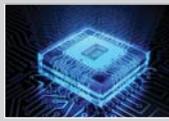




*Recession Opens  
Up Opportunities  
For Fluid Power*  
p. 14



*Elevat, Microsoft  
Push Off-Highway  
IoT Solutions*  
p. 18



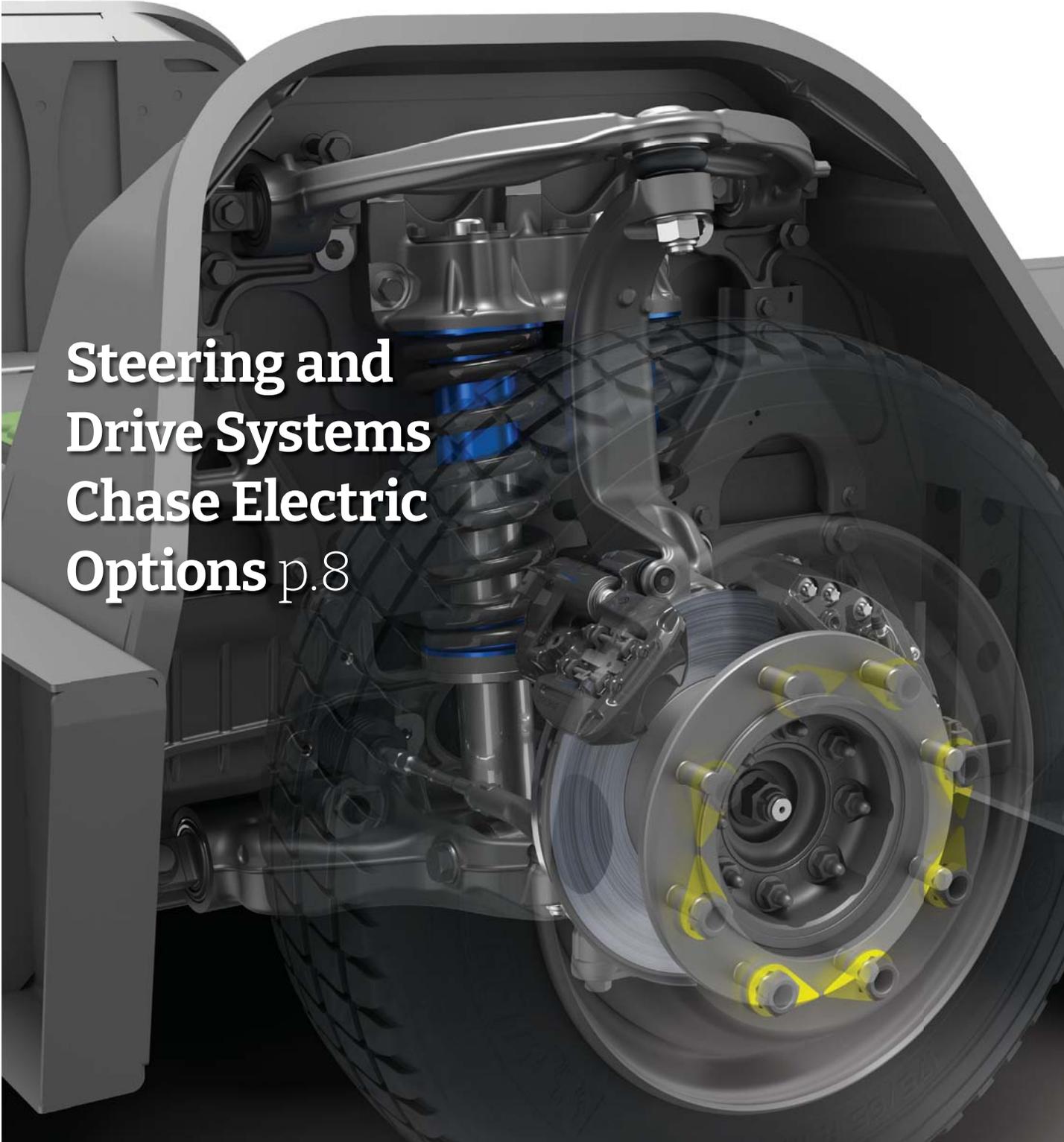
*Purpose-Built  
Design Electrifies  
Construction*  
p. 26

January/February 2024

[powermotiontech.com](http://powermotiontech.com)

# POWER & MOTION<sup>®</sup>

*How Intelligent Hydraulics, Pneumatics and Electronics Propel the Modern World*



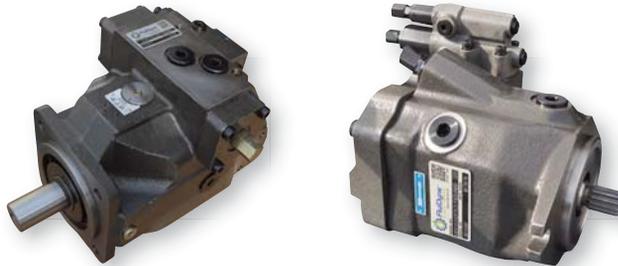
**Steering and  
Drive Systems  
Chase Electric  
Options** p.8



**Fluidyne**  
FLUID POWER

# IN STOCK, QUICK DELIVERY

**Fluidyne A4V & A10V Piston Pumps**



**Fluidyne**

interchanges with:

Eaton • Sauer-Danfoss • White • Parker/Ross/TRW • Charlynn



**Powered by  
Customer Service**

**Call, Email or LiveChat.**

## **GET INSTANT ANSWERS.**

**Providing solutions that work.**



**Fluidyne**  
FLUID POWER

586-296-7200

sales@fluidynefp.com

[www.fluidynefp.com](http://www.fluidynefp.com)



THE FPDA  
MOTION & CONTROL NETWORK  
MEMBER





# MINI VANE PUMP

- Compact medium pressure installations
- Quiet operations
- Cast Iron construction

## Suited for:

- Lubrication Units
- Compact Power Units
- Filtration Units



Model : TXA

Max pressure : 175 bar

Max Displacement : 4.0 to 16.0 cm<sup>3</sup>/rev

Max Speed : 1800 rpm

Min Speed : 750 rpm

Please contact us:

## Veljan Hydrair Inc.

Sales & Warehouse: 4034, Chamblee Road  
Oakwood, GA 30566 (USA). Phone: 877.793.6405  
Website : [www.veljan.in](http://www.veljan.in) | E-mail : [sales@veljanusa.com](mailto:sales@veljanusa.com)



We help you see your ideas work

## FEATURES

### COVER STORY

#### 8 Why Steering and Drive Systems are Transitioning to By-Wire Technology

The potential to improve design and vehicle performance is leading to a shift from hydraulic to electric options for steering and drive systems.

### MARKET TRENDS

#### 14 2024 Recession Presents Fluid Power Industry Opportunities for Investment

With a mild recession predicted for 2024, fluid power manufacturers should use this time to invest in their business and prepare for the rebound coming in the second half of the decade.



## DEPARTMENTS

- 6 Editor's Note
- 7 Industry News
- 30 New Products
- 31 Advertisers Index
- 32 One More Thing

COVER IMAGE: REE AUTOMOTIVE



### SOFTWARE

#### 18 Elevat Partners with Microsoft to Enhance IoT Deployment in Off-Highway Machines

Integration of the companies' technologies will enable deployment of IoT solutions on the edge of a network, improving design time, connectivity and data processing capabilities.

### SENSORS

#### 22 Hydraulic Cylinder Sensors Aid Pile Driver Accuracy

Use of linear position sensors in the hydraulic cylinders of a pile driver ensure accurate placement of piles for solar field installations.

### ELECTRIFICATION

#### 26 Purpose-Built Design Benefits Electric Construction Equipment

Building machines from the ground up enabled one heavy equipment manufacturer to ensure optimized designs for both electrification and market requirements.



Follow us on  @PowerMotionTech  @PowerMotionTech  [linkedin.com/company/powermotiontech](https://www.linkedin.com/company/powermotiontech)

# POWER & MOTION™

## WATCH. LISTEN. LEARN.

### POWER & MOTION VIDEOS AND WEBINARS BRING THE INDUSTRY EXPERTS TO YOU

Our impactful **Power & Motion video content** features interviews with experts in the fields of hydraulics, pneumatics and mechatronics. Watch one-on-one interviews with industry leaders, robust panel discussions on technology trends, or dig deep with other fellow engineers.



**WATCH THEM ALL AT:**

[www.powermotiontech.com/video](http://www.powermotiontech.com/video)

**Webinars with Power & Motion** feature highly technical deep-dives into new products and technologies, commentary on market trends, and robust panel discussions on emergent tech disrupting the fluid power industry.



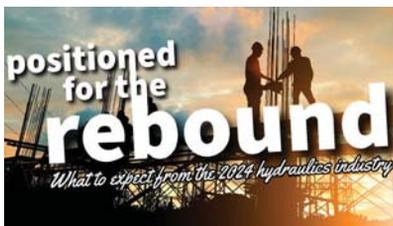
**REGISTER AND LEARN:**

[www.powermotiontech.com/webinars](http://www.powermotiontech.com/webinars)



**eBook: The State of Fluid Power and Electronic Motion Control**

Gain insights on factors which may drive future growth in the fluid power and electronic motion control sectors. [powermotiontech.com/21279781](http://powermotiontech.com/21279781)



**Hydraulics to Experience Soft Landing as Economy Slows**

Ken Baker, CEO of Bailey International, sees opportunities ahead for hydraulics despite an economic slowdown. [powermotiontech.com/21278310](http://powermotiontech.com/21278310)



**Webinar: Achieve Better Hydraulic System Maintenance with Oil Condition Monitoring**

Learn how HydraForce, TanDelta Systems, and Elevat integrated hydraulic, sensor, and IoT technologies to improve maintenance in the fluid power industry through oil condition monitoring. [powermotiontech.com/21278293](http://powermotiontech.com/21278293)

**EDITORIAL ADVISORY BOARD**

**PIM VAN DEN DIJSEL**, GROUP VICE PRESIDENT AND GENERAL MANAGER MOOG CONSTRUCTION

**JAMES DAWSON**, MECHANICAL ENGINEERING MANAGER PEKO PRECISION PRODUCTS

**PAUL CARLSON**, PRESIDENT AND CEO TOLOMATIC

**MICHAEL TERZO**, CEO AND FOUNDER MONOCERUS, LLC

**RANCE HERREN**, DIRECTOR - TECHNICAL SERVICES, FLUID POWER SME

**VALERIA TIRELLI**, PRESIDENT & CEO AIDRO HYDRAULICS & 3D PRINTING (DESKTOP METAL COMPANY)

**EDITORIAL**

SENIOR CONTENT EDITOR: **BOB VAVRA** BVAVRA@ENDEAVORB2B.COM

TECHNICAL EDITOR: **SARA JENSEN** SJENSEN@ENDEAVORB2B.COM

MANAGING EDITOR: **JEREMY COHEN** JCOHEN@ENDEAVORB2B.COM

TECHNICAL EDITOR: **SHARON SPIELMAN** SSPIELMAN@ENDEAVORB2B.COM

CONTRIBUTING EDITOR: **REHANA BEGG** RBEGG@ENDEAVORB2B.COM

SENIOR EDITOR: **MARIE MCBURNETT** MMCBURNETT@ENDEAVORB2B.COM

**ART DEPARTMENT**

GROUP DESIGN DIRECTOR: **ANTHONY VITOLO** TVITOLO@ENDEAVORB2B.COM

ART DIRECTOR: **DEJA HSU** DHSU@ENDEAVORB2B.COM

**PRODUCTION**

GROUP PRODUCTION DIRECTOR: **GREG ARAUJO** GARAUJO@ENDEAVORB2B.COM

CIRCULATION LIST RENTALS & CUSTOMER SERVICE

USER MARKETING MANAGER: **DEBBIE BRADY** DMBRADY@ENDEAVORB2B.COM

REPRINTS: REPRINTS@ENDEAVORB2B.COM

LIST RENTAL / SMARTREACH CLIENT SERVICES MANAGER: **KELLI BERRY** KBERRY@ENDEAVORB2B.COM

FREE SUBSCRIPTION / STATUS OF SUBSCRIPTION / ADDRESS CHANGE / MISSING BACK ISSUES:

