Footprint Reduction Afoot: Mostly Truckless Systems Are Commissioned

Suppliers provide ore transport solutions that cut costs, reduce payrolls and further the sustainable mining paradigm

By Jesse Morton, Technical Writer

Three majors recently reported commissioning ore transport systems advertised as free of combustion engines. On separate continents, each faced unique challenges in doing such, but announced the benefits outweighed costs.

One commissioned a rail-based system that speeds through pre-existing winding drifts underground. It cited the worker health benefits of a diesel exhaust-free work environment as a major impetus. Another commissioned a ski lift-style ropeway system to move ore up a mountain ridge that gets hammered by winter weather. The miner, frequently the target of litigious local green activists, cited the minimal environmental footprint of the system as a core benefit. And the third commissioned a system that included a conveyor, rail system and a port terminal. It reported the vast system would enable the project to become "sustainable."

The three solutions represent instances of innovation that seek to answer the twin challenges of rising energy and labor costs. They also speak to the idea that the mines of tomorrow, while employing fewer people, will be safer, more environmentally-friendly places to work than the mines of yore.

Rail-Veyor Handles Curves Underground

In April, Rail-Veyor Technologies Global Inc. announced a Rail-Veyor system is hauling "all the production material at Agnico Eagle Mines Ltd.'s Goldex mine in Val d'Or, Canada, for their Deep 1 project."

Official operation of the system commenced in May 2017, and by the second quarter of 2018, a "total of six Rail-Veyor trains are being used in a fully automated and synchronized operation," Rail-Veyor reported.

Agnico Eagle reported satisfaction with the system, which they said offered lower operating expenses than the alternatives and allowed the miner to more easily extend Deep 1 as needed.

The miner first considered the technology in 2010, Frédéric Langevin, general manager, Goldex Complex, Agnico Eagle, said. "In 2010, when we were engineering the LaRonde Extension, Rail-Veyor had been an option at that time," he said. "However, it was rated second behind the coarse conveyor they finally put in because of the higher capital costs at the time combined with the fact that it was still an unproven technology in an underground environment."

Tires on the Rail-Veyor drive stations grip side plates on the cars and propel them down the line. (Photo: Agnico Eagle)

Agnico Eagle gave Rail Veyor a second look in 2014, considering it an option for the Deep 1 project. Things had changed since 2010. "We learned that in late 2010, just after we had the quote for LaRonde Extension, the company changed hands and the new guys took the system very differently," Langevin said. The new owners come from the heavy rail industry and the fabrication industry, he said. "They looked at the system very differently and they brought the capital costs of the system way down by re-engineering it."

The new owners stayed true to the original design, simplifying it. And their estimates showed, Langevin said. "When we had the initial quote for the system for Deep 1 for Goldex, for three times the length, it came in at half the price as the 2010 estimate for the LaRonde Extension," he said.

Rail-Veyor would have to go head-to-head on costs and safety with a coarse conveyor system and a hauler-based system. Its unique design brought advantages and benefits that ultimately enabled it to win.

The system is rail-based and operates six trains. Each is comprised of 68 2.4-m-long cars, connected by pins described as Torrington joints, and with each car jointed to the next by a flexible piece of conveyor belt, forming a continuous but articulated 166-m trough. "Because it is composed of individual cars pinned to the front car, they are able to negotiate turns as tight as 40 m," Langevin said. "The train is capable of twisting a bit over a certain distance and going around bends as well."

Each train has side plates that are squeezed by the system's drive stations, which are separated by 37 m of track. "These drive stations are very simple: just two motors, two reducers, two tires, and the tires squeeze the train and push it along the track," Langevin said. "In our case, each train at any given time is in contact with four to five of these drive stations." The drive stations provide the

Low-profile steel cars in either 30 in. or 48 in. widths are linked together with a spill-proof connection to create a continuous U-shaped trough. (Photo: Agnico Eagle)

thrust and the braking action on the 17% incline. "The train itself is free on the track," Langevin said.

The ability to twist gave it a distinct advantage over coarse conveyors. "A regular conveyor needs straight lines," Langevin said. Because it could negotiate curves, the miner could reuse existing drifts. "Drifts are expensive," Langevin said. "When you factor this in, it is a huge savings."

