplies deliveries. Local control centres are replaced with mobile devices and apps carried by every worker to allow coordination of key processes and supporting services at each site. Distributed experts support the global operations with maximum use of virtual connections and digital information using augmented reality technology.



Consistent Products

Generating Optimal Activities with End-to-End Coordination

Total visibility is achieved for predictable, reliable operations using real-time monitoring and tracking of high-risk or top priority facilities such as dams, emissions, treatment plants, etc. Feeds from the mines to plants contain minimal dilution and maximize metal value recovery. All supplies and parts are available as needed, and all products are tracked and managed to meet expectations on quality and quantity. Personnel are scheduled to meet the requirements of all main production and maintenance activities, known a year in advance.



Waste Reduction

Mine Only Ore and Leaving Clean Air, Water & Soils

All waste sources are minimized in design and any new sources are fully re-distributed to the working areas and original sites. Tailings are re-directed underground as fill, surface material is dry stacked, and mine dewatering/process water is 100% recycled. Natural cooling and super cooling solutions are maximized in underground mines where air is used on an as-required basis, including in ventilating strategic maintenance bays and work areas.



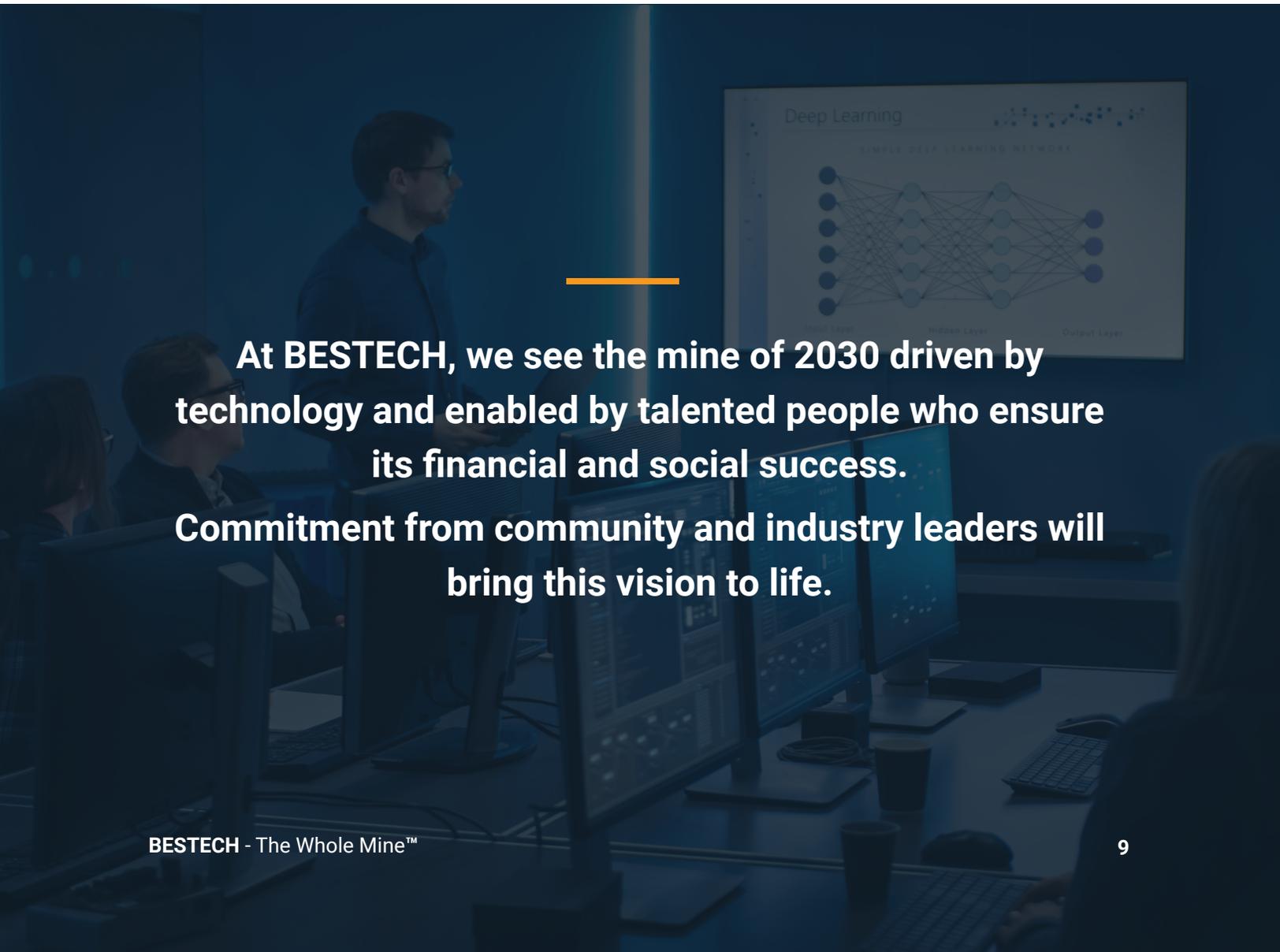
Community Involvement & Project Financing