OMEDA T | 847.559.7598 TOLL FREE | 877.382-9187 F | 847.291.4816 | POWERMOTIONTECH@OMEDA.COM

**SALES REPRESENTATIVES**

NORTH AMERICA ACCOUNTS MANAGER: **PATRICK CARMODY** PCARMODY@ENDEAVORB2B.COM

**INTERNATIONAL SALES**

ITALY: **DIEGO CASIRAGHI** DIEGO@CASIRAGHI-ADV.COM

UK, EUROPE (NOT ITALY): **HOLGER GERISCH** HGERISCH@ENDEAVORB2B.COM

**DIGITAL**

SENIOR DIGITAL INNOVATION & STRATEGY DIRECTOR: **RYAN MALEC**

RMALEC@ENDEAVORB2B.COM

**DESIGN & ENGINEERING GROUP**

EVP, DESIGN & ENGINEERING GROUP: **TRACY SMITH** TSMITH@ENDEAVORB2B.COM

GROUP CONTENT DIRECTOR: **MICHELLE KOPIER** MKOPIER@ENDEAVORB2B.COM

VP, MARKETING SOLUTIONS & DATA: **JACQUIE NIEMIEC** JNIEMIEC@ENDEAVORB2B.COM

VP, CONTENT: **TRAVIS HESSMAN** TMHESMAN@ENDEAVORB2B.COM



**ENDEAVOR BUSINESS MEDIA, LLC**

30 BURTON HILLS BLVD. SUITE 185, NASHVILLE, TN 37215, U.S. | [WWW.ENDEAVORBUSINESSMEDIA.COM](http://WWW.ENDEAVORBUSINESSMEDIA.COM)

**CEO** CHRIS FERRELL

**PRESIDENT** JUNE GRIFFIN

**COO** PATRICK RAINS

**CRO** REGGIE LAWRENCE

**CHIEF DIGITAL OFFICER** JACQUIE NIEMIEC

**CHIEF ADMINISTRATIVE AND LEGAL OFFICER** TRACY KANE

**EVP ENDEAVOR BUSINESS INTELLIGENCE** PAUL MATTIOLI



**Power & Motion Technology** (USPS Permit 254-960), (ISSN 2831-4883 print, ISSN 2831-4891 online) is published 6 times per year (January/February, March/April, May/June, July/August, September/October, November/December) by Endeavor Business Media, LLC, 201 N. Main St. 5th Floor, Fort Atkinson, WI 53538. Periodicals postage paid at Fort Atkinson, WI, and additional mailing offices. POSTMASTER: Send address changes to Power & Motion Technology, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. Subscription prices: U.S. (\$86.25 per year); Canada/Mexico (\$98.75 per year); All other countries (\$123.75 per year). All subscriptions are payable in U.S. funds. Send subscription inquiries to Power & Motion Technology, PO Box 3257, Northbrook, IL 60065-3257. Customer service can be reached toll-free at 877-382-9187 or at [powermotiontech@omeda.com](mailto:powermotiontech@omeda.com) for magazine subscription assistance or questions.

Printed in the USA. Copyright 2024 Endeavor Business Media, LLC. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopies, recordings, or any information storage or retrieval system without permission from the publisher. Endeavor Business Media, LLC does not assume and hereby disclaims any liability to any person or company for any loss or damage caused by errors or omissions in the material herein, regardless of whether such errors result from negligence, accident, or any other cause whatsoever. The views and opinions in the articles herein are not to be taken as official expressions of the publishers, unless so stated. The publishers do not warrant either expressly or by implication, the factual accuracy of the articles herein, nor do they so warrant any views or opinions by the authors of said articles.

# POWER & MOTION™

## ESSENTIAL INDUSTRY INFORMATION DELIVERED EVERY WEEK

NEVER MISS A CRITICAL ANNOUNCEMENT WITH POWER & MOTION'S NEWSLETTERS!



### Power & Motion News

The latest insights, applications and trends in the mechatronics and linear motion sector.

### In Focus

A monthly newsletter highlighting a key technology or trend impacting the fluid power and motion control industries.

### Market Trends in Power & Motion

A monthly overview of the technology and market trends influencing the development of hydraulic, pneumatic and electric power and motion systems.

**SUBSCRIBE NOW AT:**

[www.powermotiontech.com/subscribe](http://www.powermotiontech.com/subscribe)



### POWER & MOTION News



**A Technical Comparison: Pneumatic Cylinders and Electric Rod Actuators**

Here's a look at the performance criteria of electric and pneumatic sources of automated linear motion.

[FULL ARTICLE](#)



**This Week in Power & Motion: HAWC Rebrands Electrification Subsidiary**

HAWC's brand which develops electric components will now be included under the HAWC Hydraulics brand name, and more news you may have missed.



**Danfoss Editron Powers Doosan Electric Excavators**

Danfoss Editron has provided the electric powertrain as well as control systems to aid electrification of two excavators.

**drylin**<sup>®</sup>  
dry running... ... linear motion

## Eliminate maintenance and optimize motion

Belt-driven, screw-driven electric linear actuators



igus.com

### [ Editor's Note ]

SARA JENSEN  
Technical Editor  
sjensen@endeavorb2b.com



## What's in Store for Fluid Power and Electronic Motion Control in 2024?



93728849 © OLEG DOROSHIN | DREAMSTIME.COM

Starting a new calendar year brings many thoughts to mind, including those focused on what may lie ahead in the coming months.

Although a recession is predicted for 2024, it is expected to be mild one. Patrick Luce of ITR Economics said during the National Fluid Power Association's (NFPA) Fall 2023 Economic Update webinar that it could actually be a year of opportunity for the fluid power and many other industries. More normalized supply chains and product demand will give manufacturers a chance to breathe and focus on internal improvements to set themselves up for the growth predicted through the rest of the decade. You can read more about Luce's forecast for 2024 starting on page 14.

To help our audience keep track of market conditions, we have launched a new monthly newsletter called *Market Trends in Power & Motion* which will

highlight the latest economic news and market trend information related to the fluid power and electronic motion control space. Visit [powermotiontech.com/subscribe](https://www.powermotiontech.com/subscribe) to get this information delivered right to your inbox each month.

No year is complete without industry events to attend, providing the opportunity to see new technologies in person as well as network with others. And 2024 is set to be another year filled with great tradeshows and conferences. In addition to annual events such as NFPA's Annual Conference and IEOC, Hannover Messe, Automate and Pack Expo will be the return of INTERMAT and MINExpo, large mobile equipment industry events focused on two important customer markets for the fluid power sector in particular—construction and mining equipment. *What events, technologies or other aspects are you most looking forward to in 2024? Let us know! P&M*

## Volvo and Komatsu Acquiring Battery Suppliers to Aid Electrification Efforts

The OEMs are acquiring battery manufacturers to advance development of battery-electric construction, mining and other heavy-duty vehicles.

by Sara Jensen

**V**olvo Group and Komatsu have both announced plans to acquire battery manufacturers—Proterra Inc. and American Battery Solutions Inc., respectively. Doing so will help the companies with their continued development of electric-powered construction and other heavy-duty machinery.

Many heavy equipment OEMs like Volvo and Komatsu do not have battery expertise in-house. By partnering with or flat out acquiring a battery manufacturer, it is possible for the OEM to gain that knowledge and advance its technology development efforts.

The battery manufacturer can bring its expertise to the OEM who can offer its own insights into the specific needs of electrifying heavy equipment, ensuring the right battery technology for a given application is utilized.

Both Proterra and American Battery Solutions have developed battery systems for heavy-duty on- and off-road vehicles, making the companies a good fit for Volvo and Komatsu's ongoing electrification needs.

### Proterra Technology to Benefit Various Volvo Businesses

Volvo's acquisition of Proterra's battery business came about because the company is currently undergoing a voluntary Chapter 11 bankruptcy process. As part of this, Proterra Inc. and Proterra Operating Company Inc. are auctioning off business assets.

Volvo Group was selected as the winning bidder for the Proterra Powered business unit which includes Proterra's battery technology and expertise. Assets Volvo will gain as part of the acquisition are a development center for battery modules and packs in California, as well as an assembly factory in South Carolina.

Proterra started in 2004 as a developer of electric transit buses and grew over the years to also develop its own battery and powertrain technology.

With the battery business, Proterra Power, the company brought its expertise to additional applications including heavy trucks, off-highway equipment and others.

This technology expertise will fit in well with the Volvo Group which has been developing electrification solutions for its trucks, buses, and construction and mining equipment for several years now. Volvo said in its press release announcing its acquisition that Proterra's technology will complement its current battery-electric roadmap as well as help accelerate future developments.

### Komatsu to Power Mining Equipment with ABS Batteries

Komatsu's U.S. subsidiary Komatsu America Corp. has agreed to acquire Detroit-based American Battery Solutions (ABS) which develops and manufactures battery packs for both heavy-duty mobile and industrial applications. The company's lithium-ion batteries are available in standard and custom configurations to suit a range of industry requirements.

With the acquisition by Komatsu, ABS will be able to expand its technology into more off-highway and commercial vehicle, as well as industrial, applications—all of which are increasing their electrification efforts at a rapid pace.

Per Komatsu, the acquisition of ABS will enable the company to develop and produce its own battery-operated construction and mining equipment by integrating the two companies' expertise. **P&M**



The VNR Electric is a battery-electric Class 8 truck available in North America, and among the many examples of the Volvo Group's developments in the electrification space. VOLVO TRUCKS NORTH AMERICA



# Why Steering and Drive Systems are Transitioning to By-Wire Technology

The potential to improve design and vehicle performance is leading to a shift from hydraulic to electric options for steering and drive systems.

by Sara Jensen

**S**teering and drive related technologies have traditionally relied on fluid power components, particularly hydraulics. But electrically controlled options, known as by-wire systems, are increasingly taking the place of hydraulics and pneumatics in various applications.

There are numerous factors driving this technological shift including the ability to improve vehicle performance, especially in terms of safety and control, as well as the increasing development of electrified and automated vehicles.

A range of electronic options are now available in the market, offering new design opportunities for OEMs in both the passenger car market and the heavy-duty on- and off-highway sectors.

## How By-Wire Technology can Benefit Steering and Drive Systems

By-wire systems are those which use electrical or electronic control instead of a mechanical linkage (*see sidebar*). They can include drive-by-wire, brake-by-wire and steer-by-wire, among others.

Use of these systems in the automotive and aviation industries has increased over the years due to the many benefits they can provide. As the technology has advanced, its use is increasing in a range of other industries as well including heavy-duty vehicles.

Technology company ZF Friedrichshafen AG stated in a press release announcing the launch of its new brake-by-wire



Braking force in the ZF brake-by-wire system is generated by electric motors instead of a hydraulic system.

