Lighter weight AGVs

For decades, automated guided vehicles (AGVs) have played a critical role transporting heavy loads throughout steel manufacturing facilities – reliably, safely and cost-efficiently. Now, the latest generation of AGVs for carrying heavy loads – with a significant reduction in vehicle weight – are minimising maintenance and power requirements by up to 60%, delivering a new level of streamlined performance and cost efficiency for primary metals manufacturers. By **Jim McMahon***

GIVEN the highly competitive nature of the primary metals industries, particularly steel manufacturing, process uptime and consistency of throughput are necessary to operational efficiency and profitability. The use of automated guided vehicles has played a pivotal role in facilitating process constancy in these manufacturing operations. The primary metals industry has long relied on automated guided vehicles (AGVs) to transport heavy-load aluminium and steel coils, ingots, plates, wire, work rolls, turnstiles, and press brake dies and punches, into and out of storage, and throughout both hot and cold production processes. Interfacing with multiple auto-transfer devices, AGVs provide reliable heavy-load raw material and product handling, with less potential for product damage, compared to manual and overhead methods of transport.

Utilising a combination of logic software, and wired and, most often, wireless navigation, automated guided vehicles can perform tasks that are not possible with other transport systems – such as the uniform movement and positioning of huge loads of over 200,000 pounds, to within a fraction of an inch of their designated targets, without rush and noise, and with a high degree of safety for workers and the operational environment.

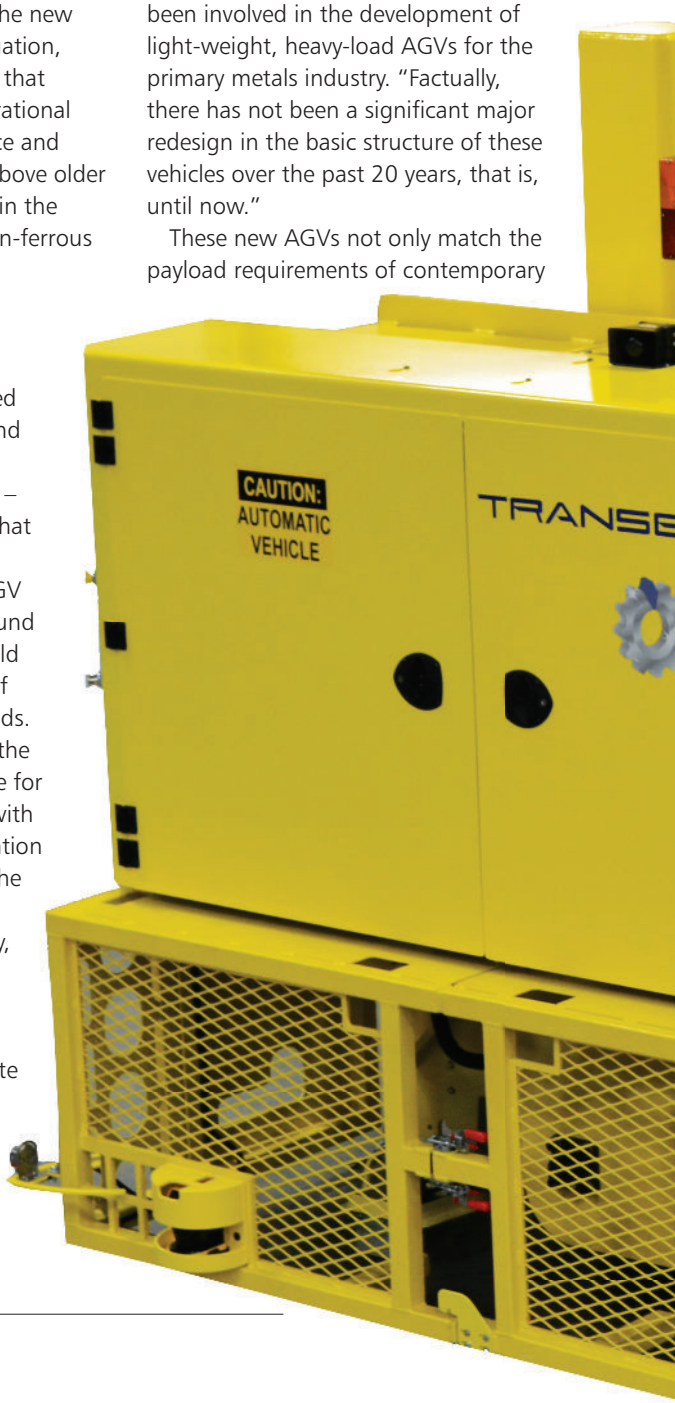
Despite obvious benefits, the heavy loads that AGVs transport impart huge forces upon these vehicles, resulting in significant maintenance and power requirements to keep AGV fleets functioning. Now, a new generation of lighter-weight, heavy-load AGVs has become available, which are considerably lighter than conventional heavy-load AGVs. The new models incorporate design, navigation, sensor and power improvements that significantly streamline their operational performance, cost of maintenance and return on investment, over and above older automated guided vehicles used in the manufacturing of ferrous and non-ferrous metals.

