



Annual Innovation Report

January 2018

MacLean Innovation Report – January 2018

Sometimes a turning point can only be seen clearly in hindsight. Such is the case for the mine of the future as we begin 2018, coming out of a 2017 where major mining companies continued to demonstrate capital spending austerity and focus on debt reduction. All the while, there were growing signals that digitalization, electrification and automation were all gaining momentum, even though actual examples of minesite implementations could as of yet, still be counted on one hand.



For MacLean, the past year was one where for the first time we had a fleet of battery electric vehicles working underground, allowing us the ability to validate our performance and total cost of ownership (TCO) models with real-world data, while at the same time continuing to build out our EV offer across the product lines.

MacLean took the opportunity that industry downturn presented over the past several years to focus intensely on three key product development ventures – first and foremost, the battery electrification of our entire fleet, which will be complete by the end of 2018; second, the successful introduction of face bolting as a feature on our 975 Omnia bolter; and, third, the launch of the latest addition to our utility vehicle product line – the LR3 Boom Lift for heavy load and high reach applications.

The Borden EV story continues



The electrification of mobile fleets in underground mining was kicked off in earnest in Canada when Goldcorp decided to move their Borden exploration project forward as an all-electric mine. MacLean was honoured to be chosen as one of the two suppliers to this project in 2016, at this point a bulk sample ramp advancing at some 4 to 5 metres per day. The mine of the future will indeed be all-electric, and it will also have a smaller geographic footprint, industry-leading water

management practices, and partnerships with the local First Nation communities.

Our first five battery electric units arrived at Borden in April of 2017, two bolters, an emulsion loader cassette, a boom truck cassette and a scissor lift, with nine more MacLean EV units to be shipped in 2018, including a blockholer, the first of our Ore Flow suite to be electrified.

In total, we put seven EV units underground in 2017 and we have orders that will double this in 2018. The EV mine upside of zero emissions, lower total cost of ownership, and reduced ventilation requirements are simply too compelling for mining companies to ignore much longer. Glencore's two cornerstone Sudbury basin expansion projects – Onaping Depth and Nickel Rim Deep – are case in point in this transition to diesel-free mines to leverage ventilation savings and reduced infrastructure costs, along with the benefits of exhaust-free and lower maintenance fleets.



Full-fleet electrification will be available by the end of 2018, but we know this is just the first step to aligning our company to what our customers need and expect. We moved rapidly into the EV propulsion space because we saw the business drivers the industry was facing – heat and ventilation requirements becoming a prohibitive cost with a diesel combustion fleet, where the only economic way to access increasingly hard-to-reach ore bodies is through the introduction of electric vehicles, reducing ventilation and equipment maintenance costs and providing a work environment free of diesel fine particulate matter.

Electrification + Automation = Value Creation



As we work hard to fully electrify our fleet of ground support, ore flow/secondary reduction, and utility vehicles, we're also aware that electrification is but one step in the ongoing mechanization of underground mining, a transition to the mine of the future that will be increasingly efficient through digitalization and automation that will increase production and reduce costs.

This will require a communications infrastructure underground that makes every piece of equipment smart and connected. It will require automation, which has already started with LHDs and now needs to work its way through the rest of the mining cycle, to potentially no cycle at all with ongoing advances in continuous mining technology. The end goal is to address historically low efficiency metrics in underground mining (e.g. average equipment utilization rates less than 30%).

It will require different skill sets both at mining companies and at the suppliers that support them – first to prepare for progressive automation and then to introduce it. No doubt programmers and mathematicians but also the human side of providing adequate training and ensuring a safety culture is entrenched within the strategic drive for improved productivity.

Taking “The MacLean” into the 21st century



On the subject of safety, specifically at the working face, MacLean committed to developing face bolting capability on our signature piece of equipment, the 975 Omnia platform bolter, back in 2016 after customer requests made it clear that reducing the risk of pressure bursts and gravity falls of ground in deeper mines with higher-stress ground conditions was a priority. Across 2017 we trialed a new configuration where the operator can bolt the face while remaining a minimum six metres from the face at all times, and this feature is now an option not only on our larger, eight-foot wide bolter but also soon on

our six-foot wide Small Section Bolter.

And face bolting, like electrification, is just the first step. We built our reputation for mining equipment safety and productivity in large part over the past thirty years since its introduction, on the back of the MacLean semi-mechanized bolter. The next era of our signature bolting unit will build on the foundation of our previous decades of bolting experience in hard rock mines around the globe, but it will do so within the context of deep mining rock stress and heat and the automation productivity imperative, the potent mix that is driving the myriad of changes coming to the mining industry at an increasing pace.

LR3 – From the south James Bay lowlands to the south Gobi Desert

The efficiency imperative that cuts across manufacturing and mining industries alike will also lead to an increasing number of larger heading mines accessing lower grade deposits worldwide.

Against this backdrop, MacLean announced last year the development of a purpose-built utility vehicle for heavy load (4.5 tonne lift capacity) and high reach (six-metre deck height) applications. The LR3 boom lift was designed specifically for the Australian market and the need to safely install twin fans, amongst other miscellaneous infrastructure needs in large mines.



The transfer of mining equipment innovation from one part of the hard rock mining world to another started for the LR3 in Canada, at the Bracemac zinc mine in Matagami, northern Quebec, and then progressed to Mongolia at the Oyu Tolgoi copper/gold mine. Meanwhile, over the past year of ongoing trialing in Australia we have continued to add functionalities to the LR3 quick-switch deck configurations and attachments, all of which support the unit’s application versatility based on mine-specific needs. The Oyu Tolgoi project is one that we have been actively exploring for over a decade, so it is a major milestone for MacLean to now be on site, and we are cognizant and humbled that this is our unit #1 in underground year #1 of a 100-year mine.

With that, a sincere thank you to our customers for allowing MacLean to be part of your day-to-day mining operations as well as your long-term innovation roadmap. The onrush of technology into an industry that has historically had barriers to adoption will no doubt come with its own set of challenges. These will need to be navigated collaboratively, as no one company or organization can seize the opportunities of digitalization, electrification and automation on their own.

Don MacLean, Chairman and Founder

MacLean Engineering

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