Value-Driven

New Opportunities and Technologies Allow AC Motors to Enhance Motion Control Applications

Matthew Jaster, Senior Editor

The induction motor was invented and perfected 100 years ago, according to Matt Hanson, general manager, industrial markets at Bison Gear & Engineering. Significant improvements have been made in insulation materials, lamination steels and bearing systems through the years, but in general, the machines operate as they did a century ago.

However, we've seen plenty of significant changes in the motor market in general. We've seen changes in regulations, weight, energy efficiency and the way manufacturers can collect component data. We've seen new opportunities for motors in areas like AGVs, robotics and vehicle electrification. *PTE* recently spoke with representatives from Bison, Bodine, Parker and Lafert North America to examine the challenges, trends and outlook for motors in motion control applications today.

The New Normal in 2020

Viruses, global competition and raw material shortages can disrupt any motor manufacturer, whether based here in the United States or abroad. The key to overcoming the many challenges facing manufacturers in 2020 is the ability to stay one-step ahead.

"As recent events have shown, the global supply chain can be negatively affected by import or export tariffs, raw material shortages, and even health related crises," said Terry Auchstetter, business development manager at Bodine Electric. "Any of these disruptors can affect manufacturing cost and delivery times to customers. Our purchasing and materials planning teams regularly review these potential disruptors and plan for these contingencies."

Jeff Nazzaro, servo motor product manager at Parker Hannifin, agreed. "The challenges today include global competition for motors, drives and controllers. There are so many manufacturers in the market today. It's also finding the right opportunities in product and service that will add value and differentiate you from your competitors. Adapting quickly (providing custom solutions) for unique opportunities that cannot be satisfied with standard catalog products," he added.

"Customer satisfaction starts with understanding the customers application and proper sizing of components. Our sales team is very good at listening to our customers and trying to help optimize product selection," Hanson said.

Another challenge that U.S.-based manufacturers continue to face is to find and retain skilled employees that are needed for today's more advanced manufacturing environment. "We continue to actively work with local high schools and colleges on skills training, recruitment and career development programs," Auchstetter said.

Advancements made with VFDs and their ability to operate permanent magnet AC motors (PMAC) have created new opportunities for Bison's new motor platform called VFsync.

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Opportunities in Motion Control Applications

Industrial intelligence firms predict strong growth for the motion control market within the Americas region for the next five years. Supporting this consensus positive outlook is the extrapolation of recent and significant year-over-year increases in new projects and sales volume for motion control applications, said Matthew Temple, outside sales, Lafert North America.

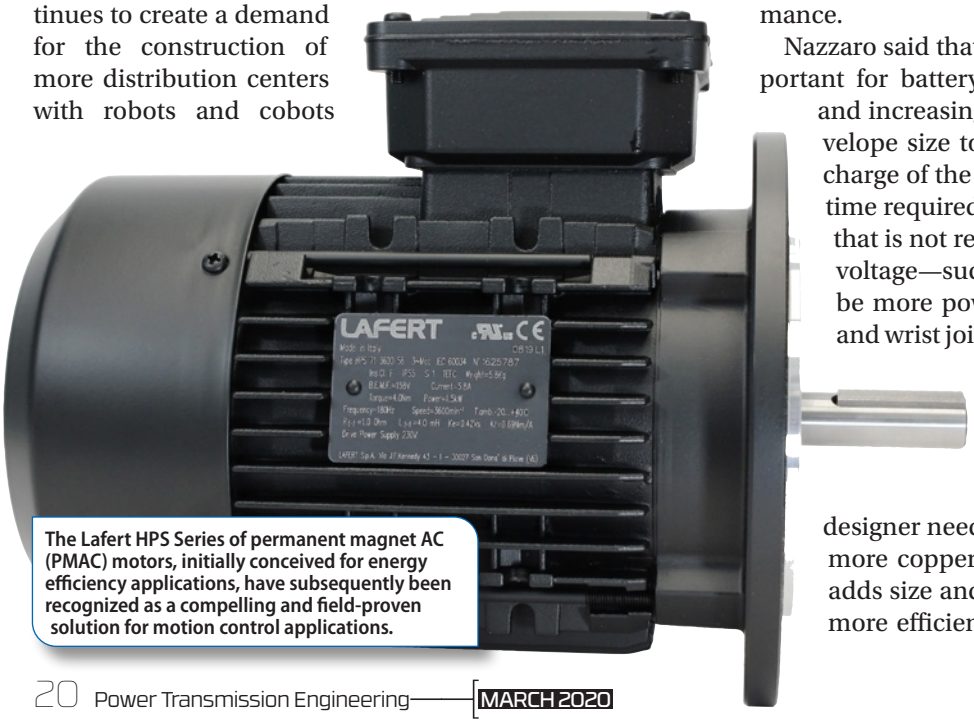
The rising tide of a growing market is undeniable as the driver but novel AC motor products from Lafert are well-positioned to serve outperforming motion sectors, namely mobile automation and industrial robotics.