New heavy-load AGV design

AGVs built to transport heavy loads of primary metals or finished products – such as 120,000 pound steel ingots, or heavy loads with weights of over 200,000 pounds – have typically been designed so that the weight of the AGV is 40% to 60% of the expected load. An AGV engineered to carry a 60,000-pound aluminum coil, for example, would have a designed vehicle weight of between 25,000 to 35,000 pounds. This 40% to 60% ratio has been the conventional AGV design practice for decades, but has now changed with the introduction of a new generation of lighter, more efficient AGVs. The new models are engineered to reduce wear and tear, and energy, and weigh considerably less than conventional models.

"This weight reduction has been achieved through a complete redesign of how heavyweight AGVs have been engineered since the early 1990s," said Chuck Russell, vice president at Transbotics Corporation (www.transbotics.com), which has been involved in the development of light-weight, heavy-load AGVs for the primary metals industry. "Factually, there has not been a significant major redesign in the basic structure of these vehicles over the past 20 years, that is, until now."

These new AGVs not only match the payload requirements of contemporary



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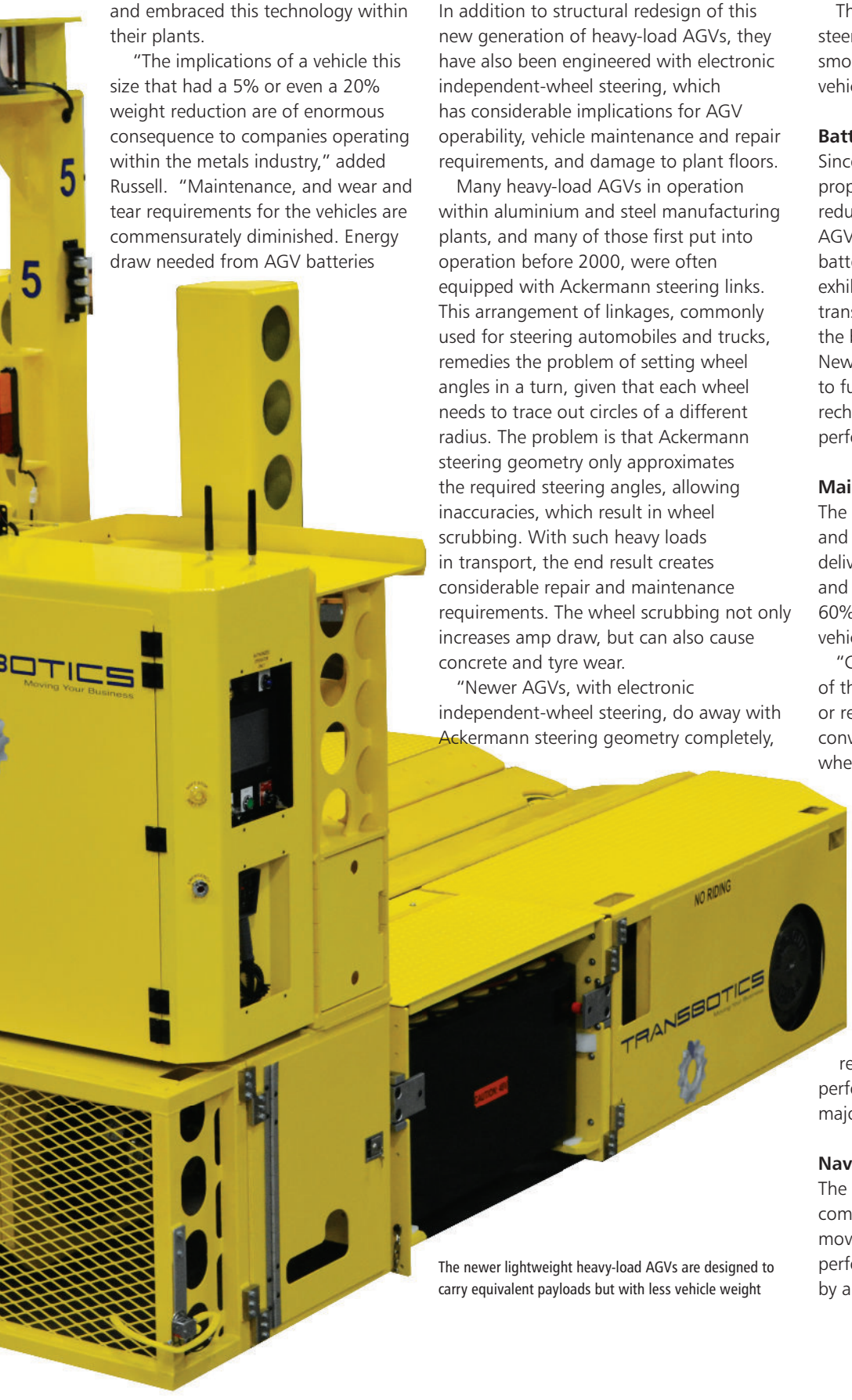
heavier models, but match or exceed those vehicles' structural stress thresholds. Such claims have been validated by a number of major manufacturers within the primary metals market, which have already vetted and embraced this technology within their plants.

