

The Snowball Effect of Smart Mining Technology

GPS-enabled SmartROC D60 Inspires
Confidence and Exceeds Expectations



INTRODUCTION

From 2022 to 2023, US-based Luck Stone conducted two field trials of the Epiroc SmartROC D60 automated drill rig equipped with GPS-enabled Hole Navigation System (HNS). The first trial took place at the Rockville, VA, plant and the second in Spotsylvania, VA.

Luck Stone's sites, especially Spotsylvania, are a challenging geology to mine. Crews primarily drill angle holes, which is exceedingly difficult for a human operator who has to not only get the angle right, but also the azimuth for that angle. Imprecise or incorrect blasts put quality, productivity and safety at risk.

Through the trials, Luck Stone sought to enhance operations by pairing shot planning technology with intelligent drilling equipment. At both sites, Luck Stone documented improvements across all stages of production, demonstrating that innovative thinking, smart technologies and solid partnerships can lead to extraordinary outcomes for a business and its people.

Innovation from day 1

Embracing innovation has been central to Luck Stone's DNA since its inception in 1923. The family-owned and -operated organization was one of the first aggregate producers to convert their crushers from steam to electric power and had the first automated plants dating back to the late 1970s.

Today, innovation is all about equipping teams with leading-edge equipment and technologies that optimize operational and human performance. "It makes us better. It makes our people better," says Bryan Smith, Mine Development and Blasting Manager at Luck Stone. Having the courage to think differently and experiment with new approaches and technologies is one way Luck Stone continues to fulfill its corporate mission to 'ignite human potential.'

Luck Stone

- Largest family-owned and operated producer of crushed stone, sand and gravel in the US
- Founded in 1923, celebrated its 100-year anniversary in 2023
- Operates 29 plants across four states
- Employs +900 associates
- Produces +20M metric tons of aggregate



CHALLENGE

In Rockville, VA, Luck Stone mines metavolcanic rock, otherwise referred to as granite. The biggest issues for drilling are joints and cracks, which can be pronounced. This can cause blasting challenges for the team, resulting in extreme burdens, poor floor and oversize rock.

Spotsylvania provides more challenges than the quarry at Rockville. An aging quarry with a much more challenging geology, the rock in Spotsylvania, VA, shoots poorly, resulting in below-average fragmentation. Significant jointing with almost no voids or cavities presents blasting challenges and causes irregular faces, heavy burdens, poor floor and oversize rock—lots of it.

The importance of precision

Historically, shot design, drilling and blasting have been labor-intensive and potentially hazardous processes that rely on human operators. Hours would be spent hand-drawing complicated, tight

shot plans on paper. A surveyor would walk along the bench to mark out the desired blasting area with tape or by painting rocks, and the operator would have a physical sheet to follow, manually tracking hole positions and depths. The driller would rely on their perception to hit the correct azimuth depths, and blasting involved a combination of blaster experience and best guesswork.

“We use a lot of angle holes at this site because of the geology, which makes the blast planning very important. Drilling those angle holes precisely is very difficult,” Bryan explains. This has led to a fairly conservative approach to planning and drilling, because if an operator misses the required depth and causes overdrills they’ll adversely affect the next bench down. If they blast too deep or too shallow, they’ll create an uneven bench when they get down to the next level. Evidently, the downstream effect of precision is significant.

The downstream effect of inaccuracy



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SOLUTION

Luck Stone's local dealer, James River Equipment, originally connected the team with Epiroc, and is now a trusted service partner for Luck Stone's eight SmartROC drill rigs. Northern Virginia Drilling, a Luck Stone contractor of more than 25 years, was also no stranger to Epiroc, having worked with Epiroc drills inside and outside Luck Stone sites. Perhaps most importantly, the Luck Stone executive team found that their values aligned with Epiroc's, setting the stage for a strong and mutually beneficial partnership.

Epiroc technology and equipment create a force multiplier

For five years, Luck Stone has been using a third-party 3D shot planning software to save time and improve

accuracy in the shot design phase. Many associates assumed that they'd maximized the gains when it came to executing the shot. "We kept hearing that when you combine 3D shot planning with the high-accuracy drilling, you get really cool results," says Bryan. "We didn't entirely believe that. We were already drilling the shot like it's planned. How can it be that big a difference?" he reflects with a knowing grin.