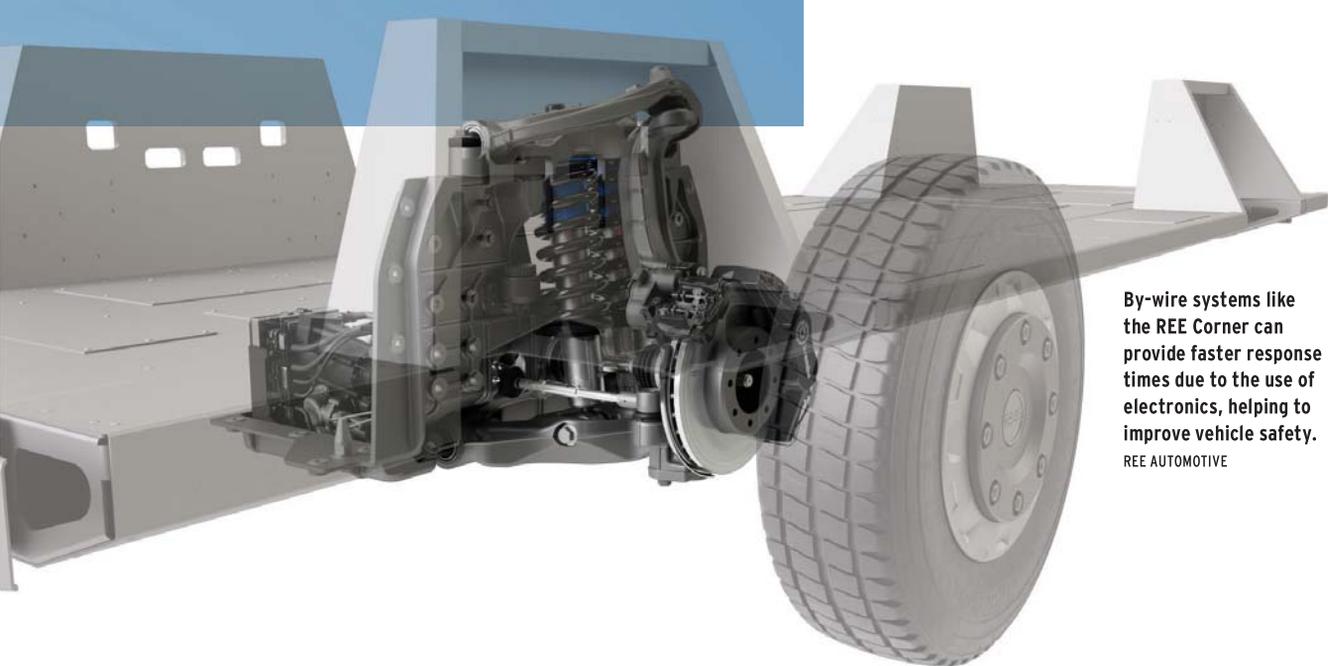
ZF FRIEDRICHSHAFEN AG

### What is a By-wire System?

“By-wire systems are those with no mechanical connection back to the control mechanisms from the driver to the steering or the pedals. It’s all electronic,” explained Peter Dow, vice president of Engineering at REE Automotive.

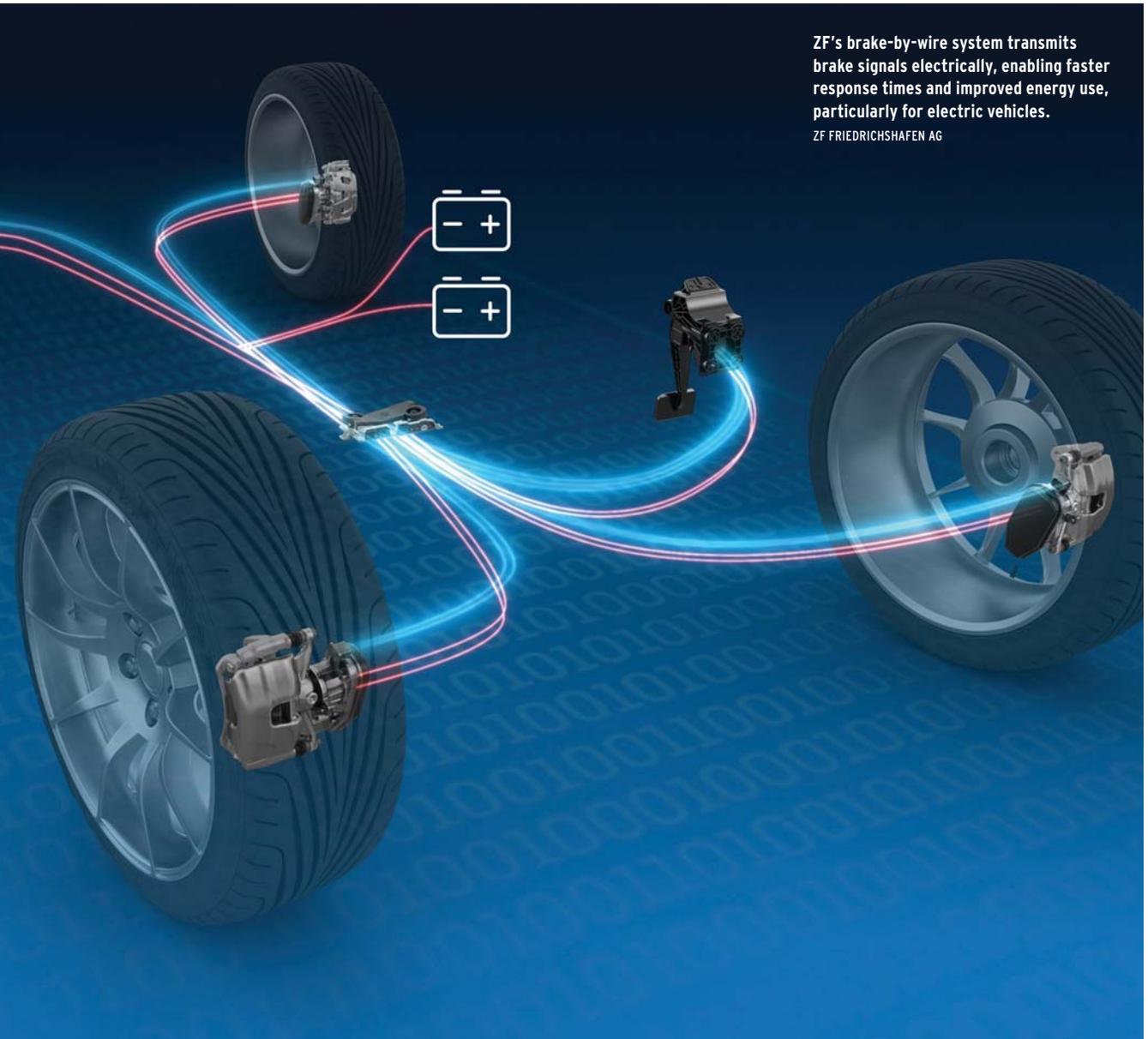
Traditionally, driver input has been transferred mechanically to a vehicle’s motor and wheels via a steering wheel, hydraulic brakes and other components. But with by-wire systems, these inputs are instead processed and communicated to the appropriate components by an electronic control system.

This enables opportunities for improved safety as the electronic controls can often react faster or even override human inputs to ensure the safest maneuvers are taken. In addition, the move to a by-wire system allows many components to be eliminated—such as steering columns, pumps and hoses—leading to lighter weight and more efficient vehicle designs.



By-wire systems like the REE Corner can provide faster response times due to the use of electronics, helping to improve vehicle safety.

REE AUTOMOTIVE



ZF's brake-by-wire system transmits brake signals electrically, enabling faster response times and improved energy use, particularly for electric vehicles.  
ZF FRIEDRICHSHAFEN AG

system that replacing the hydraulic braking system with an electric option reduces assembly and logistics costs because the system has fewer parts. The lack of hydraulic fluid also minimizes maintenance needs.

In addition, the company said moving to a purely electronically controlled and networked by-wire system offers performance benefits including better vehicle control, shorter stopping distances, greater driving stability at higher speeds and more.

ZF's brake-by-wire system generates braking force at each wheel using an electric motor and all signals from the vehicle's pedals are sent electrically. Automatic emergency braking is possible with this type of system and capable of achieving braking distances 9 m shorter than conventional braking systems at speeds of 100 km/h. For electric vehicles, this type

of system improves braking energy recovery to help increase the range up to 17%.

Wearing of brake pads and discs is minimized as well because there is limited contact with these components and reduced residual drag torque—which occurs with conventional braking systems—leading to a longer life and lower maintenance costs.

### X-by-Wire System Benefits Design

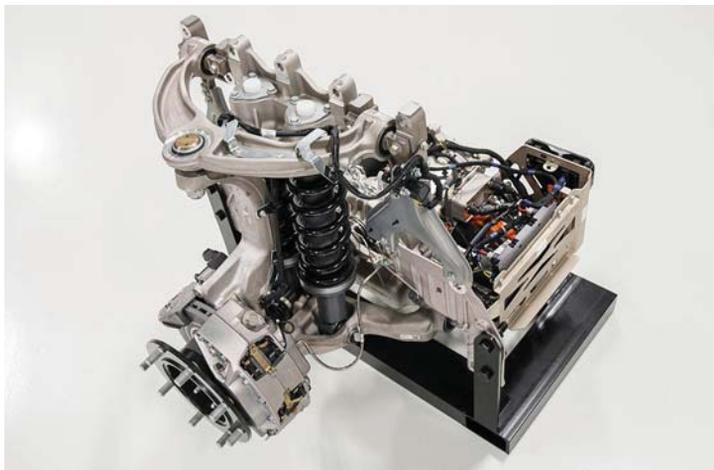
REE Automotive is an e-mobility company which has developed an x-by-wire system integrating steering, braking and driving into a single unit known as the REE Corner. All of the necessary elements for propulsion, steering and braking are contained in a single unit which can be placed on any of the four corners of a vehicle.

Peter Dow, vice president of Engineering at REE Automotive, said there has been a shift toward by-wire systems because of the control and safety they can provide. "People get scared when they hear by-wire and think it's not going to be safe," he said. "It's actually the opposite. It's much safer because you can put so many levels of redundancy and safety within the system, and you can control more."

Safety is ensured by designing mechanical, electrical and software redundancies into the REE Corner. For instance, the unit's 48V steering system is driven by an electric actuator which allows for 30 degrees of steering left or right. Dow explained that within the actuator there are two electric motors instead of a single motor, as is commonly done. If one of the electric motors should fail, the other one is still there to ensure the vehicle continues to operate as it should.

Precise measurement of the actuator is possible as well, enabling improved control capabilities.

The use of electronics along with the system architecture help to improve response time of the brakes, enabling vehicles to stop faster and thus operate in a safer manner. In addition, Dow said that because a vehicle will be equipped with four



The REE Corner is an x-by-wire system integrating steering, braking and driving into a single unit. REE AUTOMOTIVE

identical REE Corners, four-wheel steering is possible—enabling even the rear wheels to be steered—which can provide better maneuverability for larger vehicles and lead to improved safety.

He also noted the lack of a physical connection between the steering wheel and the vehicle's front and rear wheels.

[www.confortinet.com](http://www.confortinet.com)

Made in ITALY

**Making  
the difference**



E-COMMERCE



CERTIFIED  
QUALITY



CAD 3D  
CONFIGURATOR



SUPER FAST  
PRODUCTION



100%  
TESTED



HYDRAULIC CYLINDERS since 1972



**CONFORTI**  
boost your projects



The HGMe is an electrified version of Hydro-Gear's HGM hydraulic wheel motor which utilizes the same hydraulic geartrain but with a brushless DC motor attached. HYDRO-GEAR

Instead, electronics communicate driver inputs which Dow said allows for more fine tuning of the effort needed to steer the vehicle.

This can help make vehicle operation easier and open up the pool of potential candidates who could work in the transportation industry. "We talk about driving our vehicles, not fighting them," he said. "So to drive a big truck you don't need to have big biceps, you can drive it much more like a standard car or an SUV."



Despite the move to electric options, many OEMs are still looking for hydraulic drive technologies such as Hydro-Gear's pictured HGM fixed-displacement axial piston motor, because of their familiarity with the technology and electric alternatives not suiting all applications. HYDRO-GEAR

"We've seen with by-wire systems it opens up opportunities for people [and] it opens up what you can do with vehicles—bringing more comfort, safety and flexibility," he continued.

With a by-wire system, it is also possible to implement automation. As Dow explained, there is a centralized control system which collects and sends all of the necessary electric signals, and it doesn't matter if the inputs it receives are from a human driver or an autonomous system—they are the same because of the use of electric control, making it easy to implement autonomous operation if desired.

## MOCAP Solutions that Fit® the Fluid Power Industry

Many Sizes and Styles in Stock for Metric, SAE, BSP, JIC, NPT Threads & Fittings



Caps • Plugs • Grips  
for  
Protection • Finishing • Masking

Order Online For Fast Turnaround

**FREE SAMPLES** 1-800-633-6775    
www.mocap.com sales@mocap.com

Many customers still use hydraulics as part of their steering and drive systems because of familiarity with the technology.

### Electrification Growth Pushes New Drive Options into Market

Scott Wilmoth, marketing manager at Hydro-Gear—a developer of hydraulic and electric drivetrain solutions for lawn and garden and other off-highway applications—said each year the company receives more inquiries about electric options. "Everyone sees that electrification is coming," he said. "This trend is not going away but neither are hydraulics."