Rail-Veyor, while representing a bigger initial capital expense, promised to incur lower operating expenses than did the alternative hauler-based system. "It is much cheaper per metric ton (mt)," Langevin said. "What also sold it for us was the fact that, compared to trucks, trucks are more and more expensive the longer you go." And the Rail-Veyor would enable the miner to maintain its cost structure when it extends Goldex, he said. This could ensure the mine could maintain "one of the lowest underground mine costs in the world."

On paper, Rail-Veyor won out and landed the contract. The challenge became making the theoretical practical, something that would require the supplier to compromise and modify some aspects of their designs. "They were very open," Langevin said.

Deep 1 would have to be designed around the system, but the system would have to best serve the needs of the miner. Initially, Rail-Veyor envisioned using only two trains, each 650 m long. "In an underground environment where drifting is expensive, that 600-m train meant that we had to excavate at each end of the system 600 extra m of development," Langevin said. "When we came back to the drawing board with them, that is where we came to the final design, which is the six shorter trains to maximize the use of the drift that we already had."

The system ultimately proved to offer a range of benefits.

First, it saved the miner time. Goldex wanted a solution that didn't require a new crusher and Rail-Veyor was one answer. The system enabled the miner to reuse existing excavations. "We had an exploration ramp that went all the way down to 1,000 m," Langevin said. The ramp wasn't straight, but "could be reused with the Rail-Veyor," he said. "That was one of the deciding factors."

Second, it would bring worker health and safety benefits. "If we had 12 to 14 trucks on the ramp at any given time, those are big trucks and they don't have that much visibility so that would have been a risk," Langevin said. "It also reduces the risks of fire because there is almost nothing to burn on the system, compared to either trucks or conveyors."

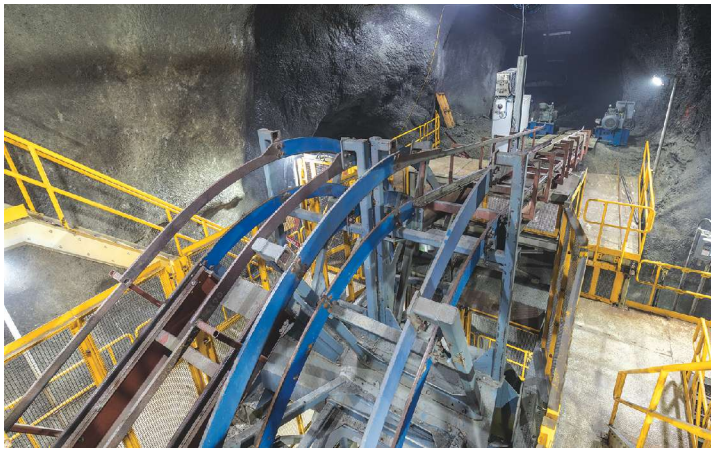
Further, it is electrically powered. "Trucks generate combustible, breathable particles, CO_2, dust, noise, heat, all of which aren't true for the Rail-Veyor," Langevin said. "That is a big advantage as well."

Because it is automated and operates in a separate, restricted-access drift, workers are never in contact with it while it is operating. "That drift is closed off to circulation so there is no one in the area of Rail-Veyor when it works," he said. "We eliminate all contact with humans."

Third, by running on electricity and requiring only limited ventilation it has a smaller energy footprint. "The best diesel engine in the world converts about 36% of energy to actual movement," Langevin said. "The Rail-Veyor converts 85% to 90% because it is electric."

As the system is being commissioned and trialed, Deep 1 is increasing production while other areas of the mine are "ramping down," Langevin said. This is optimum, he said, because it enables a gradual ramp-up of the system. "Right now, we're producing on average 7,000 mt per day (mt/d) from the line," he said. "Roughly 4,000 come from the old areas and 3,000 comes from Deep 1, which has to go through the Rail-Veyor." Eventually the system will haul 6,000 mt/d.

