MINE EVALUATES UNDERGROUND AUTONOMY FOR FUTURE EXPANSION

STUDY PROVES VALUE OF CAT® MINESTAR™ COMMAND

SITUATION

When a Canadian mining company began planning the expansion of its copper-gold mine into a new zone, a key component of the study included an investigation into technology solutions—including whether autonomous mining would be a viable solution for exploiting the new mineral resource.

The investigation into technology solutions for the new zone included a three-month study of the Cat® MineStar™ Command for underground autonomy system. The goal was to determine if implementing Command would deliver the productivity, efficiency and safety benefits expected in autonomous mining operations. In addition to operational improvements, the mine was also looking at autonomy as a way to remove operators from unsafe working areas considering past mud rush incidents.

The study included the system running on Cat R1700 underground loaders in the mine's current mine design. Strong performance in the current mine design would pave the way for the implementation of the system when operations expand to a new zone.

This evaluation yielded strong performance and productivity results as well as positive feedback from machine operators, technicians and operations personnel.

The results of the trial gave the mining company confidence that Command for underground was the right solution for the mine expansion.

STUDY EXECUTION

During the trial, autonomous operations ran Monday through Friday for about three hours per day (morning until noon). The autonomous system was utilized during blast clearing times—providing additional production to the mine during a time when manned equipment could not operate and minimizing the impact the trial had on the mine's regular production machines.

Ten operators were trained, with four primary operators running the autonomous machine throughout the trial. In addition, several technicians worked with Caterpillar and and Cat dealer Finning Canada on the installation and maintenance of the system. They reported the initial infrastructure setup was easy and straightforward.

The system performed well throughout the trial, with no maintenance required by site technicians once the implementation was complete. Operators were able to run the system on their own, making map changes and troubleshooting any issues.

Over the three-month trial, a total of 1,585 cycles were completed in autonomous mode, with a total run time of 135 hours on the system. Of the 1,585 cycles, 231 were completed during blast for a total of 2,749 tons. The trial included autonomy system operations in various modes (Guidance, Co-Pilot, Auto-Pilot, Auto Dump and Auto Load), successfully testing all semi- and fully autonomous features.

Operators also leveraged map editing features—configuring zones to regulate machine speed and establishing virtual walls and avoidance zones.

The primary objective of the study was to understand and compare performance characteristics in autonomous mode vs. manual mode. Cycle data was collected in both modes in the same operating conditions to reduce variability.

RESULTS

Even in the short duration of the study—combined with restrictions caused by the COVID-19 pandemic—the system delivered many of the expected improvements. Over the course of the trial, both average cycle times and production results improved, indicating that the more time spent operating the system, the more proficient the operators became.

In addition, if the system was being run for a full 8-hour shift rather than 3 hours of daily use throughout the trial, operators would complete cycles more consistently thanks to the ergonomic environment of the ROS. The expectation is that daily production would be higher in autonomous mode than in manual mode.

> The trial indicates that an estimated overall **9.6% increase** in daily production is achievable in autonomous versus staffed operations.

INCREASED UTILIZATION

One of the primary benefits the mine can expect will be increased utilization—and a boost in production—made possible by the consistency of operation, increased operating hours gained through the elimination of shift change and the ability to operate during blasts, and a reduction in downtime due to the ability of the operator to constantly run cycles without damaging the machine.

» During the three months of the trial, Command delivered 2,749 tons.

» The study indicated that the mine could expect an additional three hours of machine utilization every day.

» Downtime reductions are estimated to increase machine availability from 82% to 85%.

> Multiple factors combined could increase machine utilization from the current 53% to a possible 70% over a 24-hour period.

IMPROVED SAFETY

During the trial, autonomous machines completed over 1,500 cycles and moved 18,000 tons without any safety infractions and with no damage to the machine or drift.

> Reductions in machine damage could save the mine hundreds of thousands of dollars every year.

FEEDBACK

OPERATOR FEEDBACK

Operator feedback was overwhelmingly positive in terms of ease of set-up, ease of use and functionality. The map editing features also were a highlight, with operators describing them as intuitive, easy to use, and an advantage over competitive systems.

The ROS also earned high marks from operators, who said they quickly became comfortable with using the system and had no issues operating it.

FEATURES AND FUNCTIONALITY

Special mention was given to the ability to run the machine autonomously during dusty conditions. The system continued to operate reliably without dropping, which was described as an advantage over competitive systems.

INSTALLATION AND SUPPORT

The installation and commissioning process received positive feedback, with the mine noting the ease of the process and the quality of the support provided during the trial. Any questions related to the autonomous system were dealt with quickly by Cat dealer Finning Canada and Caterpillar personnel.

NEXT STEPS

While there are additional benefits of Command that may not have been demonstrated during the trial, the mine gained a clear understanding of the system's capabilities and future potential. In addition to the benefits Command delivers today, the system itself will continue to evolve, integrating seamlessly into Caterpillar's overall roadmap for future battery-electric vehicles.

Additional run time on the system will reveal other potential benefits for the mine. For example, reduced damage on the machine will save the mine hundreds of thousands of dollars annually and reduce maintenance— delivering an overall decrease in downtime and a lower total cost of ownership through reduced parts consumption.

Re-evaluating the current bucket configuration on the R1700 to match material density could deliver additional tons per cycle. Improvements to autodig capabilities will ensure bucket fill consistency across different shifts.

> While a decision has not been made on the implementation of autonomy in the mine expansion, the goal of the trial was achieved: Command for underground was proven to be a viable solution for mining in the new zone.
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> If the mine elects to implement Command, the partnership commitment shown by Finning and Caterpillar will be a key contributor to the success.

Cat MineStar Command for underground combines onboard computers, cameras, LADARS and off-board software to autonomously steer load-haul-dump (LHD) machines during hauling. That allows operators to load and dump material from safe, comfortable control stations—located well out of harm's way on the surface or underground. It also improves accuracy of tunnel navigation, boosting productivity and reducing machine damage caused by contact with drive walls.

Command is an integral part of MineStar Solutions for underground, the mining industry's most comprehensive and thoroughly integrated suite of technology offerings. Additional capabilities include:

- » Fleet, which provides real-time visibility to cycle time, payload and other key operational parameters.
- » Detect, which addresses risk to people and assets by making it possible to track them wherever they are underground—in real time.
- » Health, a suite of products and services that enable the collection and analysis of machine health data.

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