Through strategic conversations and demonstrations in 2022, Luck Stone came to understand how adding GPS-guided Hole Navigation System (HNS) to their SmartROC automated drill could be a force multiplier for their operations, driving exponential gains that they couldn't achieve with the planning software alone.



3D shot planning software

3D shot planning software helps Luck Stone precisely map each of its blasts to improve accuracy and productivity. Epiroc automated drills integrate seamlessly with Luck Stone's third-party software, creating a seamless experience from planning through drilling.

Epiroc SmartROC D60 automated drill rig

The SmartROC D60 is an intelligent drilling solution that consistently delivers high-quality blast holes with accuracy and precision. It is loaded with smart features such as automated drilling and rod handling, all controlled via an advanced rig control system displayed on a touch screen inside the cabin. It presents everything from drilling parameters to real-time Measure While Drilling (MWD) data, which allows for both visual and numerical analysis of rock mass prior to blasting.

Epiroc Hole Navigation System (HNS)

HNS uses existing satellite constellations to guide the machine's position to an accuracy of within 50 mm, eliminating the need to manually mark holes. With HNS, teams can create drill maps off-site and export them onto the rig where the operator can view the dots on screen rather than scan the ground for painted markings. The rig guides the operator directly to the correct hole position, including angles and collaring position. Drilling to the correct depth is automatic since the system has the end coordinates of the hole bottom.

RESULTS

Mining is high-stakes, and every decision has an impact both in the moment and down the line. That's why Luck Stone conducts trials—to build confidence in the technology and in the team using it. Blasting Manager George Feild explains: "When we as blasters get ready to push the button, there's no turning back. We've got to be able to count on the technology that's telling us what we used to measure by hand."

Building the case at Rockville

To prove out the technology and build a business case for wider adoption, Luck Stone conducted a six-month trial of the Epiroc SmartROC D60 with HNS in conjunction with its third-party 3D shot planning software from August 2022 to January 2023 at its Rockville site. From design through hauling and crushing, the results demonstrated that high-accuracy planning and drilling are an unstoppable force.

Expediting design while decreasing risk

From the very first stages of the drilling workflow, the team saw gains. Combining the third-party 3D shot planning software with the SmartROC D60 with HNS produces an accurate shot diagram, speeding up shot layout time by approximately one hour. There's no need for a surveyor or operator to venture out onto the bench, which saves time and reduces risk of injury.

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With the SmartROC D60 with HNS, the rig automatically locates the position of each hole with pinpoint accuracy and drills it to the correct inclination and depth. The pattern doesn't need any on-the-fly adjusting and everything gets drilled as planned.



Data collected included

- Haul truck load times
- Jaw crusher production information:
 - Total tons crushed per day
 - Hours run and hours crushed per day
 - Daily calculation of "black belt" time
 - Daily calculation of Tons per hour Run (TPH-R) and Tons per hour Crushed (TPH-C)
- Secondary plant information:
 - Base percentage
- Shot report information:
 - Shot patterns: burden X spacing = pattern footage
 - Powder factor: Tons per pound of explosives
 - Explosives cost per ton
 - Tons per foot drilled
 - Vibration monitoring
- Floor levelness
- Rock Manager information by hole



"We leaped in and put the HNS on our drill at Spotsylvania, and we have seen the magic."

- Bryan Smith, Mine Development and Blasting Manager, Luck Stone



25%

Reduction in sub-drilling

Increasing throughput

Downstream, load times also improved. Pre-trial, the average truck load time was 167.9 seconds. The trial average truck load time was 154.5 seconds, an improvement of 13.4 seconds (0.22 minutes). Based on the 12,497 loads completed during the trial, this produced an additional 46.5 hours of available loading time.

The average time per day the primary crusher was running without rock (black belt time) decreased from a pre-trial average of 1.52 hours per day to a trial average of 1.02 hours per day. This improvement of 0.5 hours per day produced an average tons per hour run of 64 tons more than the pre-trial production average—a value that, while deploying the same resources, can go straight to the bottom line.