The miner is using the commissioning period to perfect the system. The system runs during the night shift and maintenance occurs on day shift. "At some point, we will have less maintenance to perform on the system going down the road, but at this point we are very much in the initial failure area where everything that is under-designed in the system fails



Like a roller coaster, the cars come around a bend and then briefly flip over to dump the ore. (Photo: Agnico Eagle)

once," he said. "We still have a lot of maintenance to do on it, but we are fairly confident that all of these issues will be behind us in the next few months."

Meanwhile, the system is able to handle its workload and the miner is discovering its capacity. "We haven't seen the limits of the system right now," Langevin said. The miner expects the maintenance costs to level off gradually as the system handles gradually increasing production. The support the miner has received from the supplier thus far has been "very good," Langevin said. "They are going out of their way to help us and make sure the system is going to deliver what it is supposed to deliver."

The success thus far experienced furthers the idea that the system could be expanded at Goldex or copied elsewhere. "With the flexibility of the Rail-Veyor, at any point between 1,200 m from surface to 700 m from surface, we can tie in other trains into the system and use infrastructure that we have right now," Langevin said. "We also have a couple of properties beside our own that are attractive that we know we have potential targets on, and using the Rail-Veyor for these zones would make a lot of sense."

Goldex, described as the largest unexploited gold deposit in Quebec when it was purchased by Agnico Eagle in 1993, is sited 60 km east of the company's LaRonde mine in the Abitibi region. It was the first of five acquisitions in 15 years that propelled the company to the ranks of the world's top pure-play gold producers. Work and mining commenced at Goldex in 2008. Reserves at Goldex are estimated at almost 1 million oz and the remaining mine life is slated at a little more than six years.

The ropeway system operates in winter weather that could pose problems for a truck-based system. (Photo: Doppelmayr)

Ropeway System Climbs Mountain

Doppelmayr Transport Technology GmbH recently announced the December commissioning of a 4.5-km ropeway system for moving ore to a riverside facility from a copper mine sited 1,700 meters (m) above sea level in the mountains 3.5 km southwest of Artvin, in the Black Sea region of Turkey.

The Cerattepe underground copper and polymetallic mine, owned formerly by Cominco Resources and currently by Cengiz Holding, rented to Özaltın Holding, and operated by Eti Bakır A.Ş., began assembly of the ropeway in the second quarter of 2017, Stefanie Reis, spokeswoman, Doppelmayr reported. It was designed to transverse a "difference in elevation of more than 1,500 m" and a river bed. The incline is more than 43° at its steepest point.

Primary infrastructure consists of 11 towers in a crooked line going up the mountain with a station at either end. "The highest tower is about 38 m high," Reis said. "The towers used for this installation are either of tubular shaft design or of lattice steel framework."

The towers support a continuously moving steel wire rope to which 51 material buckets and a few passenger cabins are attached by means of a grip, Doppelmayr reported. "The system uses a 52-mm-round stranded steel wire rope," Reis said.

The rope loop is driven by bullwheels in the loading station and tensioned via a return bullwheel in the unloading station in the valley, the company reported. "Both drive bullwheel and return bullwheel are 6.10 m in diameter and weigh about 4.2 mt," Reis reported.

A mechanism in the stations opens the detachable grip of the material buckets, removes them from the ropeway, and slows each down, Doppelmayr reported. The buckets can thus be stopped for the loading and unloading procedures in the stations while the ropeway continues at full speed. They are reattached to the rope as they leave the station. "The system is based on proven detachable ropeway technology also used for passenger ropeways and was adjusted to cater to the specific needs of material transport," Reis said.

The system operates fully automatically, Reis said. "Loading is done via a feeding conveyor," she said. The buckets transport primarily ore and "have been fitted with lids to prevent soiling of the environment." In the unloading station, the lids are opened, and the buckets turned upside down automatically, so the material falls onto a chute. Then the buckets are tilted back to their normal position for the return trip.

Two different types of guides are installed in the stations: one for the material buckets, and one for the passenger cabins. Material flow and passenger transport are thus separated.

A ride in the cabin spans roughly 20 minutes and is described by Doppelmayr as comfortable and safe. "As it is a detachable ropeway system, you could replace the passenger cabins with material buckets, although this specific system has mostly material buckets and very few passenger cabins anyway," Reis said. "Its main purpose is material transport."

