Equipment Manufacturers Prep for Growth
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An All-Electric Wheel Loader Becomes Reality
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January/February 2023

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Fluid Power, Motion Control Glimpse the Future *P.12*

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Volvo CE Launching New Electric Machines and More at CONEXPO 2023

The construction equipment OEM plans to introduce new electric-powered machines as well as those with hydraulic system improvements.
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How to Implement AI in Fluid Power Applications

Understanding pain points to be solved and planning ahead can help manufacturers and their customers get the most out of artificial intelligence systems.
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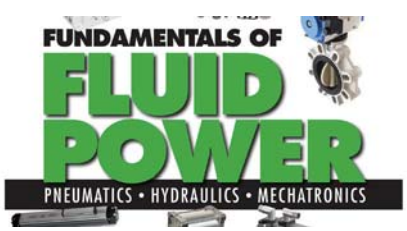

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POWER&MOTION

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Ready to Kick Off a Busy New Year

As we start 2023, the *Power & Motion* team is already looking ahead to what the year will have in store. In addition to our usual content coverage, this year we'll be focusing on three key industry trends impacting design for the fluid power and motion control industries:

- digitalization
- electrification
- automation.

While none of them are new, their implementation continues to increase, bringing about changes to hydraulic, pneumatic and other system designs. On p. 12, we take a look at how these trends are impacting the fluid power industry and the products slated to be at IFPE 2023 which show the development taking place in these areas.

Held once every three years, the International Fluid Power Exposition (IFPE) brings together the latest technology developments in the fluid power, power transmission and motion control industries. It will provide the opportunity to see what trends are impacting the industry today and the solutions now available to meet them. And being co-located with CONEXPO-CON/AGG, one of the largest construction industry trade shows, will provide the opportunity to see what new designs are entering the construction equipment market—one of the largest users of fluid power systems, particularly hydraulics.

For this issue we've focused on technologies related to the mobile equipment industry, and starting on p. 12 you'll find IFPE-specific content to help you plan for this year's biggest fluid power industry event. Even more IFPE related content can be found on our dedicated IFPE channel as well leading up to, during and after the show.

In 2023, we are anticipating a full return to the trade show and conference circuit. After a complete halt in 2020, there has been a slow return to in-person events. This past year was the busiest it has been over the past two years, and 2023 is looking to be even busier in terms of coverage and attendance. We can't wait to get out and connect again with the industry.

Read an extended version at powermotiontech.com/21256819.

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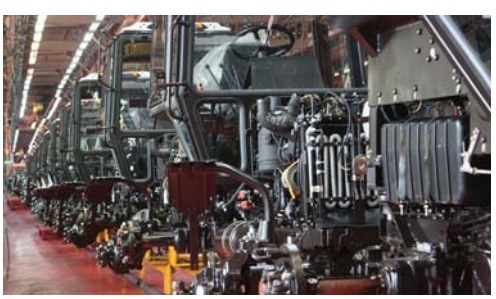
Equipment Manufacturers Plugged in for Growth in 2023

AEM experts see connection (and reconnection) as a major trend for the new year.

From Staff

After a year of reconnection with the workforce and disconnection with the supply chain, the outlook for 2023 for equipment manufacturers is to bridge the remaining gaps. That includes a greater emphasis on employee recruitment and development and a greater use of technology to help improve operations and efficiency.



Ruslan Harmel/Dreamstime

That's the view of experts from the Milwaukee-based Association of Equipment Manufacturers (AEM) as they took an in-depth look at the industry and their membership heading into the new year.

Two areas at the top of the AEM list were improving organizational culture and communication. "After struggling through the COVID-19 pandemic, people are now re-evaluating their role in the workplace," said Jaime Vos, AEM senior director of revenue development and cultural innovation, in a press release discussing the AEM vision for the coming year. "Many have placed a stronger value on their health and have chosen to accept other opportunities better aligned with their personal well-being. Taking this into account, organizations will need to create a shared vision."

From creating a greater work-life balance and employing better collaboration tools to recognizing the need for improved mental health support, Vos said the need to better engage workers comes at a time of continued uncertainty. "Organizations in many industries, including equipment manufacturing, are being forced to respond by reexamining their business models," Vos said. "Supply chain issues, increased competition, technology advancements and economic uncertainty have all placed pressure on companies to adapt, innovate and rethink how they do business."

Kate Huskin, AEM senior director of communications, noted the need to improve communications is not just a matter of words. "The key to driving change in an organization is rooted in an organization's ability to communicate effectively and build lasting connections with important stakeholders," Huskin said. "In 2023, communications will take on a leading role in helping organizations address challenges, identify opportunities and drive success. Effective communications happens from the inside out, and a renewed focus on internal communications will be needed to help organizations establish and 'walk the talk' of their culture."

That cultural shift will include the recruitment, training and retention of the next generation of workers. Many of them, notes Julie Davis, AEM senior director of workforce and industry initiatives, will bring new skills to the business and others will need to be trained in those new skills.

