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3 Big Wins for Wheel Loader Operators

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The hybrid-electric ultra-class WE1850-3 wheel loader completes performance testing at Komatsu's Arizona Proving Grounds in December. It can be used for production as well as cleanup and ramp building. (Photo: Komatsu)

The newest releases help operators hone their performance and hit their production goals, while working in comfort

By Jesse Morton, Technical Writer

Wheel loader operator jobs just got easier. That is the message from a couple major suppliers that spoke with

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E&MJ about their newest solutions. The latest releases are clearly at the apex of their respective family trees, and operators are perhaps the big winners.

They benefit from all the hard lessons learned by the OEMs about predecessor machines and about the core needs of modern mining operations. They can also benefit from advanced digital solutions that either simplify otherwise complex tasks or that make training easier, faster and more effective.

Indeed, the suppliers say the latest advances in the space suggest that, whether the market currently demands it or not, wheel loaders have the features and capabilities needed for them to be more broadly used in the mines of the future.

Hybrid Wheel Loader Completes Testing

Komatsu reported the new WE1850-3 wheel loader completed performance testing at the Komatsu Arizona Proving Grounds in December. “The WE1850-3 has completed a major milestone,” said Jesse Dubberly, product director, hybrid wheel loaders, Komatsu.

Their hybrid-electric ultra-class wheel loader, the second largest of its kind in the world, is designed to work with 218- to 327-mt (or 830E to 930E) haul trucks. It is “a versatile loading tool that can be used for mainline

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production and shovel backup as well as cleanup and ramp building,” Komatsu reported.

With a 268-mt operating weight, the wheel loader is roughly 20 m long and 6 m wide. It comes standard with a 33-m³ bucket, capable of a 59-mt payload. With a 1,500-kW engine, it offers breakout force of roughly 1,300 kN.

In standard configuration, it has a “dump clearance” of roughly 6.5 m. In “high lift” configuration, the clearance is 7.6 m.

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The wheel loader has ground clearance of 0.7 m, and a wheel base of 7.5 m.

The frames “are fabricated from high-strength, low-alloy steel with excellent weld characteristics and extreme low temperature properties,” Komatsu reported. “High-strength castings are used in key areas of fabricated structures to reduce stress and improve structural life.”

The solution traces its lineage back to the L1850, introduced two decades ago and considered “Generation 1,” Dubberly said. “Generation 2 was developed and commercially released 11 years ago, which introduced the drive system and digital controls,” he said. “We unveiled our Generation 3 drive system in 2017 with the WE1350-3, and now with our WE1850-3.”

Released in September 2021, the

WE1850-3 was engineered to help mines get more payload and higher productivity, “while minimizing fuel and maintenance costs,” Dubberly said. “It’s typically 35% to 45% more fuel efficient with commensurately less emissions than comparable mechanical or diesel-powered loading tools.”

WE-series wheel loaders use an SR Hybrid Drive system “that is fully regenerative,” described by Dubberly as a top feature. “During braking or retarding, electrical motors become generators and feed power back into the electrical system,” he said.

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“This allows for up to 45% less fuel consumption than comparably sized mechanical-drive wheel loaders,” Dubberly said, “as well as a considerable reduction in carbon emissions per ton of material moved.”

With fewer components, “the SR Hybrid Drive system eliminates inefficient mechanical systems, reducing wear and extending operating life for major components,” he said. The drive helps reduce “tire scrubbing when turning and loading, and it provides dynamic braking, which prevents mechanical brake wear and maintenance.”

The SR Hybrid Drive is designed with a low center of gravity to increase “the machine’s stability while loading and building ramps, which helps keep projects moving forward, safely,” Dubberly said.

The Kinetic Energy Storage System supports the SR Hybrid Drive, and can store “significant horsepower captured from braking and direct it to supplement peak power demand,” he said.

“The result is fast cycle times without a commensurate increase in fuel usage,” Dubberly said. That can increase productivity, while lowering cost per ton.

The wheel loader comes standard with the LINCS II microprocessor-based control system “with monitoring and diagnostics, including integrated data logging and storage,” Komatsu reported. “The LINCS II network control system on the WE1850-3 provides real-time feedback and vital statistics, such as bucket height and angle, individual bucket payload, and total tons moved.”

The load-weighing feature on the system “displays real-time load per pass, per truck, and total loads,” Komatsu said. It can store data for months, and can couple to radio dispatch systems “for real-time monitoring.”

That can help improve productivity by helping operators quickly adjust to conditions, Komatsu said.