The ropeway can also be used to transport backfill material from the valley to the mouth of the mine.

Being fully automatic, operating costs are optimized, Doppelmayr reported. The system is comprised of "hardly any moving parts along the track," and "all material buckets and cabins travel through the stations regularly and can be easily inspected," the company reported.

Maintenance is carried out in the stations, Reis said. "If it becomes necessary to do maintenance on a bucket, it would be directed to the maintenance position in the station, and another bucket would take its position along the line," she said.

The required motor output during normal operation is approximately 370 kilowatts, Reis said.

The ropeway is superior to alternatives because of its operability in extreme conditions and its small footprint. "It does not represent an insurmountable obstacle for man or wildlife," the company reported. Further, Reis added, road access to the mine is steep and could be difficult in snow. "The ropeway is driven by an electric motor and saves many truck journeys along with the related exhaust fumes and noise emissions," she said. "The system is elevated off the ground and thus occupies only little ground space."

The Cerattepe deposit was reportedly discovered in 1991 and was subsequently labeled world-class. Drilling started in

1992. It was acquired in 1994 by Cominco Madencilik Sanayi A.Ş., the Turkish subsidiary of London's Cominco Resources International Ltd. The company drilled more than 550 holes.

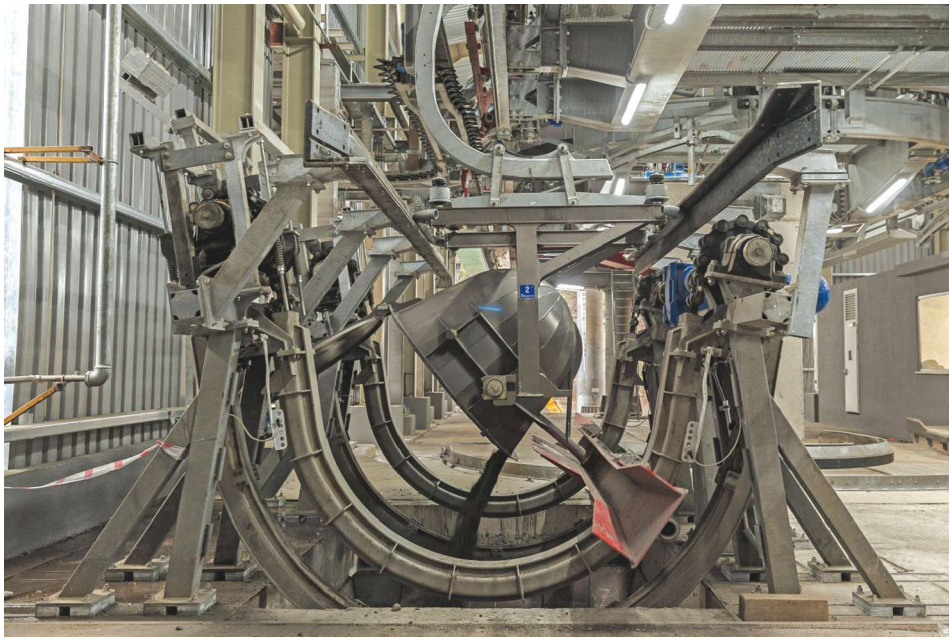
In 2009, The Turkish Council of State, acting on litigation brought by the Green Artvin Association and the Artvin Bar citing water table pollution allegedly linked to drilling, pulled the exploration licenses for all parties working the deposit, nixing projects run by Cominco Resources and Toronto's INMET Mining.

In 2011, the Turkish Ministry of Energy and Natural Resources updated the country's mining laws. Cengiz Holding and Özaltın Holding acquired a drilling license in 2012, launching the partnership's operations there.

Reportedly containing silver, gold and zinc, Cerattepe's copper ore will be transported to an Eti Bakır A.Ş. Facility for flotation and processing at a rate of just under a half million mt per year.

AssetVista Alerts on Stacker Snafu

ABB reported that its asset-condition monitoring system, AssetVista, is helping Vale manage the maintenance of stackers and the conveyor system at the expansive S11D iron ore project in the Carajás mountains of northern Brazil.