"Imagine being able to cast an organizational hiring net to consider people based on the skills, talents and interests that would make working in the skilled trades good fit instead of hiring someone based on skills used in a job a person could get as a 20-year-old," Davis said. "This is exactly how skills-based hiring works, and it results in having a wider talent pool from which to recruit. The catch is equipment manufacturers must be able to assess individual skills and then train them to competency. This can be done either by partnering actively with education, possessing trainers or a combination of the two."

Supply Chain, Electric Power Issues

Two specific challenges facing equipment manufacturers are the rapid growth in electric vehicle technology and the related industries and products growing up around it, and the still-shaky supply chain needed to deliver on those technological innovations.

"Diesel fuel is the primary power source for the non-road equipment industry, and it will likely continue to be for the foreseeable future," said Jason Malcore, AEM senior director of safety & product leadership. "However, if one thing's for certain, it's this year will spotlight the many alternative power challenges and opportunities facing the non-road equipment industry and represent an inflection point for new power sources over the coming decade."

That's largely because the environmental and governmental pressures on vehicle manufacturers continue to accelerate. "Governmental agencies and non-governmental organizations throughout Europe and across North America and Asia continue to look for new opportunities to transition their automotive and equipment fleets toward new decarbonized technologies," Malcore said. "These pressures and motivations reveal themselves in the form of new rules and regulations on internal combustion engine emissions and incentive programs for zero-emission equipment purchases. In addition, increasing customer demands for hybrid and zero-emission vehicles also highlight the industry's evolution and direction in this space."

The supply chain issues that roiled manufacturing throughout 2022 showed

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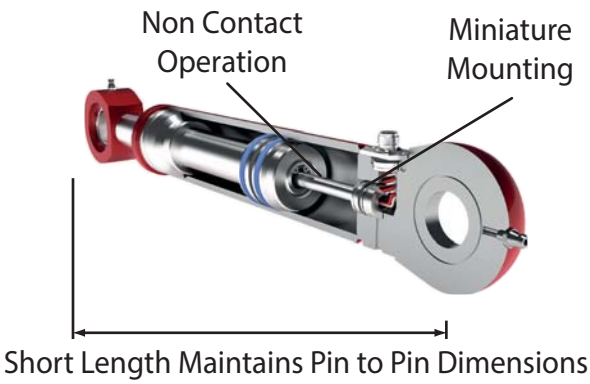

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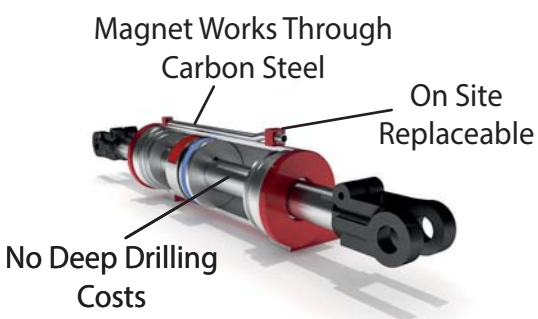

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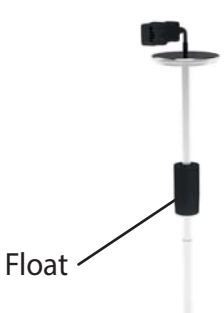

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signs of easing near the end of the year. That doesn't mean there still aren't some storm clouds on the horizon, however.

"There is no denying the 2020 COVID-19 pandemic turned the world on its head, but it was tough to predict just how long the supply chain would be impacted by the pandemic," said Kip Eideberg, AEM senior vice president of government and industry relations. "A recent AEM survey of 179 equipment manufacturers revealed that 98% of equipment manufacturers are still battling with an unreliable supply chain—and over half (58%) are experiencing worsening conditions.

"AEM confirmed that the two driving factors of these supply chain woes stem from workforce shortages and access to intermediate components for production," Eidberg said. "These things coupled together paint a stark picture, but there are reasons to be optimistic that supply chain challenges will start to abate over the course of this year. One thing is certain, equipment manufacturers remain willing to rise to the occasion and adapt." P&M

Helios Technologies Restructuring Hydraulics Segment

The company will consolidate manufacturing for its hydraulics products and create two Regional Operational Centers of Excellence.

by Sara Jensen

Helios Technologies Inc. plans to form two new Regional Operational Centers of Excellence (CoE) for its hydraulics business. To do so, it will consolidate manufacturing at two of its facilities.

The company's Mishawaka, IN, facility—a 72,000 sq. ft. building gained from the acquisition of hydraulic manifold developer Daman Products Co.—is currently undergoing an expansion. Over 50,000 sq. ft. will be added to create the Hydraulic Manifold Solutions CoE.

Helios Technologies

The ENERGEN cartridge valve converts hydraulic flow to electric energy.

At the Indiana facility, Daman products will continue to be manufactured as well as the integrated package business from Faster Inc., another hydraulics brand under the Helios umbrella. The company also plans to house manifold and integreated package assembly operations from the Sun Hydraulics brand at the facility.

Manufacturing for the company's quick release couplings (QRC) will be moved to the current cartridge valve technology location in Sarasota, Fla. This will create the Hydraulic Valve and Coupling Solutions CoE.