The LINCS II system “uses a dash-mounted, full-color touchscreen display,” Komatsu reported. “Out-of-range conditions will cause an audible alarm along with a message screen

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that is color coded to indicate severity.”

One of the key benefits offered by the wheel loader is operator comfort. The cab is spacious and “designed to offer excellent visibility,” Komatsu said. “Digital joysticks offer easy and responsive control, while the highly adjustable, heated/cooled seat helps maximize operator comfort.”

The cab is pressurized, and features air filtration and conditioning. It has joystick steering, joystick hoist and bucket control, an adjustable operator seat, a trainer seat, and a 360° camera system.

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The wheel loader is designed to simplify operator functions, Dubberly said. “The operator can focus on the dig face and less on pedals with dynamic braking as the primary braking mechanism,” he said. “Dynamic braking does not require engaging a pedal; the brake pedal is used for service or spotting braking, not during normal loading operations.”

It also reduces some maintenance tasks, he said. “It is common for wheel motor brakes to go 25,000 and 30,000 hours of operation, whereas they’re typically consumable items in mechanical-drive loaders.”

Therefore, training is “a big part of Komatsu’s product introduction to help our customers overcome the change management for successful adoption of the electric-drive wheel

loader,” he said.

The wheel loader enters the market as Komatsu moves to rebrand “all of its hybrid wheel loader products,” part of an “ongoing process to integrate its legacy brands into One Komatsu,” the supplier reported. “This rebranding transitions legacy brands, such as the P&H L1150, P&H L1350, P&H L1850 and P&H L2350 loaders to Komatsu.”

Those units have a rich history and a bright future, the company said.

“Our large hybrid loaders have carried the legendary LeTourneau and P&H names for many years, but we are proud to move the product line to the Komatsu brand,” said Brian Fox, vice president, mining products. “Since the Komatsu acquisition of Joy Global in 2017, we’ve been making significant investments in our factories and new product development with the goal of bringing the Komatsu standard of quality and product support to this unique, highly efficient product line.”

It also enters the market as OEMs compete to offer solutions that help miners attain sustainable development goals.

“Driven by the demands of the future, Komatsu is committed to meeting the world’s need for sustainable solutions that reduce CO₂ emissions and waste, while increasing the use of renewable energy sources and water conservation,” Dubberly said. “To help support our customers’ sustainability

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targets while prioritizing safety and productivity, the WE1850-3 provides a robust, flexible loading tool, while reducing fuel and carbon emissions per ton of material moved.”

Operator Assistance Improves Performance

Caterpillar reported that an internal study showed that after using an automated coaching feature available for the new 992 wheel loader, operators loaded a whopping 14% more mt/hour and used 3% less fuel for efficiency gains of 19% in mt/L.

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“Operator Coaching is a computer system that detects specific coaching opportunities and provides corresponding tips for the operator through an in-cab display,” Caterpillar said. “Video tutorials show the issue and then illustrate the recommended way to perform the task. Improvement progress is tracked in a performance summary.”

The company said the tool provides needed information to operators of all experience levels. “It leads to more productive work, less wear and tear on the machine, and a reduction in the human source of variation in operations,” said John Marek, product application specialist.

The tool uses existing sensors on the machine to measure the effects of operator actions. It gives coaching tips on one of the existing in-cab screens.

The 13 tips, if used, can lead to performance improvements that increase “productivity and extend component life,” Marek said.

Users are coached on shortening travel, racking more before lifting, operating in the proper mode, optimal pedal usage, optimal bucket angles, timing of actions and optimizing dump height.



Payload Overload Prevention on the new 992 helps prevent an overloaded bucket from being raised to full truck height. It either slows or stops the action when a payload threshold is exceeded. (Photo: Caterpillar)

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Of the 13 tips, 10 speak to digging action, two to travel, and one to dumping. Ten of the 13 are designed to help improve productivity, Cat reported. Nine offer efficiency gains. Eight, if followed, could result in both productivity and efficiency gains. And seven of the 13 could help improve component life.

The tool can be used by trainers to reinforce lessons and messages, Marek said. “This is an exciting way to take training to the next level,” he added.

Previously, systems were available that could track results by operator, but that could not report on exactly how the operator achieved them, he

said. “Now we can measure aspects of the operator’s technique in order to provide feedback,” Marek said. That means that, with Operator Coaching, training can become laser focused, and it can be continuous.

With the tool, the trainer can, at intervals and after initial training is completed, “review the individual results report with each operator until they are fully proficient,” he said.