"It is likely that hydraulics will remain the dominant choice in our industry for many more years and we still see significant

**Mechanical, electrical and software redundancies are designed into the REE Corner to ensure vehicle safety.**

REE AUTOMOTIVE



opportunities for innovation and growth on the hydraulic side,” he continued.

However, because there is also increasing interest in electric drive solutions the company is continually developing both types of components to provide customers with the options that will best suit their design requirements.

In October 2023, Hydro-Gear introduced its latest electric drive solution the HGMe which is an electrified version of the company’s HGM hydraulic wheel motor. Wilmoth said it uses the same hydraulic geartrain as the HGM version because customers are familiar with the technology, and it has been proven in the industry. The difference is the attachment of the company’s in-house developed brushless DC motor.

Various sizes of the electric motor are available to meet specific customer application requirements which Wilmoth said is possible by varying the stack height. In addition, the motor can be wound for different voltages. The HGMe will debut as a 56 mm stack wound for 48V operation.

A key design criterion for the new HGMe was making it easy for customers to transition to an electric solution. Its similarities to the hydraulic version enabled this. In addition to using the same geartrain as the original HGM, the electric

version fits into the same frame sizes making it an easy drop-in replacement.

Wilmoth said the company foresees a lot of interest in the new product, particularly from the commercial space, as more electric-powered machines are brought into the market. Electrification is still a niche for Hydro-Gear’s core market of the lawn and garden sector, but as regulations increase and benefits such as lower operating noises are realized, the uptick in electric-powered machines will continue, necessitating electric drivetrain solutions.

One area he said the company sees there being more interest in electric over hydraulic options is in specialty applications, including those in which an electric vehicle is designed from the ground up to take advantage of the inherent benefits of electrification.

### **Hydraulics Will Continue to Play a Vital Role**

As Hydro-Gear’s Wilmoth noted, there are still customers who want to use hydraulics as part of their steering and drive systems because of familiarity with the technology or electric options do not yet meet an application’s requirements.

There is also the option to use hydraulics as part of an otherwise electrically controlled system which can help with market uptake. This is a key reason REE continues to use the technology for its REE Corner’s braking system.

Although the brakes are electrically controlled, conventional hydraulic braking is utilized at the actual wheel of a vehicle said Dow. “The wheel itself is controlled the same way a conventional hydraulic braking system is apart from the hydraulics, which are...being driven by an electric actuator [instead of] a pedal,” he explained.

While much of what’s contained in the REE Corner is comprised of electronics, components outside of it such as the suspension and braking system are standard designs that would be found on any other vehicle. “We want dealers and customers to be able to use the same technicians,” said Dow. “We’re trying to bring something [to market] that is new but reliable.”

Using industry standard designs means customers and technicians will still understand how to service the vehicle when necessary. “They know how to change brake pads, they know how to do inspections on them,” he said. “We’re not giving them something that’s completely new.”

Hydraulic solutions are likely to stick around for the foreseeable future in steering and drive systems, in some capacity, but as electric options continue to increase and advance in capabilities, there will be new design opportunities possible to help make vehicles on and off the road safer and more efficient. **P&M**

# 2024 Recession Presents Fluid Power Industry

With a mild recession predicted for 2024, fluid power manufacturers should use this time to invest in their business and prepare for the rebound coming in the second half of the decade.

by Sara Jensen

**A**fter months of predictions about a potential recession in 2024 for the fluid power industry, and broader U.S. and global economies, the data shows this will in fact be the case.

The data indicates total shipments for fluid power products have tentatively peaked and are facing decline in the year ahead, said Patrick Luce of ITR Economics during the National Fluid Power Association's (NFPA) Fall 2023 Economic Update webinar. He noted there are some headwinds in place which have the potential to cause downside pressures to linger into early 2025.

Declining profits, stricter lending criteria and overall elevated interest rates are creating tougher financial conditions for businesses. Because of this economic evidence, Luce said ITR expects contraction in a wide array of fluid power end markets. The current expectation is a nearly 10.9% contraction in 2024 compared to 2023.

However, those in the hydraulics and pneumatics industry should think of 2024 as an opportunity year he said. Companies should invest in their business to not only get ready for the nearly 10% year-over-year growth expected in 2025 but also take advantage of the reductions in pricing that will occur in 2024. A mild decline is expected for the producer price index throughout the year, offering good buy-low opportunities.

In addition, a light dip is expected for the interest rate environment in late 2024 and early 2025 which will benefit both the overall economy and businesses looking to make capital investments.

## Hydraulic and Pneumatic Shipments to Decline in 2024

Both segments of the fluid power industry are expected to experience a downward trajectory in 2024 before seeing growth again in 2025. Looking at the broader forces within the industry, the data trends move in sync with one another, said Luce. The cyclical momentum hydraulics and pneumatics have experienced since 2020 is beginning to wain and a dip in overall activity is starting. This dip will continue into late 2024 and early 2025 at a variety of paces.

ITR is forecasting hydraulic shipments in 2023 to be up 6.3% compared to 2022 but down about 11% in 2024 before



124273829 © STEVE ALLEN | DREAMSTIME.COM

**The agricultural equipment market is among the mobile machinery sectors facing headwinds from the slowing global economy.**

rebounding in 2025 when growth is currently forecast to be up 9.1%. Key end markets for this segment of the industry—including agriculture, mining and construction equipment—are facing downside pressures due to the tougher financial conditions these sectors, like many others, are experiencing, said Luce.

Softening in the overall economy is presenting headwinds for the agricultural and mining equipment markets, both of which are already declining, although he noted the oil and gas segment is an outlier. This portion of the mining industry is showing some resilience and rising at a steady pace. It is expected to only experience a mild decline in 2024 and therefore could be an area of opportunity for hydraulics manufacturers.

Pneumatics shipments should end 2023 up about 5.3% compared to 2022 based on recently revised data from ITR, said Luce. In 2024, this segment of the fluid power industry is expected to be down 5.9% compared to 2023 but rebound to growth of 2.9% in 2025.

Early to mid-2024 is when the pullback in pneumatic shipments is primarily expected, he said. This is due in part to declines in the manufacturing sector—a key customer market for pneumatic components and systems.

## Focus on Positive Markets for Fluid Power

Given the forecasted slower growth trends, it will be important for companies working in the fluid power space to strategize into the market winners in 2024, said Luce.

# Opportunities for Investment

He said companies should be planning now and have contingency plans in place for both upside and downside risks which could occur in 2024. Some of the leading indicators show an economic recovery could happen sooner, presenting a possible upside risk for which businesses will want to be prepared. Potential downside risks to account for include waning profitability and higher interest rates.

While planning for 2024 and beyond, he said companies should think about previous economic booms and what they wish they had done differently during the downturn to set their business up for success. Using this information can help better time actions to take so a business can capitalize on and be ready for the rise in economic conditions anticipated in 2025 and much of the second half of the decade.

Companies should look for ways to lean into their competitive advantages while also taking the time to address any possible competitive disadvantages it has in their marketplace. Identify, recognize and address them, said Luce. The slower economy provides an opportunity to invest in system upgrades and efficiency improvements. Anything a company can do now to abate current labor challenges will better set it up for success during the last half of the decade.

## Manufacturing Production Offers Insights into Opportunity Areas

The U.S. Total Manufacturing Production Index has been in decline through much of 2023 and expected to remain so into 2024. However, it will already be in a state of recovery by the end of 2024 and into 2025. Luce explained that ITR does not define recovery as a market experiencing growth but instead as the rates of change becoming less negative.



Pneumatic shipments are forecast to primarily be lower in the first half of 2024 before picking up again as the various sectors it serves, particularly manufacturing, start to recover later in the year.

By year-end 2024, manufacturing production rates of change will be getting less negative, he said, and gearing up for growth in 2025.

Besides looking at this broader macroeconomic trend, he said examining where manufacturing output is most robust is beneficial as well by targeting regionally specific opportunities. The best way to ride out a recession is to gain market share, whether in vertical markets or exploring new ones.

### What is a Recession?

Patrick Luce of ITR Economics said there are two ways to define a recession. The first is the technical definition which is when there are two consecutive quarters of GDP (gross domestic product) decline.

He said ITR is not forecasting there to be two consecutive quarters of GDP decline in 2024. Instead, it will be a little bouncy—so quarter one down, quarter two up, quarter three down and quarter four up—and have a generally flat trend. Ultimately, GDP will not enter into a technical definition of a recession.

The more formalized definition from the National Bureau of Economic Research says a recession occurs when there are decreases in overall employment and overall output and industrial production. Luce said ITR does see recession in these terms occurring in 2024, and it has already begun.

As manufacturing production enters recovery, there may be market regions—like the Midwest—where that sector plays a greater role in overall GDP and therefore could be an opportunity area to explore.

Related to this, Luce said there is a lot of new money coming into the U.S. to propel new spending in the economy for more production due to reshoring efforts as well as foreign direct investment. Monitoring these activities could provide fluid power manufacturers with potential new business opportunities. Investments in electrification, including battery production, and chemicals are strong sectors from a reshoring standpoint.

Fluid power companies should also re-evaluate their product offerings and end markets. It is important to place an emphasis on the products and services which tend to do well during periods of contraction, said Luce. These typically include those capable of improving a customer's return on investment. As such, a company's marketing and other aspects should be focused on how they can offer a competitive advantage in this area.

He said now is also the time to evaluate any unprofitable business segments. If there are ones which are having trouble making profits in 2023, they will likely have more trouble

doing so in 2024 and therefore a company should de-emphasize investments in these segments. Reallocate time and investment into more profitable market segments to help maintain overall business health.

### Potential in Maintenance Services

According to Luce, services have been holding up better than the overall economy and spending on durable goods. The rates of change for U.S. Commercial and Industrial Equipment Repair and Maintenance Services Revenue remain elevated.

As such, this an area the fluid power industry could evaluate as a potential avenue for new revenue streams either by providing services or offering solutions for those in the service industry. The service and repair space is not necessarily recession proof but recession resilient, said Luce, and therefore an area of opportunity during these economic periods.

The rates of change look to remain elevated in the foreseeable future for this space, making it one for those in the hydraulics and pneumatics industry to consider while making marketing and strategy plans for the coming year.

### How Broader Macroeconomic Trends Could Impact Hydraulics and Pneumatics

There are several trends happening in the broader macroeconomy which could influence the fluid power industry and its customer markets in the coming year.

Third quarter 2023 U.S. GDP (gross domestic product) figures were generally positive, said Luce, and slightly above expectations. The U.S. economy grew during the quarter and record high levels were achieved for real GDP.

However, he said there are some cracks showing in the economy's general trends. Consumers continued to spend in the third quarter, but delinquency rates are starting to rise, an indication financial weakness is beginning for consumers.

The ability of consumers and businesses to weather the higher interest rate environment may be dwindling as indicated by the supply of money in the economy drying up and weakening credit conditions. The latter could make it more



4536297 © ANASTASIYAANASTASIYA | DREAMSTIME.COM

**Companies should look to the regions where manufacturing is strongest as they may provide economic opportunities when the sector enters a recovery phase toward the end of 2024.**

difficult to get loans and is a key factor for the recessionary headwinds ITR sees, said Luce.

How the Federal Reserve interprets the third quarter GDP figures could determine when the economic recovery begins, said Luce. The Federal Reserve could see the strong performance as a reason to keep interest rates at higher levels for a longer period of time which could delay the start of the 2025 rebound.

When digging deeper into what drove third quarter GDP growth, he said personal consumption expenditures for household services was the number one driver. Utilities are included in this and take away from spending on other activities, especially durable goods. The pace of growth for goods was smaller and most resided in the automotive sector, he said, which is not expected to be as robust going forward because much of the pent-up demand and supply chain pressures from the last few years are abating.

Government spending—at local, state and federal levels—was also a strong contributor to GDP growth in the third quarter. Luce said this could be an opportunity area for the fluid power industry. All levels of government are still spending money as well as adding staff, making it one of the stronger market sectors currently. The Infrastructure Bill, CHIPS and Science Act and Inflation Reduction Act are all helping put money into the economy and providing good opportunities for domestic production with a lot of reshoring activities occurring as a result.