"The implications of a vehicle this size that had a 5% or even a 20% weight reduction are of enormous consequence to companies operating within the metals industry," added Russell. "Maintenance, and wear and tear requirements for the vehicles are commensurately diminished. Energy draw needed from AGV batteries is reduced. And repairs required for plant floors, caused by the AGVs and their load weights, are also significantly lessened."



The newer lightweight heavy-load AGVs are designed to carry equivalent payloads but with less vehicle weight

Electronic independent-wheel steering

In addition to structural redesign of this new generation of heavy-load AGVs, they have also been engineered with electronic independent-wheel steering, which has considerable implications for AGV operability, vehicle maintenance and repair requirements, and damage to plant floors.

Many heavy-load AGVs in operation within aluminium and steel manufacturing plants, and many of those first put into operation before 2000, were often equipped with Ackermann steering links. This arrangement of linkages, commonly used for steering automobiles and trucks, remedies the problem of setting wheel angles in a turn, given that each wheel needs to trace out circles of a different radius. The problem is that Ackermann steering geometry only approximates the required steering angles, allowing inaccuracies, which result in wheel scrubbing. With such heavy loads in transport, the end result creates considerable repair and maintenance requirements. The wheel scrubbing not only increases amp draw, but can also cause concrete and tyre wear.

"Newer AGVs, with electronic independent-wheel steering, do away with Ackermann steering geometry completely, and the issues it creates," continued Russell. "Additionally, the vehicle can now drive sideways or in any direction, enabling shorter trips, thereby reducing the fleet size."

The electronic four-wheel independent steering provides tight manoeuvring, smoother cornering, and all-directional vehicle travel.

Battery performance

Since battery run time is directly proportional to vehicle and payload weight, reduction in vehicle weight on the new AGVs directly impacts the run time of its batteries. Therefore, any weight reduction exhibited by these new-generation AGVs translates into longer run time from the batteries before requiring recharge. New battery technology also contributes to further weight reduction, faster recharge times and overall better system performance.

Maintenance

The new AGVs, with their weight reduction and electronic independent-wheel steering, deliver a sizeable reduction in maintenance and repairs. Realistically, as much as a 60% reduction in annual maintenance, per vehicle, can be achieved.

"Contributing to this is the accessibility of the AGV to perform maintenance or repairs," explained Russell. "With conventional heavy-load AGVs, access to wheels, gears and other moving parts is, for the most part unexposed, requiring the vehicle to be hoisted or moved into a pit to be serviced. This is an inherent difficulty prevalent in many earlier heavy-load AGVs."

Because of the unique design of the latest AGVs, however, wheels, gears and other moving parts are easily accessible without the need for hoisting or service pits. This means that much of the maintenance requirements, and even repair, can be performed on the plant floor, without major interruption to the use of the vehicle.