The tool is one of several that Caterpillar recently reported can be used to help increase productivity on the new 992. New optional Autodig system components automate “three of the most difficult parts of the dig cycle in both rehandled and tough digging applications, delivering additional increases in productivity and efficiency while also improving tire life through reduced wear,” Caterpillar said.

Tire Slip Prevention, Tire Set and Lift Stall Prevention can be individually enabled or disabled using one of the in-cab touchscreens.

“Tire Slip Prevention reduces rimpull when the tires are not set, and increases rimpull when downward force is applied to the tire,” Caterpillar said.

“Tire Set detects pile contact and automatically lifts against the pile to set the tires, increasing available traction,” Cat reported. “It also reduces rack velocity before tires are

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set.”

Both components help reduce tire slip, increase tire life and improve digging performance.

“Lift Stall Prevention enables automatic management of rimpull to prevent hydraulic stall while lifting up through the face,” Caterpillar said. “The result is less time spent in the pile.”

Another component, Payload Overload Prevention, helps prevent “an overloaded bucket from being raised to full truck height,” Cat said. “The system can be configured to either slow down or bring the raise function to a controlled stop when a configurable payload value is exceeded,” it said. “This prevents operators from being able to overload the machine.”

The system recommends the payload based on linkage type, machine application and bucket weight. “The maximum payload can be set within the password-protected service mode to any value,” Cat reported.

It allows the operator to use the bucket needed to achieve the target pass match without overloading it, Marek said. “This means you can use a larger bucket to consistently four-pass load the truck, versus using a smaller bucket that varies from four to five passes depending on density.”

The components help operators

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achieve the full efficiency potential of the new 992, he said.

The announcement comes after the supplier reported in March the 992 offers up to 32% greater productivity over the predecessor model. The wheel loader can cut maintenance costs by 10% and give a 48% increase in payload/L.

The new model “provides 9.5% more rimpull during digging and up to 20% more breakout force, increasing productivity,” Caterpillar said.

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It “features an on-demand throttle mode to optimize payload-per-fuel efficiency without slowing production,” the supplier said. “New standard automatic retarding controls disable the impeller clutch, enable the lockup clutch, and use the implement and fan pumps retarding to slow the machine on grade,” it said. “The available advanced automatic retarding controls with engine brake feature offers full control of the loader’s speed on grade to maintain a desired hold speed.”

The unit features improvements to setback and strike plane angles, a longer bucket floor, and a stronger and larger bottom section, which increases bucket fill factor by 10%. “The taller side plate with level top surface helps to improve visibility beyond the bucket edge to the material pile,” Caterpillar said.

Compared to that of the earlier model,

the cab gives more visibility, has intuitive controls and a 50% increase in legroom.

The controls “feature electrohydraulic speed-sensing steering with force feedback,” Caterpillar reported. “Two 254-mm color LED monitors display machine control and operating functions,” it said. “A separate 203-mm screen provides a dedicated viewing feed of the standard rearview camera, upgradable with optional 270° vision and object detection.”

Compared to the predecessor model, the new 992 has 10% lower maintenance costs. Automatic lubrication, improved hydraulic systems filtration and pump prognostics, and improved access to maintenance items help reduce downtime and facilitate maintenance planning.

With a powerful Cat C32B (Tier 4 Final/Stage V or Tier 2) engine, the wheel loader delivers production numbers while helping mine sites achieve some sustainable development goals, Caterpillar reported. Available in both standard- and high-lift configurations, “the 992 delivers the lowest cost-per-ton when paired with fleets of Cat 775, 777 and 785 trucks.”

Simulator Training Delivers Results

Immersive Technologies said a mining customer reported operators trained on simulators subsequently achieved major performance improvements.

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“Recently, a customer in Latin America trained 21 wheel loader operators and saw improvements of 64% reduction in steering errors, 68% reduction in tire slip errors, and a 54% reduction in work equipment protection errors,” said Glenn Heldberg, product development manager, Immersive Technologies. Those results “combine for an overall reduction in unscheduled maintenance on the machines, and an improvement in production rates.”

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Training in simulators that accurately duplicate the new wheel loaders made by the top OEMs can lead to significant performance improvements that ultimately translate to cost savings and improved production. (Image: Immersive Technologies)

Those results, as well as those from other customers, also show Immersive Technologies “has a Wheel Loader solution for any mine and any application,” he said.

Immersive Technologies offers a “comprehensive range” of simulators, with conversion kits for models from all OEMs. “We work closely with mining operations and equipment manufacturers to solve real mining industry problems in areas of safety,

productivity, reactive maintenance and the availability of skilled equipment operators,” Heldberg said. “This approach has allowed us to consistently deploy solutions that deliver real results.”