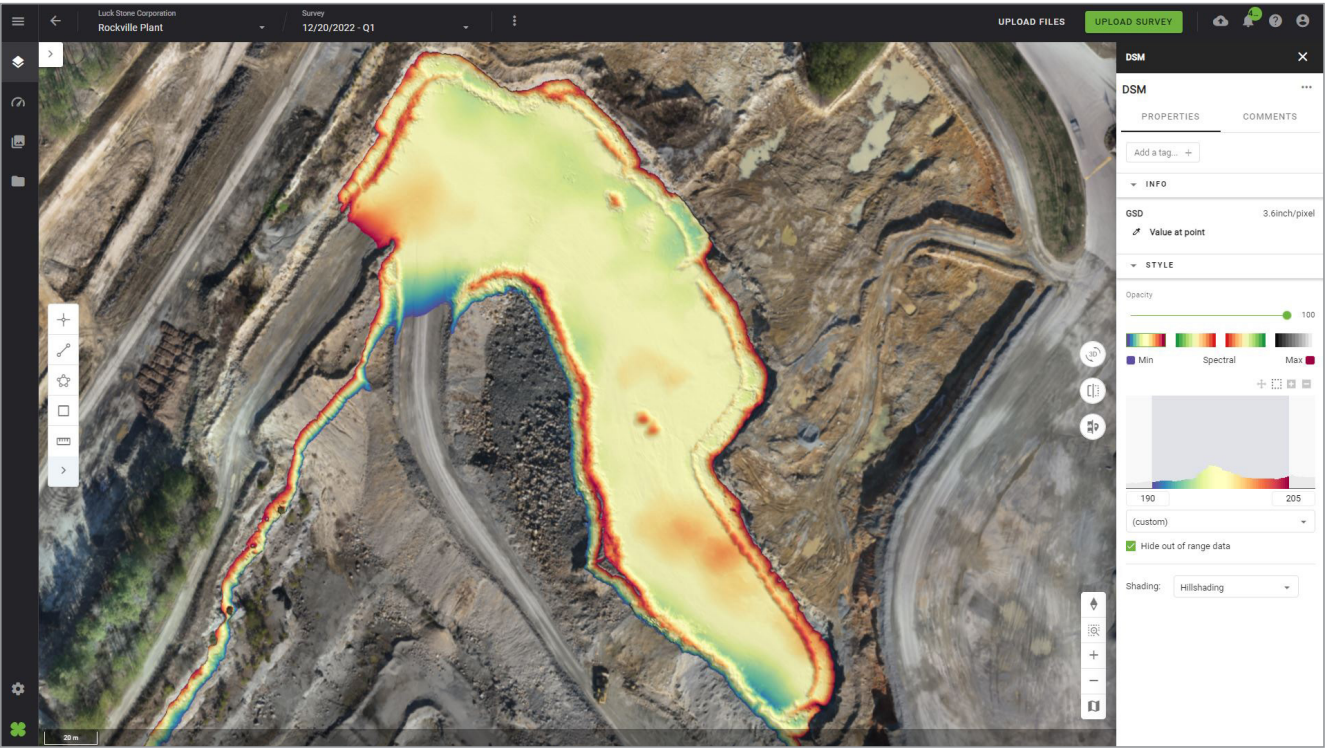
Improving the floor

Through the trial, the trends of the floor were improved. The variability was within the 5-ft tolerance of the sub-drilling. But the greatest improvement was seen on the top lift. The combination of the Epiroc SmartROC with HNS plus the 3D shot planning software accounted for surface topography and made it easy to drill to a consistent depth and log accurate locations for broken material, joints and seams.

Results at a glance

	Pre-Trial	Trial	Impact
Shot layout time	4 hrs	3 hrs	– 1 hr
Truck load time	167.9 sec	154.5 sec	– 13.4 sec
Black belt time	1.52 hrs/day	1.02 hrs/day	– 0.5 hrs/day

RESULTS (continued)



+ Topography of the first lift floor: Rockville, VA

The shading represents a maximum 15-foot elevation change. Note the overall consistency of the floor. Some of the higher elevations (red) along the southern area represent a berm. Some of the lower elevations (green) show the beginning of the ramp or where the loader operator has dug down into the muckpile that was cast over the lift below.

Optimizing capital equipment utilization

These results also impact the equipment itself. Based on hourly operating costs, each day costs Luck Stone approximately \$10,000 to own and operate its mobile equipment. A 46.5-hour time savings over 5 months equates to substantial savings. Or, if additional rock is needed, this means better returns on the operation of the equipment.