Buckets are opened, tipped and dumped automatically. (Photo: Doppelmayr)

The software was adopted when the miner launched a capacity expansion in the third quarter 2014 and contracted ABB to supply and install automation packages and electrical equipment at a price tag of roughly $100 million. At the time, Vale announced the expansion and automation would contribute to the mine becoming a "sustainable mine of the future," ABB reported.

The monolithic S11D Carajás complex, which includes an open-pit mine, factory, railway and port, and includes operations in both Pará and Maranhão, reportedly produces 90 million mt of ore annually. The ore is moved via a half-dozen stackers and a sprawling, 9-km conveyor system dubbed the Long-Distance Belt Transporter.

AssetVista monitors the health of the stackers at the sprawling S11D project. Above, an aerial view of stackers in the S11D, Eliezer Batista Complex, stocking yard in June 2017. (Photo: Vale)

AssetVista enabled the miner to closely monitor the functioning of 6,000 critical assets on the site, including hundreds of dry transformers and large motors, more than 1,500 switchgears and almost 400 drives, and hundreds of process controllers and servers, ABB reported. "AssetVista helps them to understand the asset condition of their material handling system much better," said Eduardo Ingegneri, global product manager, AssetVista, ABB.

AssetVista runs on ABB's 800XA distributed control system (DCS), which collects, stores, and processes data on the machines and components across the project. Primarily AssetVista operates as an interface that presents the data in graphics and tables and provides alerts and reports that facilitate timely decisions and streamline preventative maintenance.

For example, AssetVista enables a user to first pan out to the family of machines that comprise a leg of the conveyor system, and then drill down on detailed real-time data captured from a single motor or drive, Ingegneri said. "You can see whatever you want: bearing temperature, motor temperature, all that stuff that is collected, that is watched in the background, that is processed by these algorithms, and is displayed as an alert," he said.

The software enabled the miner to detect an above-normal pressure differential in the luffing cylinders of one of the company's six 70-m-long stackers in the coor-

dination yard, where as much as a million mt of ore is stockpiled. The yard operates three bridge-type reclaimers and three twin boom stackers, which were commissioned in the second quarter of 2016.

AssetVista warned the miner of the abnormal differential, and then launched an investigation that arrived at two possible causes. Either the pressure sensor switched connections or the pressure distribution control system failed. The former would result in inconsistent feedback for luffing elevation control. The latter would set off a series of events. Either could have resulted in unplanned downtime and possibly cascading costs.

The software pegged the situation an alert. On a screen summarizing the performance of an entire family, the alert presents as an orange box among other boxes colored to indicate the normal performance of the other assets.

This allows the user to quickly scan the screen and know which assets merit attention and which are performing as expected.

In this case, orange represents a third-level diagnosis. Green, level one, means normal. Yellow, level two, indicates attention is needed. Blue is level four, for alarm. Level five is red, for fault; six is black, for bad.

Selecting the alert instantly brought up the Health Index Dashboard and Faceplate, which revealed both the limits and the actual inputs for the cylinders. A piston and two rods on two cylinders were registering pressure well above the upper range. Honing in further, AssetVista's Asset Reporter windows revealed, in table format, the severity level, itemized possible causes and recommended actions, primarily a regime of inspections.

The AssetVista-generated warnings occurred before the standard DCS alarms, ABB reported, which gave the miner time to draw up a plan of action that prevented unplanned downtime.

It also typified the benefits and advantages offered by the software. "The maintenance manager can sit on a screen and he sees an overview, and if he is interested in a particular asset he can click into it and then he sees all these values the system has processed in the background," Ingegneri said. The system can be customized to highlight the most pertinent key performance indicators (KPIs).

It can also be set according to needs and preferences to send alerts via email. "You would say these are the 10 most important KPIs," Ingegneri said. "Maybe I would like to see more, maybe 20 — that is something that depends on the operational needs of the mining operator."

AssetVista delivers push-button reports, which can also be customized to contain exactly the information deemed most important by the user.

But foremost of the main selling points are the analytics it performs, such as a root cause analysis of an anomalous pressure differential reported by luffing cylinders on a stacker. It also conducts, either automatically or at the push of a button, fault tree analysis, failure mode and effects analysis, and reliability-centered maintenance strategies.