The simulated cabins, controls and machines are true to OEM design, with “highly accurate machine dynamics, a comprehensive set of situational events, compatibility with AHS, and high fidelity on-screen graphics and motion,” he said. The list of benefits offered includes “unsurpassed realism to OEM machines, superior operator training retention, and motivation by the trainee to drive training engagement.”

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The realism and quality of the situational events proves the conversion kits and platform is “world-best technology,” complemented by “a global support network offering 24/7 technical and professional services support,” he said.

“We appreciate how important it is for our customers to achieve the highest level of operational availability through responsive and high-quality products and services,” Heldberg said.

The platform and conversion kits have evolved over roughly three decades and in “close consultation with the mining industry to obtain the most realistic simulation product possible,” he said. “Ongoing development has seen new models regularly released to

the market upon customer demand.”

The customers that reap the most benefits are the ones that have identified performance improvement areas prior to adoption. “To maximize training outcomes, ideally customers will need to have a good understanding of their hurt points related to training needs,” Heldberg said.

“What are the skills gaps causing their business the most problems, and what areas would they like to see the most improvement from?” he said. “Real-world data from the operation assists us in compiling a thorough training curriculum customized to their operation, operators, machine fleet and environment.”

That data also enables Immersive Technologies track results and customize support to ensure the customer attains their goals, Heldberg said. “By providing the highest fidelity simulators available on the market today, such as our Wheel Loader range, Immersive Technologies continues to provide world-leading training solutions for our global customer base.”

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Challenging Bucket Floor Design Dogma

A study¹ from Missouri S&T’s mining department found that neither loader bucket floor design nor blade thickness significantly affects penetration or draft. These findings

are contrary to mainstream understanding, should be considered during purchasing or engineering decisions, and merit further research, the study said.

“Mine engineers and managers should note that neither flat nor wedged-floor buckets provide significantly different performance relative to longitudinal penetration or draft,” it said. “Thus the bucket floor profile should play a minor role in bucket selection.”

And thicker blades, which do not “significantly compromise the penetration and performance of the bucket,” should be chosen “for strength and longevity.”

The study also found that semi-spade-nose blades outperform spade-nose and straight blades at penetration. Otherwise, bucket geometry had “no statistically significant association” with draft.

Speed, motor power output, and the particle size of the muck all separately correlate to penetration performance and draft, the study said. “These parameters also combine to influence penetration and draft,” the study said.

The study used a 1:16 representative scale model of an 18-mt-capacity Komatsu loader. The model was, in part, the subject of a prior study that basically proved its scalability and the applicability of findings of future

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studies using it.

The model used a ROBOTZONE 12-Volts DC planetary gear brush motor and a geared conveyor simulated tire traction. The maximum power output was set at 2 Amps.

“We used an Arduino integrated development environment to write code to control the model and recorded the draft, penetration, speed, acceleration, motor power output, lift, current and voltage derived by the motor every 0.02 s,” the study said. “We tested five buckets of different geometries using five different muckpile particle size distributions at various speeds and limiting the maximum motor power output to assess their effect on longitudinal displacement or penetration and draft.”

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The tested buckets were all of the same width and height.

One had a wedged-floor profile. The rest had a flat-floor profile.

One had a 2-mm-thick cutting edge. The rest had a 5-mm-thick one.

One had a spade nose cutting edge. One had a semi-spade cutting edge. The rest had a straight cutting edge.

The muckpiles were rebuilt every five runs. “In this work, different piles represented processed material, waste or reject material, development blast,

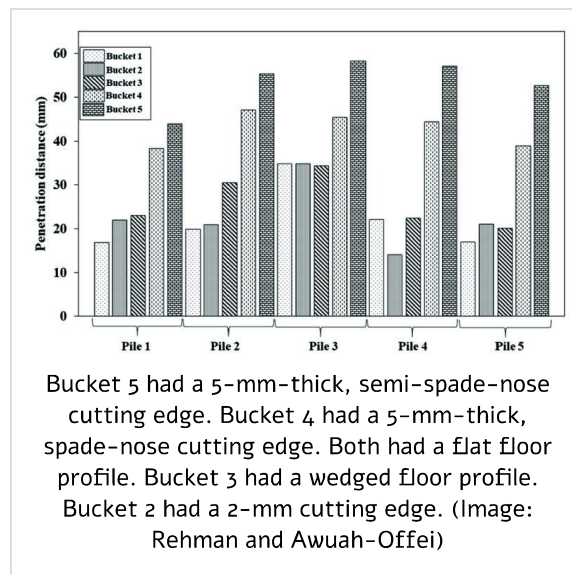
and an actual replication of a pile,” the study said. “We chose to construct realistic particle sizes at reduced scale without scaling down a specific size distribution.”