"Increasing market awareness and understanding of the value proposition for permanent magnet AC motors will remain key to continued Lafert growth within the motion control market segment," Temple said.

At Parker, Nazzaro is seeing expansion in semiconductor, electronics, robotics and vehicle electrification. "For robotics and vehicle electrification we have seen a significant increase in the purchase of frameless motors and custom housed motors which incorporate frameless motors into their design," he said. "We see the motion control market expanding in general due to continued adoption of automation in factories, particularly with advances in artificial intelligence in the control systems and autonomous operation of the machines."

Auchstetter at Bodine Electric believes the small AC induction gearmotor is playing more of a "supporting role" to the highly advanced servo-driven machinery. Because AC gearmotors and motors are constrained to a more-less stationary installation by nature of the AC power supply, they are used more often in point-to-point transportation of material, such as a conveyor system between production cells, or in a packaging line. This is in stark contrast to the free movement of battery powered AGVs or service robots.

"Online commerce continues to create a demand for the construction of more distribution centers with robots and cobots engaged in the transportation of goods from the shelf to the packing station to the shipping dock. The AC-powered gearmotors and motors are found in the stationary cells from which the battery-powered robots or AGVs travel to collect items or pick orders," Auchstetter said. "We're seeing new opportunities in packaging, conveyors, greenhouse equipment and bottling equipment today."



The Lafert HPS Series of permanent magnet AC (PMAC) motors, initially conceived for energy efficiency applications, have subsequently been recognized as a compelling and field-proven solution for motion control applications.

Hanson said that advancements made with variable frequency drives and their ability to operate permanent magnet AC motors (PMAC) have created new opportunities for Bison's new motor platform called VF*sync*. These are variable speed AC motors that run synchronously with the input AC frequency. PMAC motors are a great choice for applications that require velocity control, as they are less expensive than their servo counterparts. The motors rotor contains magnets that precisely follow the rotating magnetic field, without slip, as in general induction motors. All the major motion control platforms offer electronic drives that will run PMAC motors, so capturing the cost savings by switching motor types can happen with minimum engineering investment.

All Lafert HPS Series permanent magnet AC motors reach or exceed the IE4 "Super Premium" efficiency level.

Examining Weight & Motor Efficiency

Our interviewees all believed that weight and motor efficiency remained critical in order to meet energy regulations and improve overall system performance.

Nazzaro said that efficiency and weight are especially important for battery operated vehicles. Minimizing weight and increasing efficiency helps to keep the overall envelope size to a minimum and will allow the battery charge of the vehicle to last longer reducing the down time required to recharge. "Even a robotic application that is not relying on battery but operating under low voltage—such as 48 VDC—benefits as your motor will be more power dense and moment loads for elbow and wrist joints will be kept to a minimum," he added.

Bison's customers require motors that have improved efficiency in order to meet DOE regulations on a variety of equipment types. In order to improve efficiency on induction motors a motor designer needs to add additional lamination steel and more copper magnet wire, which reduces losses but adds size and weight. PMAC motors are considerably more efficient as the rotor uses permanent magnets.

PMAC motors are considerably smaller in diameter and lighter in weight than their induction motor counterparts.

"Today's small three phase induction motors range in efficiency from 60% to 70% efficient. Bison's new PMAC motors are 80 to 90% efficient. As a result, the size of the motors is reduced by 50% and up to 60% less weight than conventional AC induction motors," said Hanson.

Auchstetter said that motor efficiency and weight are less critical in stationary applications where AC-powered fractional HP gearmotors are used, versus in mobile applications where battery-powered DC gearmotors are used.

"However, both are critical performance characteristics for many gearmotor applications. Efficiency is related to motor temperature, and many stationary machines in a factory setting have exposed motors that can be a burn hazard to humans. Weight is related to size, and a compact size is generally desirable to keep the gearmotors from sticking out into aisles where humans might bump into them when walking by the machine," he added.

Temple said that energy costs have not been a traditional performance metric for motion control applications in North America, but the market increasingly recognizes that motor efficiency has real and measurable impacts on the performance and reliability of motors and systems.

"Reduction or elimination of iron or copper motor losses, which convert input electrical energy to waste heat, translate to increased motor energy efficiency and reduced operating temperature. The well-documented inverse relationship between operating temperature and expected motor insulation system lifetime is often raised when discussing the value of increased motor efficiency, but the benefits of cooler operation for motion control applications are multi-dimensional. Increased efficiency motors can enable motion systems to operate continuously at higher ambient temperatures and power output or increase the permissible duty cycle and root mean square (RMS) torque during intermittent operation," Temple said.