### Take Precaution with Inventory Levels

One GDP growth factor which particularly stood out to Luce—and was the second largest contributing factor to third quarter growth—was the fact increases in non-farm inventories were very elevated. Increases in inventory can add to the overall GDP level but are not necessarily a signal of economic health, he explained. Companies which have rapid rises in their inventories must typically pull back on business investment so they can rebalance their inventories.



16072814 © DENYS YELMANOV | DREAMSTIME.COM

**Maintenance and repair is a relatively recession resistant sector, making it a potential opportunity area for hydraulics and pneumatics manufacturers.**

Inventories are likely going to pose challenges for the economy going forward and many companies are already feeling the effects of the current imbalance as demonstrated by business investments currently being down from year-ago levels.

Luce said a key trend to monitor is inventory levels and that it is normal for the U.S. economy to overbuild inventories when transitioning from growth to contraction. This happens because the inventory turnover ratio falls and companies want to compensate, which is a normal cyclical relationship.

However, the COVID-19 pandemic exacerbated this because of the challenges many businesses were facing. There was an elevated lead time situation due to global supply chain pressures compounded by a surge of stimulus spending and demand, he said. This created a lot of upside pressure on lead times, causing businesses to buy forward on their inventory to keep up.

As supply chain pressure and demand began to slow, there has been a surge of inventory throughout the last half of 2022 and into 2023. Over the next 12 months ITR expects a rebalancing of inventories. Businesses will sell off their existing inventories and not necessarily build them up or grow them, said Luce.

This could provide opportunities for those in the fluid power industry. As businesses look to offload their inventories, hydraulics and pneumatics manufacturers could take advantage by locking in contracts and stocking up their own inventories

in the later half of the year in preparation for the growth anticipated in 2025. Typically, he said the economy lags in inventory planning, but this could be a chance for fluid power manufacturers to plan ahead and have the capacity to meet demand as it picks up again after 2024.

Ken Baker, CEO of Bailey International, said in an interview with *Power & Motion* the company will be keeping a close eye on its inventory levels because it is important to find a good balance between not building up too much but being ready for the coming rebound.

### Key Economic Takeaways for Fluid Power

Although 2024 will be a recessionary year, it is expected to be a mild one—and nothing like what was experienced in 2008. The slowdown in economic activity will provide an opportunity for many businesses to breathe after the strong uptick which took place as the world emerged from the COVID-19 pandemic.

With demand and the overall economy slowing, supply chain pressures have eased which is beneficial for many businesses as they spent much of the past few years trying to overcome this challenge.

But in general, 2024 should be seen as a year to invest in one's business and maximize competitive advantages to prepare for the growth anticipated in 2025 and beyond. **P&M**



HOSE REELS - CABLE REELS - SWIVEL JOINTS



**DREAMS ARE NOT REEL**  
IT CAN BE REAL!



TECNOLOGIE PER L'INNOVAZIONE - INDUSTRIE 4.0

March 6-8 2024

Bologna, IT

# Elevāt Partners with Microsoft to Enhance

Integration of the companies' technologies will enable deployment of IoT solutions on the edge of a network, improving design time, connectivity and data processing capabilities.

by Sara Jensen

**E**levāt has formed a partnership with Microsoft Corp. to help improve the development of IoT (Internet of Things) solutions in the heavy-duty mobile equipment industry.

The company will integrate its Elevāt Machine Connect, an IoT platform which monitors machine health, with Microsoft Azure Edge, a software that enables cloud computing to occur at the edge of a network (see sidebar, page 21). This provides faster processing of data collected from solutions like Elevāt's, allowing more timely decision making to occur so unplanned machine downtime can be minimized.

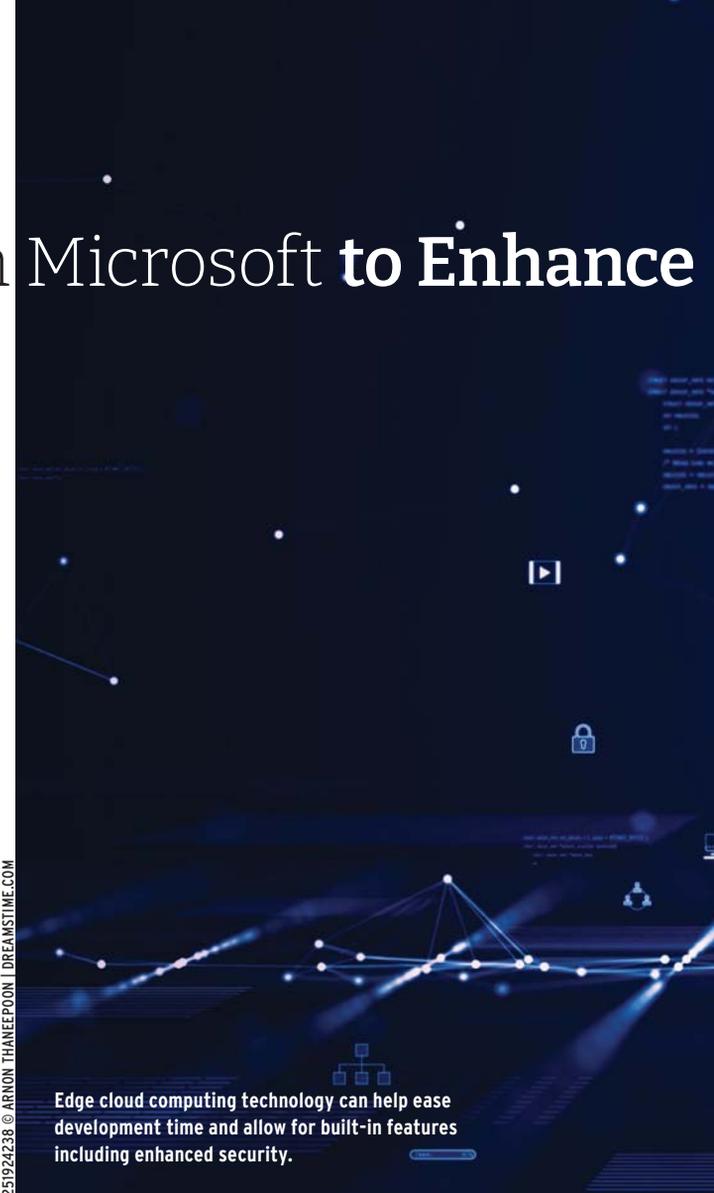
Adam Livesay, co-founder and CRO of Elevāt, said the company was approached by the Microsoft Azure team because they were interested in expanding into the off-highway space. To date, the technology is mostly used in healthcare, retail and trucking. "We started to look at what it takes to put the Elevāt software inside what is called Azure IoT Edge," said Livesay in an interview with *Power & Motion*.

Elevāt was then able to work with a customer to implement the combined solution. Doing so helped demonstrate what could be achieved by bringing the two companies' technologies together such as improved connectivity between devices on a machine and enhanced analytics capabilities.

## Deploying IoT on the Edge Reduces R&D Efforts

According to Livesay, one of the major benefits of the partnership with Microsoft is the ability to ease the development and deployment of IoT solutions—both for Elevāt and OEMs.

He explained that Azure IoT Edge is basically a software container which allows companies such as Elevāt to have their code reside on the edge. "Previously, any time someone like Elevāt would work with different hardware suppliers we would have to spend a lot of time deploying and engineering our software to that exact piece of hardware," he said.



Edge cloud computing technology can help ease development time and allow for built-in features including enhanced security.

Not only did this require a lot of resources going into a single project, but it could also limit the number of hardware vendors an OEM customer could use. If a different hardware configuration was desired, fewer options may have been possible because the supplier did not have a device available that worked with the IoT and telematics platform.

"An OEM could have three or four different hardware suppliers for the different machines it builds," said Livesay. "But if they're all Azure Edge compatible, then the software can stay the same."

This provides OEMs with greater flexibility because they can use any Azure Edge compliant hardware and be assured their IoT and telematics platform will work as desired. Livesay said this benefits development and scalability for OEMs while also helping to mitigate potential supply chain risks by expanding the network of hardware suppliers with which an equipment manufacturer can choose to work.

Another key benefit is how much Microsoft is investing in security. "There are a lot of enhanced security features on Azure IoT Edge that inherently comes from using an IoT platform that's deployed on there," said Livesay.

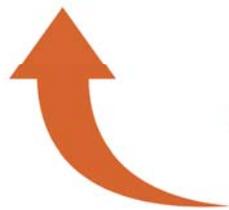
251924238 © ARNON THANEPOON | DREAMSTIME.COM

# IoT Deployment in Off-Highway Machines



## Azure Edge IoT List Features

- Edge Computing
- Real-Time Processing
- Azure Integration
- Security and Management



Azure IoT Edge allows the code for Elevāt's IoT platform to reside on the edge, easing development and speeding up processing time for machine performance data. ELEVĀT

In addition, he said there are services available with the Microsoft technology which allow users to work with machine learning (ML) and artificial intelligence (AI). “Even if your company is not ready for [AI and ML] yet, the building blocks and foundation are there for when you are ready as a company,” said Livesay. “And those services are just going to continue to get better over time.”

He said it's likely at some point an OEM or one of its customers will decide to do something in the ML or AI space. Because the technology building blocks are already built into Azure IoT Edge, the heavy equipment manufacturer will not be starting from scratch and therefore investing less time and money into development efforts.

Livesay said the partnership is exciting for Elevāt because of the investments Microsoft is making in edge and cloud technologies as well as IoT. “And it really does help with the different types of hardware options out there now,” he said. “You don't have to do really large deployment projects. You can find partners that fit the [Azure IoT Edge] criteria and you can start working with them pretty quickly.”

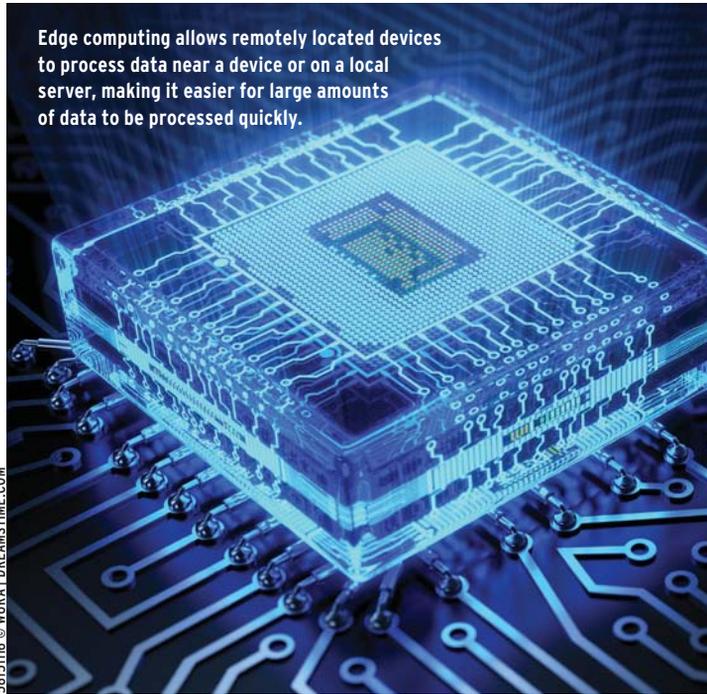
## How Technology Partnerships are Benefitting the Industry

Partnerships like the one between Elevät and Microsoft have become increasingly more common as a means of accelerating development and scalability of new technologies as well as helping to mitigate some of the risk involved with deploying new products in the market.

Livesay said having major cloud players like Microsoft now looking at how they can create tools to help accelerate IoT services and solutions is a big deal. “Before, companies would have to spend a ton of resources on ‘How do we do this? How do we manage this?’ Now you have this massive giant behind you with Azure that’s helping with that,” he said.

Elevät’s technology partnership with Microsoft will benefit both OEMs and component suppliers in the off-highway equipment industry, as well as many other industries. As the number of smart, connected components and services increases, the biggest headwinds for component suppliers will be scalability, prototyping and security. Many of them work with various hardware suppliers to implement these smart, connected capabilities. “If those suppliers become Azure compliant, it gives them more options as well,” said Livesay.