Regression analysis was used to evaluate the effect of the bucket parameters and other factors. “We treated longitudinal displacement and draft, the maximum draft during each run, as dependent variables and speed, motor power output, and bucket geometry as independent variables,” the study said.

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“We tested the association between the longitudinal displacement of and draft encountered by the scaled model bucket for every possible combination,” it said. Speed and motor power were treated as continuous variables. Bucket “geometry and pile” were nominal variables.



The study found “a strong correlation between speed, maximum motor power output, and muckpile particle

sizes, on the one hand, and penetration and draft on the other.”

Penetration increases with increased speed. “The combined effect of speed and particle sizes ... affect penetration, though this work does not show a similar effect on the draft,” the study said. The combined effect “can be used to optimize the speed based on muckpile particle sizes.”

Separately, penetration increases with increased motor power output. A loader “with higher motor power output will result in higher penetration in the material of finer particle sizes,” it said.

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Increasing speed and increasing motor power output at the same time, however, “actually yields lower penetration,” the study said.

“Attempting to move the bucket at a higher speed can lead to the motor stalling before the bucket penetrates as much as it could with a lower speed,” it said. “Managers should train operators or assist them with technology to optimize speed and how hard they drive loaders to achieve the best penetration with the least energy consumption.”

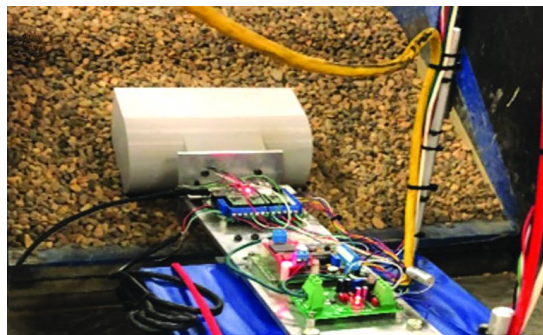
In general, increasing particle size reduced penetration, and was “positively correlated to draft,” the study said. “Finer particles will result in a lower draft, whereas coarser particles will have a higher draft.” Still, the pile with the finest particles

resulted in a higher draft than those of larger particle sizes “due to better packing.”

The results also showed different penetration and draft depending on bucket geometries, “even at the same speed and in the same pile,” it said.

Specifically, the different blade shapes attained different results. “The bucket with a semi-spade cutting blade has the highest mean penetration, followed by that with spade-type cutting blade and straight cutting blade, respectively,” the study said.

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The 1:16 scale model previously used in bucket geometry studies from Missouri University of Science and Technology. (Image: Rehman and Awuah-Offei)

“The mean penetration for the bucket with semi-spade cutting blade is 118.3 mm, which is 10 mm higher than spade nose, and almost 27 mm higher than the longitudinal penetration observed for the buckets with straight cutting edge,” it said. The findings showed no “significant association between draft” and blade profile.

“No other comparison yielded a significant difference between the

observed longitudinal penetration and draft for different buckets,” the study said.

Bucket floor profile had “no significant effect,” a finding that runs “contrary to the industry practices,” it said. The study’s author told E&MJ that the benefits of different bucket floor profiles have been trumpeted by marketers without the scientific data to prove it. “Different manufacturers make them based on their in-house working or due diligence and probably their marketing teams sell them as their unique features,” said Atta Ur Rehman, post-doctoral fellow, Bureau of Economic Geology, University of Texas at Austin. “This is why this debate needed scientific answers without subjective bias.”

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Also, blade thickness proved to be a non-factor, the study said. “Engineers who design rubber tire loaders buckets can use thicker blades,” it said. Otherwise, blade thickness decisions can be driven by maintenance priorities, Rehman said.

Future research and development by suppliers on improving loaders for better penetration can be focused in the areas of engine, driveline, tire and blade shape design, he said. “This is where it is leading to as traction is coming from the engine’s ability to provide torque and the tire’s ability to hold on to the ground.”

Future research by Rehman could look at, among other things, determining

how to optimize fragmentation and speed to improve penetration.

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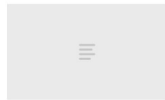
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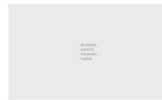
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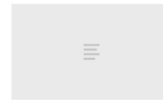
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