Bigger not always better

Technologies that integrate mine and mill can make marginal hard-rock mines profitable

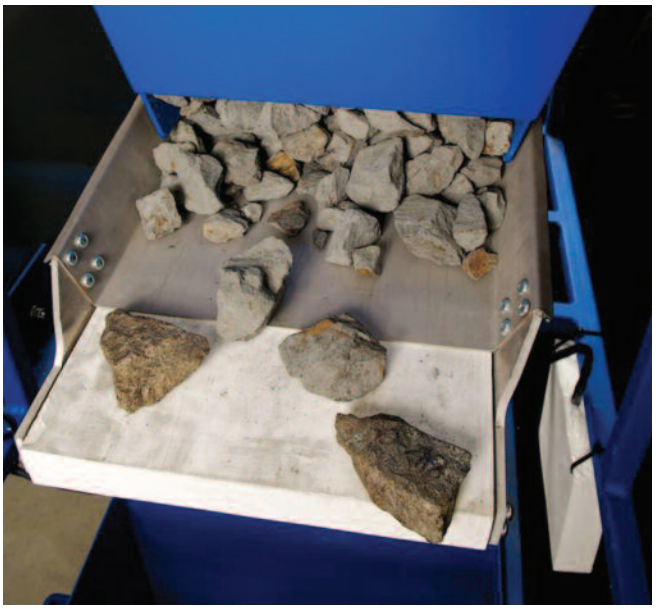

Photo credit: Andrew Csinger, MineSense Technologies

The sensor system can be used in shovels, belts and sorters to detect ore from waste before sending it to the mill.

In the 1980s, Toyota revolutionized its automobile production by adopting the principle of lean manufacturing. The practice assumes that all expenditure of resources should be focused on creating value for the end customer. Anything else is considered wasteful and should be eliminated. In its simplest terms, lean manufacturing means getting more done with less.

As a graduate student in mining engineering at the University of British Columbia eight years ago, Andrew Bamber adapted this idea and developed the concept of "lean mining." The objective is to help reduce waste, excess plant capacity and re-work, which is caused by misallocating ore and waste. "Large-scale mining only dilutes inefficiencies by spreading them out over a large operation," explains Bamber, CEO of MineSense Technologies Ltd. in Vancouver. "Lean mining, on the other hand, removes inefficiencies. The end results are smaller, more technologically intensive and productive mines, faster permitting, smaller footprint and higher returns."

More efficient processing

The MineSense Solution, created by Bamber's firm, is a practical outcome of the lean mining idea. Using sensors integrated into conventional mining process equipment (shovels, belts, sorters, etc.), it allows miners to detect and separate ore from waste before sending it to the mill. The sensor system can also recover valuable material that was previously cast aside as waste and send it to the mill for processing. "The reduction in waste rock benefits not only the mine, but also the mill and the smelter," Bamber says. "This is a valuable difference. With these cost savings, mines that are marginally profitable or unprofitable using traditional methods can become profitable."

"Sensing can also be used to quantitatively evaluate ore chemistry in the run-of-mine product and transmit that data to the mill," he explains. "Such early knowledge of ore chemistry can be used to proactively adjust process parameters in downstream operations such as grinding, leaching and flotation, and thereby improve metal recoveries by one to two per cent."

The MineSense Solution is a Canadian-made example of mine-mill integration. The term refers to methods of improving the interface between the mining operation and the surface mill. "Mine-mill integration can have a direct impact on the profitability of a mine of between 10 and 30 per cent," says Professor Bern Klein, head of the Norman B. Keevil Institute of Mining Engineering at the University of British Columbia.

According to Bamber, there are a number of preconcentration technologies available, including sorting and separation by size and sorting by electromagnetic, optical, X-ray and nuclear means. By comparison, he says MineSense is a non-conventional preconcentration method. "What makes it different is the combination of ore sensing and the separation of ore from waste during and within the mining and material handling process."

Less is more

The core of the MineSense technology is a proprietary signal generation and analysis system called high-frequency electromagnetic spectrometry (HFEMS). It can detect the type and quantity of mineralization in the ore. HFEMS helps miners decide whether to process, upgrade or dispose of it.

In laboratory and field testing for Xstrata and Vale, the prototype MineSense HFEMS sensor system demonstrated detection levels in ore particles as small as 15 mm of 0.1% nickel and 0.2% copper. MineSense has several customers in the nickel mining industry, both major and junior companies, and is engaged in projects in Canada as well as outside North America.

Bamber says that using the MineSense Solution will help reduce energy consumption, water use and greenhouse gas emissions, thus improving the sustainability of integrated mine, mill and smelter operations. He further adds that projected operational savings would enable the system to pay for itself in months rather than years.

The value equation

To inform potential users of the features and benefits of the MineSense Solution and other preconcentration technologies,

MineSense joined forces with the Sudbury-based Centre for Excellence in Mining Innovation (CEMI) and Falconbridge, Ontario-based Xstrata Process Support (XPS), and developed PreCalculatOre, a free software program that can be downloaded from both the CEMI and MineSense websites.

PreCalculatOre is an integrated process and cost-modelling tool that performs like a very sophisticated spreadsheet for mining, milling and smelting operations. It can compare and contrast the impact on operating costs, ore extraction and overall metal recoveries of the traditional mining approach to one with a preconcentration stage, such as the MineSense Solution. Preconcentration impacts are evaluated by hypothetically introducing a degree of waste rejection through an ore preconcentration process inserted between the mine and the mill.

PreCalculatOre enables users to adjust the base costs of their operations by making changes to mining and milling costs. Each of the operating and capital costs of the mining operation (mine fill, muck, hoisting, waste and ore haul) and the milling operation (preconcentration, waste handling, mill haul, grinding, flotation, roasting, leaching, dewatering, tailings, concentrate haul, smelting, slag handling and refining) can be adjusted.

PreCalculatOre can be used to evaluate the suitability of preconcentration techniques in open pit and underground copper, nickel, gold and molybdenum sulphide mines. Bamber says the application came about when MineSense was working with XPS on a desktop research project into ore preconcentration for CEMI. "CEMI concluded that a lack of tools for the economic evaluation of preconcentration opportunities was a barrier to increased adoption of the approach in the industry," he explains.

Room for improvement

"Some conventional processing can be done in the mine or the pit, such as preconcentration, which is the rejection of barren waste from the mill feed," Bamber says. "The process generates a smaller amount of higher quality concentrate. There is a wide range of ores that can be preconcentrated, depending on their properties. It's not widely used now and it needs to be done more."

The industry is actively searching for practical ways to reduce the operational costs and the environmental impacts of mining. Mine-mill integration is a practical and sustainable solution to these challenges. "Because of growing environmental constraints and the increasing lack of capital, it's no longer feasible to build the sort of mega-mines that process large quantities of ore and waste to obtain a relatively small amount of concentrate," says Bamber. "The industry is starting to realize that bigger isn't always better." CIM

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