He said the partnership also helps to differentiate Elevät in the market. Many of the companies it works with are already using the Azure cloud for other aspects of their business, such as their IT department, so it can help to ensure compliance across an enterprise. “From a solutions provider perspective, it really helps us because they are investing so much in this



Edge computing allows remotely located devices to process data near a device or on a local server, making it easier for large amounts of data to be processed quickly.

[IoT] area,” he said. “They’re investing in the machine learning and AI space, they’re investing heavily into the security space; partnering up with companies that do that helps solution providers like Elevät.”

From an OEM’s standpoint, there is the ability to work with an IoT provider which can scale up its offering as the manufacturer

IoT platforms like Elevät Machine Connect allow monitoring of machine health to enable better decision making for maintenance and repairs.



220503623 © IGOR BORISENKO | DREAMSTIME.COM

looks to further improve its own solution. “We’re working with the OEM for its next deployment of service,” said Livesay, which can include remote updates, service alerts and more.

“We’re looking at utilization, helping them drive non-machine revenue, like aftermarket parts and services; we’re helping them with their over-the-air software updates, running their service tools remotely...those are all the things we’re focused on. And the more you do [those], the more security and scalability you need,” he said which is possible because of Elevät’s partnership with Microsoft Azure.

When working with an OEM or component supplier, Elevät will first determine if the customer’s hardware devices have the possibility of becoming Azure compatible, which Livesay said Elevät can help facilitate, or if they are already compatible.

The latter is what happened with the current OEM Elevät is working with—the OEM already had Azure Edge approval which made the development time much faster. “All we had to do was put our software on there [the hardware device] and development to deployment time was days instead of weeks or months,” said Livesay.

## Edge Computing Required to Handle Increasing Amounts of Data

Livesay said the partnership with Microsoft enabling the use of edge cloud computing is likely the first time it is being brought to the off-highway equipment market. However, he thinks it will be a common theme over the next 3-4 years because more intelligence is going to move to the edge.

As devices become smarter, more capabilities will be added to them which technology like Azure IoT Edge enables. And

### Edge Computing: What is it and Why Does it Matter?

Microsoft defines edge computing as a distributed computing framework which allows remotely located devices to process data at the edge of a network—either near the device or on a local server. This enables large amounts of data to be processed quickly because it is done at or near where the data is collected instead of sending data to a centralized cloud which could be thousands of miles away, causing potential delays in analyzing the data.

Processing data at the edge ensures more accurate, timely decisions can be made. For those in the heavy equipment industry, this can help to ensure any component or system malfunctions are detected right away and immediate actions can be taken to fix the issue or alert maintenance personnel.

The amount of data being produced around the world is expected to significantly increase in the coming years. Edge computing is seen as a potential way to efficiently handle it because of the ability to process data at the edge of a network instead of a data center—which not only uses a lot of energy but can also slow processing and reaction time.

it enables these capabilities to be deployed in a fast and secure manner.

He said this type of technology will be key to companies establishing their edge infrastructure by allowing a combination of standardization and flexibility.

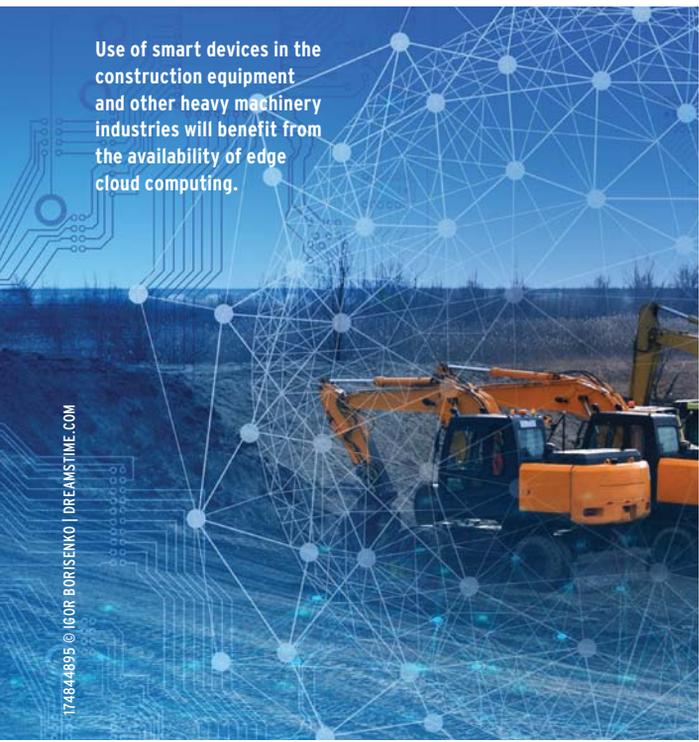
As an example, an OEM may have several brands under its umbrella which utilize various hardware devices from a range of suppliers. It might then decide that going forward its brands can use whichever hardware devices and IoT solution they like as long as they are Azure IoT Edge compliant. This provides some standards at the corporate level to aid with security and scalability while still offering the individual brands some design flexibility.

Specifying some criteria a chosen hardware device must meet not only helps to provide standardization within a corporation, and even the industry, but will also be necessary as components and machines become smarter. “As you get smarter on the edge and there’s more data processing, you’re going to need more systems like this,” said Livesay.

Deployment of Elevät’s IoT platform on the Azure Edge software will provide more capabilities for data processing, data batching, analytics and more. He equates it to when companies ran their servers in house then shifted to running the majority of them on the cloud. This allowed companies to move at a faster pace and bring more applications into their fold.

“Now we’re saying you can move the cloud to the edge,” said Livesay. “This is going to be the next wave of IoT.”

“[There will be] more connected machines, systems and tools running out [in the market] and having a really good edge strategy with the foundation of Azure IoT Edge, with partners like Elevät that are working with it, are going to be key to that long-term strategy,” he concluded. **P&M**



Use of smart devices in the construction equipment and other heavy machinery industries will benefit from the availability of edge cloud computing.

# Hydraulic Cylinder Sensors Aid Pile Driver Accuracy

Use of linear position sensors in the hydraulic cylinders of a pile driver ensure accurate placement of piles for solar field installations.

by Sara Jensen

**I**ncorporation of sensors into hydraulic cylinders can help them move in a more precise manner, enabling improved accuracy and the ability to automate machine movements. These capabilities were demonstrated when Rota Limited worked with heavy equipment manufacturer Vermeer on the development of its PD10 pile driver for solar field installations.

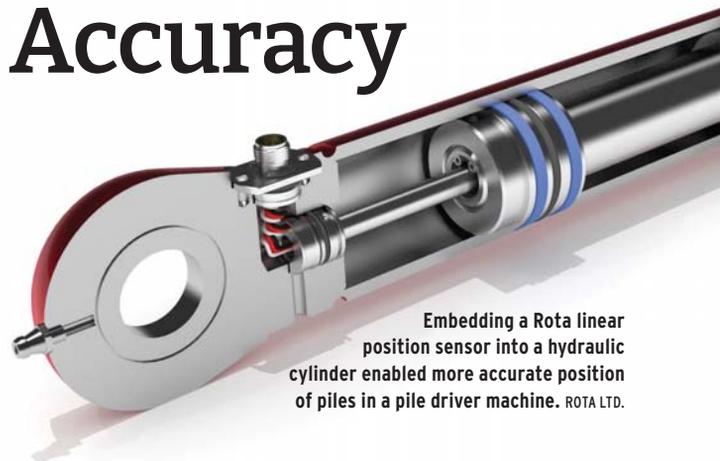
A high level of accuracy is required when driving the piles used to support solar panels into the ground during a solar field installation. Understanding this, Vermeer contacted Rota



An independent mount version of the Rota position sensor was mounted in parallel to the hydraulic cylinder used with the mast of the Vermeer pile driver to keep its necessary wire harnesses safe from damage. ROTA LTD.

about integrating its linear position sensors into two of the PD10's hydraulic cylinders. Adding the sensors would help to ensure accuracy when driving piles into the ground as well as help to automate this typically difficult and repetitive task.

Piles need to be driven into the ground 10 ft. apart, at just the right angle, thousands of times a day during a solar field installation. “[This is] a very repetitive process that really



Embedding a Rota linear position sensor into a hydraulic cylinder enabled more accurate position of piles in a pile driver machine. ROTA LTD.

needs to be automated and [cohesive] so there is a nice, feng shui look of the solar panels when you're done,” said Jake Hewes, PMP, international sales manager at Rota Limited.

With the Rota sensors, Vermeer was able to design the PD10 so operators could more easily install piles at the correct location, depth and angle to achieve the accuracy and aesthetics desired by the project at hand.

## Hydraulic Cylinder Position Sensor Enables Precise Control

Rota's linear position sensors are based on Hall Effect technology—an absolute technology which is robust and resistant to high-vibration applications, said Hewes, which benefits its use in the Vermeer PD10. The sensors provide x and y axis readings to help accurately align the pile driver.

Integrating the sensors enables electronic feedback to be added to the hydraulic cylinders for more precise control and adjustment of the stroke length. “Say it is a 12-in. stroke cylinder. Each time it moves a fraction of an inch, you get a reading on your electronics,” explained Hewes.

This feedback can be communicated to the machine's CANbus and software to better calculate and adjust the pile driver to the desired angle.

The driving depth of the pile can be better controlled as well, mitigating the risk of over- or under-penetration to ensure the structural integrity of the solar panels. This helps to minimize any possible rework, improving productivity and efficiency of the solar field installation.

Two different types of Rota sensors were used in the PD10. The initial goal was to embed them in the machine's hydraulic cylinders to protect the sensors from the shocks and vibrations that would likely be experienced in this application.

One of the sensors is embedded in a hydraulic cylinder used on the substructure of the pile driver. Hewes said keeping the pin-to-pin dimensions of a hydraulic cylinder unchanged can



be difficult when embedding a sensor. “A lot of times the cylinder will need to grow in length to add a sensor,” he explained. “Because our technology is Hall Effect and fits in a small package, it allowed us to fit one of the sensors in the cylinder without increasing the pin-to-pin [dimensions] which was key to fitting it underneath this machine.”

The second sensor in the mast of the machine is an independent mount sensor. While Rota had a solution which could be embedded into a hydraulic cylinder, its location made it difficult to run necessary wire harnesses or connectors without them getting damaged. “The solution was to remove the sensor from the cylinder and bolt it in parallel with the cylinder a safe distance away from it where we could run the wire harness safely through the machine to prevent it from being damaged in the field,” explained Hewes.

For this sensor, Rota used a heavy-duty stainless-steel version to ensure it could withstand the high-vibration environments in which the pile driver would be working.

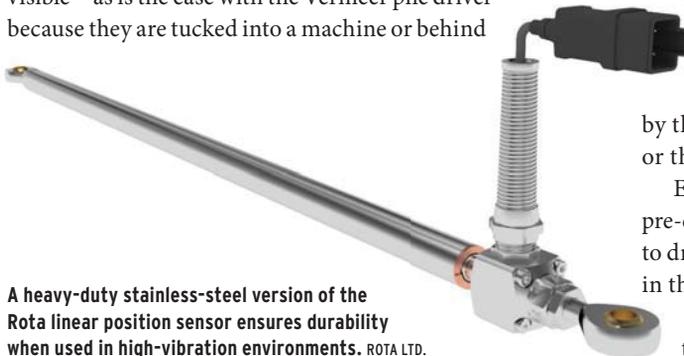
To ensure optimal integration of the Rota sensors, the company worked closely together with Vermeer and its hydraulic cylinder supplier. Multiple groups at Vermeer needed to be involved, including its electronics department to specify the CANbus signal. “It really becomes a three-way conversation” between Rota, Vermeer and the cylinder manufacturer said Hewes.

## Electronics Improve Pile Driver Accuracy and Ease of Use

Integration of the Rota sensors and other electronics as well as software on the PD10 enabled better drilling accuracy and ease of use to be achieved, key goals for Vermeer when it was developing the pile driver for use in solar field installations.

Without the sensors or other electronics, ensuring the pile is driven at the correct angle and depth would be a more visual, hands-on type of job which could lead to errors. Hewes said that if machine operators can see the hydraulic cylinders, it may be easier for them to ensure accurate drilling.