Navigation

The latest new-generation AGV systems comprise one or more vehicles that move around predetermined routes to perform transport functions as directed by a stationary control system. They are

equipped with navigation systems, based on laser and/or inertial guidance.

Laser navigation systems are based on target triangulation to keep the vehicles on course. The vehicle is equipped with a rotating laser beacon, which scans 360 degrees around the vehicle for laser targets mounted on columns, walls and stationary machinery. The reflections from these targets are measured relative to angles from the vehicle, and triangulated to allow the vehicle to determine its position. This position is compared to a CAD-type map stored in the vehicle's memory. The system uses positive-positioning feedback in real time, computing algorithms hundreds of times per second. The targets are typically located 20 to 50 feet apart, on both sides of the path to provide sufficient navigation resolution. The steering is adjusted accordingly to keep the AGV on track. It can then navigate to a desired target using the constantly updating position. Laser navigation can obtain tracking accuracy of about +/- .75 inches on vehicles of this size.

Inertial navigation systems use a gyroscope onboard the AGV to detect changes in vehicle direction and attitude. Each vehicle has a CAD-type map of the system layout in its memory. The vehicle steers by comparing information from the gyroscope and odometry sensors (which estimate change in position) to the map, and making necessary course corrections each time it passes over a magnet or transponder. Typically, the tracking of inertial navigation systems is +/- one inch of the true path. Magnets or transponders are embedded in the floor every 30 to 60 feet to maintain the tracking accuracy.

"Both navigation methods can be seamlessly combined in a concept called multi-navigation, which switches back and forth from laser to inertial guidance without stopping the vehicle," added Russell. "This allows the AGVs to move throughout a plant and outside, where one system alone may not have access to the physical surroundings or weather conditions necessary to support that system."

The AGVs travel nominally at 2 mph, and are equipped with outboard laser bumper sensors for object detection. Covering the vehicle 360 degrees including upwards, the sensors are designed to cause the vehicles to adjust their speed, or stop if necessary, if an obstacle is detected in their path. Once the path is clear, the AGVs will automatically continue their mission.

60,000 pound aluminium coil being loaded onto a lightweight AGV

Some bumper sensors have a range starting at about 1,500 lux (the SI unit of illuminance and luminous emittance). These new AGVs use the latest in safety laser technology, incorporating 15,000 lux systems, with a 10 times higher tolerance to light.

PC-based real-time controls

The smooth functioning of these new AGVs is dependent on their control system, which has the task of co-ordinating the orders received from the plants' process system or ERP, then directing the work for the automated guided vehicles. It is a Windows and SQL database architecture that is able to uniquely operate within a single platform. Communication is provided by two-way radio transmissions between the vehicles and the computer.

The controls provide real-time management of the system's operation, including management information, load prioritisation, load status, productivity statistics and reports, and workload analysis. It allows associated functions to be automated – such as with receiving, raw materials storage, hot line processes, roll mill processes, cold mill processes, finished product storage and shipping.

The positional status of each AGV is continuously being updated through the control system, at least once per second, regarding such factors as whether it is loaded or unloaded, emergency stopped or soft stopped, operating in manual mode and battery level. A simulation module simulates the AGVs in the system. An HMI graphical interface gives the operator a graphical overview of the AGV locations in the system and monitors each in real-time.

"Operational flexibility is clearly inherent within this new-generation, heavy-load AGV system," said Russell. "Not just in its capability to direct and manage the fleet of AGVs, but also in its expandability. Any number of automated guided vehicles can be added to the network, at any time plant production needs require."

As automated materials handling remains a critical component of primary metals manufacturing, heavy-load AGVs will continue to play an important role in influencing plant efficiency.

Heavy-load AGVs enable significant efficiencies to primary metals manufacturing. They improve production flow by bringing material to the operators, thereby cutting cycle times, and eliminating wait, walk and search time. They reduce work-in-progress inventory. They cut labour costs by eliminating simple jobs related to material movement, and permit reassignment of those workers to areas where they can add more value.

They virtually eliminate product damage with gentle handling of loads. And they provide flexibility of process flow within the plant, as needs change.

The latest generation of heavy-load AGVs is delivering a new level of streamlined performance and cost efficiency for primary metals manufacturers. ■

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