Collecting (and Utilizing) Component Data

Auchstetter said that as controls with higher processing power, artificial intelligence, and machines that operate autonomously become more prevalent, the reliability of the gearmotors in industrial applications becomes far more important than the cost. Reliability can be accomplished in the design through higher quality materials and components, or through simpler or modular designs.

"Sensors are added to the motors to predict when failure is imminent. Depending on the gearmotor size, the appropriate

Parker is seeing expansion in semiconductor, electronics, robotics and vehicle electrification applications.

type of sensor might be for vibration or for temperature monitoring. Or both. The data from encoders, besides being used for position and speed control of the gearmotor, can be used for logging the number of hours of operation of the motor and comparing it to the MTBF of the gearmotor," he added.

New PMAC motors, when ordered with an optional encoder, provide feedback on the motor that can be used by controls for rotor shaft position. PMAC VFD controls provide online information regarding current draw, input frequency and a variety of other parameters. Depending on the application, IIoT features are available with our standard products to meet the engineer's requirements, said Hanson.

"On the motor side it is primarily with the addition of sensors and with the gathering of information, let's say into an encoder, for condition monitoring. This can help in supporting the preventative maintenance of the motor as well as the components that the motor is driving (ie.. linear actuators, gearheads, etc...)" Nazzaro added.

Temple said that the core concept of smart manufacturing is to implement systems which capture, collect, analyze and act upon manufacturing process information to improve and optimize the process. The traditional standalone AC motor, absent the embedded logic to for condition monitoring and communication, does not directly generate input data for smart manufacturing systems.

"This should not be understood to mean that AC motors cannot make meaningful contributions to systematic efforts to continuously improve manufacturing operations, most particularly in reducing energy usage. Strategic Energy Management (SEM) programs, for example, which implement systems to help manufacturers understand, monitor and continuously improve their energy consumption, are very much aligned to and compatible with smart manufacturing methodology and goals," Temple said.

Considering that electric motors account for approximately half of US manufacturing energy consumption, it is not surprising that leading manufacturers have utilized SEM programs to quantify and consider the energy costs for their

motor-driven equipment.

"The outsized role of motors in manufacturing energy consumption means that AC motor energy savings, such as those achieved through replacement of induction motors with Lafert HPS Series PMAC motors, can translate to significant facility energy savings. Motion control systems for continuous or high duty cycle applications, such as conveyors and sortation, are consequently bound to be identified as opportunities for efficiency improvements through the SEM process," Temple added.

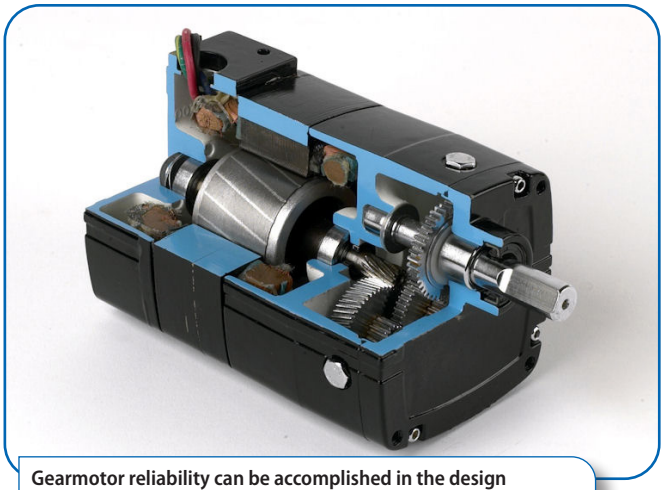
A Change in Technology

While the inside (the guts) of induction and synchronous motors have remained relatively the same, new market opportunities demand new technologies and functions.

For example, in traction applications and high-power work function, active cooling is necessary to deliver the power density.

"When you add minimizing size and weight, and cost, the result is motors that are a combination permanent magnet torque and reluctance torque. This motor type is often referred to as salient-motors or PM assisted synchronous reluctance motors. The control of these motor is more complex as compared to PM only designs. Without the proper controls, full performance cannot be extracted from the motor. New tools and technique will be required to improve the ease of use of salient motors designs. At present, day to week on the dyno is required to map the control parameters at each operating point in order to squeeze the last bit of motor performance," Nazzaro said.

Finite Element Analysis tools have changed how motors are *designed* over the last 20 years. "These software programs use FEA tools to analyze the magnetic system within the motor being worked on, and then apply decades of motor engineering equations and relationships to predict the performance of the motor," Hanson said. "Today's software can predict size, performance and thermal characteristics of a design in minutes, allowing engineers to tune motor performance as the customer requires. Design accuracy continues to improve with additional software developments." **PTE**



Gearmotor reliability can be accomplished in the design through higher quality materials and components, or through simpler or modular designs. (Courtesy of Bodine)

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AC gearmotors and motors are often found in conveyor systems, between production cells or in packaging lines. (Courtesy of Bodine)