However, he said as soon as the cylinders are no longer visible—as is the case with the Vermeer pile driver—because they are tucked into a machine or behind



A heavy-duty stainless-steel version of the Rota linear position sensor ensures durability when used in high-vibration environments. ROTA LTD.



Two different Rota position sensors were embedded with hydraulic cylinders on the Vermeer PD10 to help accurately align the machine's pile driver. ROTA LTD.

the operator “it becomes extremely advantageous to have a position sensor inside of [the cylinder] so that you can see [the drilling angle] on your dash.”

The PD10 features an integrated control system, providing operators with a range of machine information such as pile angle, height as well as maintenance needs, much of which is possible because of the inclusion of the position sensors in the hydraulic cylinders said Hewes. Providing operators with easy access to this information helps them to stay on task and ensure they are installing the piles as desired by the project at hand.

The linear position feedback provided by the Rota sensors also enables real-time monitoring and analysis of the machine's driving force and impact. Immediate adjustments can be made to these when necessary because of the electronic control capabilities provided by the sensors, helping to prevent potential damage to piles or the machine itself.

Electronic feedback provided by the sensors can be used for pre-calculated automation or angle figures as well. “If you want to drive the piles at a 20-degree angle...that can be calculated in the machine's control system,” he said.

With this capability, automated functions can be added to a machine as Vermeer did with the PD10. An auto plumb

feature on the pile driver automatically moves the mast to a plumb orientation with a simple push of a button which Vermeer says can reduce cycle time—aiding overall productivity and efficiency of an installation. This also makes the task easier for operators, an increasingly important aspect with construction equipment of all types due to the lack of skilled labor entering the industry.

Making the machines easier to use helps get novice operators up to speed faster while also helping even the most experienced operators do the job correctly the first time, which is critical to ensuring projects are completed in a timely manner.

Hewes said customers he's spoken to have found the Vermeer PD10 pile driver to be extremely precise, to the point where they can create solar fields with

**Growing Use of Sensors and Automation in Off-Highway Machinery**

Jake Hewes, PMP, international sales manager at Rota Limited, said the company is definitely seeing a massive uptick in the use of sensors within hydraulic systems. As such, the company is continuing to add more personnel to help work with the growing number of OEM and hydraulic cylinder manufacturer customers using its sensors.

Use of hydraulic cylinder sensors continues to gain ground in mobile agricultural equipment, in particular. Hewes said it is a different driving force in this market because you are selling to farmers who are willing and ready to pay for added features, like automation, that will save them time.

On the construction equipment side, the machines are typically sold to a rental company. The addition of sensors and automation is not so much for time savings and benefits but to start overcoming the skills gap facing the construction industry he said.

"You may have a senior operator on an excavator that has hours and hours of [experience]. There's a decent learning curve to operating an excavator," said Hewes. But as you make it more automated, it can become easier through use of joystick controls similar to a video game. "That has a much shorter learning curve and has a lot of built-in safety aspects to it."

He said this greater demand for sensors and automation is just starting to see it take off in the construction sector. The agricultural equipment market is by no means mature, but it has been ahead of the construction industry in regards to uptake of these technologies.

Hewes noted Vermeer actually offers two versions of the PD10 pile driver; the PD10R model has no operator cab but instead enables wireless remote control of the machine. All other aspects, including use of the Rota sensors, are the same as the original PD10 pile driver but with the ability to remotely operate the machine.

Spec NitroSteel® today for a sustainable tomorrow.



**NitroSteel®**

NitroSteel® is a proprietary ferritic nitrocarburized product for hydraulic cylinders - a steel hardening process that delivers durability, corrosion resistance, and other characteristics that are superior to traditional chrome plating.

**zero**

hazardous by-products in the landfill compared to hexavalent chrome

**zero**

chemical emissions

**zero**

dangerous carcinogens

**zero**

surface pitting or flaking

**100%**

swarf recycled

**100%**

electrically heated process

**150**

minimum ASTM B-117 Neutral Salt Spray corrosion test for every batch



For more information please call 812.350.7438 or scan the QR code.





Use of Rota linear position sensors for hydraulic cylinders in a Vermeer pile driver enables better accuracy during solar field installations by ensuring piles are driven at the precise angle desired. VERMEER

an aesthetically pleasing flow—making them more attractive to the communities in which they are installed and potentially helping further the market uptake of solar fields to meet increasing sustainability initiatives. **P&M**



The Vermeer PD10R pile driver, equipped with Rota linear position sensors, allows remote operation to help ease solar field installations. VERMEER



**WORLD LEADING MANUFACTURER  
OF HIGH PRESSURE VALVES & QUICK COUPLINGS**



**GEMELS NORTH AMERICA INC.**

Billing Address 1800 West Loop South - Suite 1600 - Houston, TX 77027  
Warehouse & Distribution Center 35 Watterson St. - Dayton, OH 45417

northamerica@gemels.com / gemels.com

in f tv @ Made in GEMELS S.p.A.



# Purpose-Built Design Benefits Electric Construction Equipment

Building machines from the ground up enabled one heavy equipment manufacturer to ensure optimized designs for both electrification and market requirements.

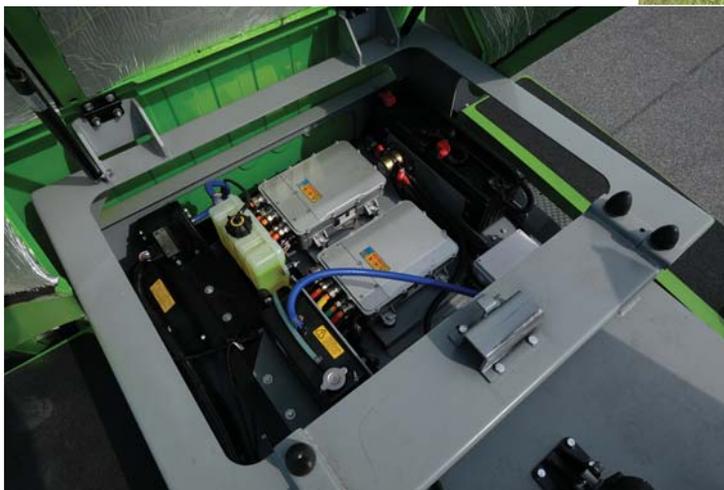
by Sara Jensen

**T**he U.S. heavy equipment industry is dominated by the use of diesel. HEVI, a developer of all-electric machines, wants to change this by offering clean and sustainable alternatives to the heavy machinery space.

“Any organization looking to be a little cleaner about their work has no option today,” said Raymond Wang, CEO of HEVI, in an interview with *Power & Motion*. “We wanted to change that.”

In 2022, the company launched its first product line of all-electric heavy equipment which includes two front loaders (aka wheel loaders) and one excavator ranging in size from about 12,000 to 40,000 lbs. “These are the large-scale products ready for the job site to move some material and get some work done,” he said.

Wang noted the company is a subsidiary of Greenland Technologies whose core business is the manufacture of drivetrains and transmissions for various types of machines including forklifts, front loaders and excavators. “So, we took that know-how to try to electrify a space that no one else was touching—construction [and other] heavy equipment.



HEVI's GEL-5000 electric wheel loader is powered by a 282 kW, 660V battery which is placed at the back of the machine. HEVI



Use of standard hydraulic lines in HEVI's electric machines help to provide operation similar to that of diesel versions. HEVI

“At any given point in time, in the U.S., we have about 1.2 million machines operating, and each machine will burn about 10 gallons of diesel per hour of use,” explained Wang. “That is equivalent to about 200 lbs. of CO<sub>2</sub> [carbon dioxide] burned per machine per hour...[creating] a major dent in the carbon emissions pie for our country. So, we want to try to convert as many as we can from diesel to a cleaner source.”

### Why a Ground-Up Design is Beneficial

Although there are many heavy equipment manufacturers developing electric-powered construction equipment, much of it is still in the prototype stage. The few machines which are available on the market are in the compact size range and availability is still limited.

HEVI, however, has developed larger machines to help suit a range of application needs. And unlike some manufacturers, the company’s equipment is purpose-built for electrification and the needs of the applications in which it will be used.

### Why Machine Owners Have Mixed Feelings on Quiet Operation

A key benefit of electric machines is their quieter operation. But Raymond Wang, CEO of HEVI, says there is still some debate about this. While collecting feedback from customers, he said there are differing opinions about whether machine noise is desired on a work site or not.

Many clients who have one to three pieces of equipment on their site want more noise with the machinery for safety reasons; they feel it provides an extra level of security being able to hear a machine coming.

But other customer sites, particularly those running multiple pieces of equipment during a shift, or running machines indoors, want less noise. If every machine is making noise when it backs up and moves forward, workers may become desensitized and thus susceptible to safety issues.

“It’s really based off need, so what we’re leaning more towards is customized options to be able to provide the right sound,” said Wang.





The line of HEVI electric heavy machinery currently includes two front loaders (aka wheel loaders) and one excavator ranging in size from about 12,000 to 40,000 lbs. HEVI

“These are not retrofits in any way, shape or form,” said Wang. “These are built from the ground up, designed entirely for the application.”

He said a lot of the electric vehicles in the market currently are designed for road applications where aerodynamics plays an important role. In those vehicles, the batteries are embedded in the chassis to keep a low profile and still have space for passengers. “But for heavy equipment, it’s a completely different application. Those skateboard battery systems don’t apply; they’re not good fits.”

At any job site, the bottom of a machine is likely to get bumped and dented while maneuvering over rough terrain, he explained, so you don’t want the power source located at the bottom of that piece of equipment.

Instead, HEVI places the batteries at the back of its machines. “The entire backside of our front loaders—everything behind the cab—it’s all batteries,” said Wang.

He explained that all of HEVI’s equipment is designed to operate for 9 hours on a single charge. To achieve that, a lot of battery power is required—typically batteries which are over 2 tons in size. For instance, the company’s larger loader uses a 282 kW, 660V battery.

Despite the large size of the battery, Wang said machine weight was actually reduced. “Because it’s not a retrofit, all of the motors and other system components related to an internal combustion engine were removed. It actually ends up being lighter... we had to add further ballasts to the back to make sure [the front loader] can handle the load without any risk of tipping over.”

In HEVI’s machines, the engine is completely replaced by the battery and electric motors. According to Wang, removal of the engine and its various accessory components, such as the oil tank, belts and spark plugs provides a lot of opportunity to enjoy the benefits of electric because maintenance costs are significantly reduced. “A lot of your standard routine maintenance—replacing spark plugs, changing the oil, replacing the belt—all of that is eliminated,” he said.

Besides keeping the electric motors clean, the only other maintenance necessary is keeping coolant topped off for the alternator system as well as following a standard lubrication routine for the hydraulics system.

### Hydraulics Benefit Ease of Use and Market Uptake

When developing its machines, HEVI wanted to make the move to electric an easy one for customers. “To get people to try new technology, we had to make sure we proceeded by baby steps,” said Wang.

In its machines, HEVI uses hydraulics to power digging and lifting functions. This helps to ensure familiarity for operators as well as performance similar to that of other equipment in the market. “Someone that’s been driving loaders or excavators all their life can get behind the wheel of [our machines] and be comfortable in 5 seconds,” he said.

The company chose to use standard, industry recognized hydraulic lines to not only ease operation but also maintenance. If someone were to work on the hydraulics system of a comparable diesel machine, he or she would be able to just as easily work with the hydraulics on HEVI’s equipment.

Wang said a major aspect of importance for HEVI’s electric machines is that they can be maintained by the owner. “We actually promote the right to repair for our equipment,” he said. “What that means is anyone that is an owner of our equipment, if they wanted to be able to replace the hydraulic lines themselves or do any type of maintenance they don’t have to work with a dealer in our network or use proprietary [technology].”

He explained that customers can call HEVI to get the information, and components if desired, necessary to perform the required maintenance. The company is also establishing a network of authorized service providers for those customers who may want such an option.

“We want to empower our clients to be able to repair [the equipment]. And the way that we can enforce that is by

using as many standardized parts as we could throughout the machinery, including our hydraulic lines,” said Wang.

## Multi-Motor Configuration Ensures Efficiency

The HEVI electric construction equipment uses seven primary electric motors. Only those motors required for specific tasks are used, keeping power expenditure low.