Exceeding expectations at Spotsylvania

The Rockville trial was successful by any measure, but Luck Stone was eager to realize results at more

challenging locations. "We leaped in and put the HNS on our drill at Spotsylvania, we have seen the magic," Bryan proclaims. "By combining everything that we've got at our fingertips, we're seeing things right now at Spotsylvania that exceed our expectations."

The SmartROC with HNS in combination with the 3D shot planning software enables high-accuracy placement of holes, hole angles and depths, even in a highly challenging environment like Spotsylvania. This delivers better blast results, more favorable fragmentation, improved loadability, reduced oversize material, more consistent digability and a more uniform bench.



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RESULTS (continued)

Increased accuracy inspires confidence

The team at Spotsylvania has been able to increase shot pattern footage by 11% and reduce sub-drilling by 25%. Total tons per foot of borehole has improved by 13%, significantly lowering the feet drilled per month. For Blasting Manager George Feild, it's about more than the productivity gains. It's about assurance: "We can confidently know that the design we put in that computer is now in that block of rock that we're getting ready to put 1000s of pounds of explosives into and we can execute it with a lot more confidence."

The team has also been able to increase their powder factor (tons per pound of explosives) by 15% and reduce explosives costs by 16%. With technology-enabled results like that, it's easy to mistake innovation for magic. "This technology has turned our drilling and blasting team into wizards," jokes Bryan.

Historically, to accomplish these types of production gains, operators would typically "shoot harder" by reducing the shot pattern or increasing the blast hole diameter to accept more explosives. This leads to a lower powder factor and higher blasting costs per ton. But with intelligent equipment and technology, Luck Stone is working smarter, not harder. And that delivers confidence to push the limits and experiment responsibly, whether that's with more spacing or less burden, knowing the system will correct itself if anything's inaccurate or unsafe.

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– George Feild, Blasting Manager, Luck Stone

13%

Tons per foot of borehole





RESULTS (continued)

Productivity runs high

When it comes time to load, the trickle-down effect of high-accuracy planning and drilling continues to pay off. During the trial, the Spotsylvania crew decreased load time by 21 seconds, totalling 2.5 hours per week.

At the crusher, Spotsylvania saw a +14% increase—that's almost 100 tons an hour—in throughput as measured in tons per hour run (TPH-R). Black belt time decreased by 5% and the team estimates a ~25% decrease in the amount of oversize rock that requires secondary breakage. Incredibly, a hydraulic rock-breaker that has worked full-time at the site for years has now been able to leave the site for brief periods since the material is now right-sized for the primary crusher.

Like at Rockville, floor conditions have improved. Level floors allow the Spotsylvania teams to get even fracturing and rock that is easier to dig through, which means more tons per hour heading for the crusher. Operator Griffin Lober observed more consistent digability, less oversize rock that's difficult to navigate and reduced cycle times, all leading to higher production and a more enjoyable working experience. There's also the equipment wear to consider: "When you're working on a rough floor, you can eat those tires up in a very short period of time," explains Bryan. "By getting a good level floor, it improves tire life."

The rollout continues at Luck Stone

While every innovation comes with a learning curve, the team at Luck Stone has embraced the technology and experienced the benefits. Following two successful trials, Luck Stone is all in on Epiroc SmartROC with HNS and what it means for the growth of the business and the development of its people.

The team is already making plans to take intelligent Epiroc equipment and technology into more challenging conditions and difficult blast zones. "We started down this path knowing Spotsylvania was a place where the technology could really shine. Now we'd like to take it across the whole company," George concludes. "Make it all shine."

Results at a glance	
Shot pattern footage	+11%
Sub-drilling	-25%
Borehole utilization	+13%
Powder factor	+15%
Explosives costs	-16%
Oversized rock	-25%
Truck load time	-21 sec
Crusher throughput	+14%
Black belt time	-5%



CONCLUSION

Luck Stone was eager to find ways to increase precision, reduce risk of injury and activate efficiencies at its quarries, especially those plagued by difficult geologies. Partnering with Epiroc to bring together smart equipment and technology delivered the outcomes they were seeking—and then some.

The dual trials of the Epiroc SmartROC D60 automated drill rig equipped with GPS-guided Hole Navigation System (HNS) demonstrate the snowball effect of high-accuracy planning and mining. When combined, the technology and equipment create competitive advantages at every stage of the mining process, making operations safer, smarter and more productive. Epiroc is proud to support Luck Stone on its mission to 'ignite human potential' and is looking forward to what's next.



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