Working Together as a Responsible Industry

The future mining industry will involve the full community. Financial investments and returns are synergistic with key infrastructure such as power stations that energize mines and hospitals. Industry will collaborate with all core associations and advocacy groups, along with academia, government, supplies/service sector, NGOs and the indigenous communities with strong partnerships at all levels. An engaged mining culture is fostered, and it brings out the best in people in terms of meeting business, environmental, community and safety performance. Shift schedules, working assignments, and working/training sessions are tailored to meet the needs of the employees and the business. Mental health and physical health are optimal such that the workforce

Continued...

and business excel at achieving and maintaining zero harm in all aspects. The mining companies meet all stakeholder expectations in a world where there is an increasing demand for human resources. A new generation of worker is employed including those who manage technically advanced processes and others with multi-trade skills combining electrical, mechanical and IT knowledge to maintain the evolving complexity of equipment and systems. There is an overall celebration in the collaboration and a pride in the resulting excellence. Focus groups will continue to evolve and transform the mining industry. There is economic vitality and well-being within the entire ecosystem. The mining industry is highly valued for its essential contributions to society.

A man in a dark shirt is standing and presenting to a group of people seated at computer workstations in a control room. A large screen behind him displays a diagram titled 'Deep Learning' showing a 'SIMPLE DEEP LEARNING NETWORK' with 'Input Layer', 'Hidden Layer', and 'Output Layer' nodes. The scene is dimly lit with blue ambient lighting.

At BESTECH, we see the mine of 2030 driven by technology and enabled by talented people who ensure its financial and social success. Commitment from community and industry leaders will bring this vision to life.



About BESTECH

Working Together as a Responsible Industry

We help our clients design the mines of the future that are easier to build, more economic to operate, and easier to fund. We deliver studies, designs, and budgets faster and more accurately than old school firms. We provide a comprehensive, whole mine view you can trust and on which you can build your operation and future.

 bestech.com/services/mining-engineering



About the Author

Samantha Espley, Vice President, BESTECH

Samantha Espley is a mining executive and professional engineer with over 25 years' experience as a leader of multidisciplinary experts and programs in the mining industry.

As vice president at BESTECH, she leads mining transformation, bringing innovative solutions to clients and to the Inovinta group of companies. She is instrumental in the creation of technology and innovation roadmaps and working with a wide range of stakeholder groups.

In 2020, Samantha is President of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) and an active director on the boards of MIRARCO, Laurentian University's Bharti School of Engineering, Centre of Excellence in Mining Innovation (CEMI) and the Canadian Academy of Engineering (CAE). Samantha is a fellow of the CAE and CIM, and received the CIM Service Award, Women in Mining Trailblazer's Award, Professional Engineers of Ontario Management Award, and the Governor General's Gold Medal.