Wang explained that instead of having one major power source for all machine functions, the company separated that out into individual components based off their application in the machine. This multi-motor design helps to drive the efficiency of HEVI’s equipment.

Construction equipment and other heavy machines will have different working scenarios throughout the day—sometimes they are doing heavy work, other times they are sitting and waiting. Creating a multi-motor system ensures the needs of all those working scenarios can be met efficiently.

The system works by activating certain electric motors based on what the machine needs to be doing at the time. Those motors not being used are not running and therefore not drawing power from the batteries, ensuring efficiency and extended life.

Wang provided an example from a customer demo in which a machine was left running yet lost very little battery power. “Being electric, our machinery is mouse quiet, which is drastically different from diesel equipment today,” he said.

After running the machine for some time, an operator got out of it and left for the day without realizing the machine was still on because it was so quiet. He came back hours later, realized the machine was running but when he stepped inside the operator cab to turn it off, he saw the battery charge had dropped by less than 1% in the 4 hours he was gone.

“He was amazed at the longevity of it,” said Wang. “While [the machine] is just sitting there, it’s not running every motor constantly. For efficiency purposes, it’s only running what it takes to be in that state.”

## Demand is Growing for Electric Machines

The electric machines from HEVI are suited for applications where the equipment is not leaving the job site or will have access to power, such as waste management, agriculture, landscaping, urban construction or public works yards. Demand for the company’s machines has been extremely high said Wang.

He said the company is the first to offer electric heavy equipment, categorized as over 10,000 lbs., in the U.S. and because of that, the company works more as educators than manufacturers at this stage due to diesel being the dominant power source for over a century. “The only thing that came before was steam power, so it’s going to take a lot to get people to try it out,” he said. “But that’s exactly what we’re doing. Our whole inventory right now is dedicated to demos.”

HEVI will bring its machines to a work site and let potential customers use them for a few days so they can see firsthand how they work. “To get them comfortable, they have to be in the seat behind the wheel. And that’s exactly what we’re doing,” said Wang. “And we’re seeing a ton of demand.”

“That will translate over because people can actually see they can do their work cleaner, can do it in a more sustainable manner for the future. This is feasible. This is technology that exists today. And that’s exactly the stage that we’re in.”

Because these electric machines are a business asset, the potential return on investment (ROI) they can provide is what initially draws customers to them. “From an ROI standpoint, we’re extremely cost advantageous,” said Wang.

The HEVI machines are priced the same as a comparable diesel, eliminating the sticker shock sometimes associated with electric vehicles. This is further benefited by the fact the company sells directly to customers instead of through dealers, enabling them to be upfront about costs and other machine aspects.



HEVI developed its own line of mobile chargers which can recharge its equipment to provide 9 hours of operation. HEVI

In addition, the reduced maintenance and fuel costs benefit the machine’s ROI. Recharging can take place on site, and electricity costs are much lower than diesel. Wang said in New Jersey where HEVI is headquartered, electricity is about 11 cents per kW hour, equating to about \$4-6 per hour of operation. Meanwhile, diesel is about \$4 per gal. and the typical machine burns 10 gal. per hour, leading to \$40 per hour of operation. “Major savings [can be realized] just on a single shift in the first year,” he said. “And that gets better as the diesel [machine] becomes less efficient.”

“That’s how we turn heads to begin with. And then we’re able to talk about the sustainability impacts, such as that piece of electric equipment offsetting 400 tons of CO<sub>2</sub> per year on a single shift. That’s the equivalent of replacing about six to eight transit buses, or over 80 passenger cars—a major impact to a company’s environmental goals,” he concluded. **P&M**



### **Webtec RFIK270 Hydraulic Tester**

Webtec now offers the RFIK270 mechanical hydraulic tester with an increased flow capacity of 270 lpm (70 gpm). The tester can be used for measurement of flow, pressure and temperature.

Key features of the hydraulic tester include:

- modified load valve to reduce pressure drop
- broad flow range from 20-270 lpm
- self-contained for ease of use
- internal safety protection system to protect hydraulic circuit and operators.

[powermotiontech.com/21279761](http://powermotiontech.com/21279761)

### **Proportion-Air QB3 Pressure Control Valve**

The Proportion-Air QB3 proportional electro-pneumatic pressure regulator provides pressure regulation for high-flow applications in a single, compact unit.

Key features of the QB3 include:

- monitoring output pressure for closed loop control
- accuracy of 0.5%
- ability to monitor flow rates up to 30 SCFM
- compact package with flexible mounting options.

[powermotiontech.com/21279713](http://powermotiontech.com/21279713)



### **ALT Bearings HRA-i Roller Screw**

ALT Bearings (Advanced Linear Technologies) has developed the HRA-i which integrates an inverted roller screw with an ultra-high capacity roller bearing known as the Herringbone Roller Bearing (HRB).

Features of the HRA-i include:

- reduced weight and improved reliability
- need for flange and locknut to secure location eliminated
- high power density
- variety of application uses.

[powermotiontech.com/21281134](http://powermotiontech.com/21281134)



### **Festo DHPL Long-Stroke Parallel Gripper**

The DHPL from Festo is a long-stroke, parallel pneumatic gripper designed for use in high load and torque applications.

Key benefits of the DHPL pneumatic gripper include:

- $\leq 0.03$  mm repetition accuracy
- compact and lightweight design
- high load and torque grip
- flexible mounting options.

[powermotiontech.com/21281136](http://powermotiontech.com/21281136)



### SMAC LPL80 Electric Actuators

SMAC Moving Coil Actuators (SMAC) has added the LPL80 electric linear moving coil actuators to its offering. The actuators are designed to offer a replacement to pneumatics in liquid filling machines.

Features of the LPL80 actuators include:

- fully programmable
- peak force of 170 Newton
- soft-land capability
- standard dimensions for filling machines.

[powermotiontech.com/21271660](http://powermotiontech.com/21271660)



### Thomson Customizable Compact Linear Motion Systems

Thomson Industries Inc. now offers a family of linear motion systems to provide an easy-to-integrate solution for designers who need thrust and bearing support in a single, compact unit.

Components within these linear motion systems include:

- integrated stepper motors
- lead screws
- profile rail linear guides
- linear Ball Bushing bearings.

[powermotiontech.com/21267668](http://powermotiontech.com/21267668)

## Advertiser Index

Aalberts Surface Technologies HQ	24
Altech Corporation	BC
Conforti Oleodinamica Srl	11
Demac SRL	17
Fluidyne Fluid Power	IFC
Gemels North America Inc.	25
igus Inc.	6
Market Moves Manufacturing	IBC
MOCAP LLC	12
Novotechnik US Inc.	31
Power & Motion/Subscription	5
Power & Motion/Webinar	3
Veljan Hydrair Limited	1

## In And Out

TM1 Series Position Sensors for In-Cylinder and Outside Cylinder Use.



TM1 Series magnetostrictive sensors are available in **screw flange** or **plug-in flange models** and utilize a ring-shaped magnetic marker for touchless operation.

#### Key Specifications include:

- Absolute linearity  $\leq \pm 0.04\%$  FS (min. 0.3 mm)
- Absolute output: meets specs without calibration
- Operating pressure range of 0 to 350 bar (5,076 psi), 450 bar peaks (6,526 psi)
- Stroke lengths: 50 to 2,000 mm (1.9 to 78.7 in)
- Repeatability  $\leq \pm 0.1$  mm
- Sealed up to IP 69K
- EMC compatibility tested

To learn more contact  
Novotechnik or visit  
[novotechnik.com/tm1](http://novotechnik.com/tm1)

**novotechnik**

Siedle Group

Novotechnik U.S., Inc.

Tel: 508-485-2244

Email: [info@novotechnik.com](mailto:info@novotechnik.com)

# How Artificial Intelligence Benefits Manufacturing

Artificial Intelligence can help improve efficiency, enhance quality, and bolster productivity in manufacturing operations.

by Sara Jensen

Use of artificial intelligence (AI) is increasing in manufacturing and a range of other industries. AI's ability to continually learn and process information enables it to help analyze data and solve problems.

With these capabilities, manufacturers and other users of AI have the potential to improve efficiency and productivity of their operations.

Power & Motion spoke with Murad Kurwa, vice president, Advanced Manufacturing Engineering at Flex—a global technology, supply chain, and manufacturing solutions provider—about the benefits of AI in manufacturing as well as trends the company sees related to this technology.

*\*Editor's Note: Questions and responses have been edited for clarity.*

## Power & Motion: How are you seeing AI being used within the manufacturing industry?

**Murad Kurwa:** Several manufacturing processes can benefit from artificial intelligence. When deciding how to deploy AI technologies on the factory floor, it's important to start with an end goal in mind, and then use the technology to help meet that goal. Some examples include factory line optimization, predictive maintenance, anomaly detection, inventory management and bottleneck prevention.

Based on the end goal, an AI model life cycle can be created by gathering and curating data, selecting the type of AI model you want to use, training the model, determining if the model performs well enough to achieve the final goal and finally deploying it in production.



Use of artificial intelligence alongside other Industry 4.0 technologies can help create smart factories which are more productive and efficient.

In addition, ensuring that the model works and can scale to meet required manufacturing speeds is also important to derive the value out of AI. By constantly learning and improving over time, these programs promote significant progress in quality and efficiency and facilitate more informed and data-driven decisions.

## P&M: What benefits can be achieved by using AI within manufacturing operations?

**MK:** AI can help improve efficiency, enhance quality and bolster productivity. Take some of the use cases I listed earlier, for instance.

When we think about predictive maintenance, AI solutions can help collect, analyze, and detect shop floor machine issues before they happen. With significant upstream data from connected machines, AI models can indicate that an adverse event might happen before it does, allowing manufacturers to stop potential failures and eliminate downtime.

When you think about anomaly detection, manufacturers can train AI models for quality control by detecting product defects and anomalies, reducing the need for manual inspection and helping drive product consistency and quality.

In general, using AI can help people at all levels of the organization make informed, data-driven decisions in real-time that can lead to huge cost and efficiency savings.

## P&M: Do you have an example you can share for how you've seen AI deployed in an effective manner?

**MK:** At a few of our Flex locations, we deployed AI to improve the quality inspection process. Traditionally, this was a task done by human operators.

Here is a fitting example of how this type of technology works. On a particular manufacturing line, we had two almost identical capacitors. The only difference between the two components was the valves. This made it incredibly difficult for the human eye to detect anomalies. And if the wrong capacitor was used, the product wouldn't work properly.

By using vision data and an AI model, our advanced manufacturing technology could see if an operator placed the components in the correct spot and provide feedback to fix any issues in real time. This not only resulted in greater performance and yield but also enabled us to reduce scrap by identifying key issues before a part was sent to another step in the line

Read the full article at [powermotiontech.com/21276201](https://www.powermotiontech.com/21276201). **P&M**

MARKET MOVES



# MANUFACTURING

Delivering the latest trends and expert analysis to professionals responsible **for innovation** and **growth strategies**.

---

Insight and analysis from manufacturing and sector experts into the global manufacturing economy.



**Learn More:**

[markets.endeavorbusinessmedia.com/market-moves-newsletters](https://markets.endeavorbusinessmedia.com/market-moves-newsletters)

IN STOCK

# Altech® has your Back-Up

## The ONLY All-In-One DC-UPS

- Power supply, battery charger, battery care module and backup module in one device
  - Works with battery based systems\*
  - Three charging modes
  - Available in 12V DC, 24V DC and 48V DC
  - Adjustable charging current up to 35A
  - Easy battery diagnosis and fault identification either by LED or external devices connected to fault
  - High efficiency up to 91% via switching technology
- \*battery not included



## Ultra-Capacitors DC-UPS No Battery Needed

- Environmentally safe
- No toxic chemicals
- Virtually maintenance free
- Operating temperature range -40°C to +65°C
- Higher energy vs. electrolytic capacitors
- Up to 10,000 Ws energy plus extension mods
- 12 or 24V system design
- Customized systems up to 600A
- Higher power vs. batteries
- Resists shock and vibration



Altech Corp.® 40 years  
Automation & Control Components 1984 - 2024

AltechCorp.com · 908.806.9400