In the company's press release announcing its CoE plans, Josef Matosevic, president and chief executive officer of Helios stated:

"The restructuring of our Hydraulics segment in the Americas into two Centers of Excellence is a major step in our journey to leverage our long history in hydraulics with our acquisitions. With this move, we expect to drive greater operational efficiencies, quality control and enable technology enhancements that create advanced hydraulic solutions for our customers. Importantly, we can further our expertise in hydraulics and electronics to exceed the boundaries of today's approach to motion control by expanding our unique pure-play position in the industry.

"We believe that our two new Centers of Excellence, combined with the strength of innovation in our quick release coupling and hydraulic valve operations in Italy, create the platforms that accelerate our drive to being a global leader of electro/hydraulic solutions. We engineer motion control solutions for applications in our targeted markets that require high degrees of precision, reliability, and durability. The integration and consolidation serve to strengthen our 'in the region, for the region' strategy, promote enhanced R&D collaboration, and enable expanded capacity to support our future growth."

Strong Markets, Product Diversification

Helios reported strong financial results throughout 2022 with its revenues up 6% as reported in its third quarter financial results. Hydraulics remains a large part of the company's business, hence investing in its new CoEs, and demand for these products is expected to remain positive.

The company reports industrial machinery, recreational and mobile equipment helped drive sales during the quarter. These markets, key users of hydraulic components, are expected to remain positive; mobile equipment, such as construction machinery, for instance will benefit from the U.S. infrastructure bill which will help drive demand for equipment and the components used in it.

Helios has also worked to diversify its portfolio through its various acquisitions, enabling it to offer a range of hydraulic and electronic components.

Most recently, the company brought together its hydraulics and electronics expertise with the introduction of the Sun Hydraulics ENERGEN cartridge valve. The valve converts hydraulic flow into electric energy, helping to reduce energy loss common with hydraulic components and meet the needs of the growing electrification space.

The company anticipates the relocation of its manufacturing operations to be completed by the third quarter of 2023. P&M

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MAKELAB

Autonomy is a system-level problem bringing together various components which can include hydraulics and pneumatics.
DANFOSS POWER SOLUTIONS

3 KEY TECHNOLOGY TRENDS at IFPE 2023

Technology advancements on display at IFPE will focus on sustainability, automation and digitalization.

by Sara Jensen

Once every three years the fluid power industry comes together alongside the construction industry—one of the largest users of fluid power components, particularly hydraulics—for the International Fluid Power Exposition (IFPE) and CONEXPO-CON/AGG.

The 2023 edition of IFPE will once again highlight the latest hydraulic and pneumatic solutions, as well as technology advancements in motion control and power transmission.

Marica Klein, treasurer at Casappa Corp. and chairperson of IFPE 2023, said in an interview with *Power & Motion* the key themes for IFPE 2023 include:

- sustainability,
- automation,
- digitalization.

These themes are driving many of the technology advancements taking place in the fluid power industry as well as the markets they serve like construction, and several manufacturers will highlight their progress in these development areas during IFPE 2023.

Technology Enables Sustainability

Sustainability can be achieved in many ways, such as reducing fuel consumption, utilizing fewer materials and implementation of new power sources to eliminate emissions. And fluid power components can play an important part in reaching sustainability goals.

Improving the efficiency of fluid power components and systems is one of the many ways the industry is going about doing so. By improving efficiency, overall energy and fuel used by a machine can be reduced which leads to lower fuel costs and emissions.

At IFPE 2023, Danfoss Power Solutions plans to display its Dextreme system for excavators which is based on its Digital Displacement technology. Per Danfoss, the Dextreme system provides a pathway to 50% energy savings by tackling losses in the whole excavator hydraulic system. At the heart of the system is a digitally controlled hydraulic pump which enables more efficient and controlled hydraulic flow, leading to improved system efficiency and faster operator response times.

According to Danfoss, the fast response and digital control of the hydraulic pump allows for an excavator's engine loading to be controlled and thus a significant reduction in fuel consumption without negative impacts to productivity.

Additive manufacturing, also commonly referred to as 3D printing, is bringing opportunities to rethink the design of hydraulic components. Doing so can lead to a reduction in component weight and size, which can reduce overall machine weight to improve fuel consumption.

Crowds flooded IFPE 2020, and the 2023 show is expected to be even larger.
ASSOCIATION OF EQUIPMENT MANUFACTURERS

Valeria Tirelli, president & CEO of Aidro Hydraulics & 3D Printing (a Desktop Metal company), explained in an interview with *Power & Motion* that additive manufacturing enables less

materials and energy to be used than conventional manufacturing methods. It also reduces the amount of tooling necessary for production parts, further benefiting energy reduction.

The ability to create lighter weight parts with additive manufacturing benefits traditional machine designs as well as newer, electric-powered equipment. For electric machines, use of lighter weight components is vital to offsetting the additional weight of batteries.

Electrification Provides Opportunities

The transition to electrification is likely what immediately comes to mind when the term sustainability is mentioned. Although there are examples of hydraulics being replaced in some cases, such as the all-electric compact wheel loader developed by Moog and Komatsu, most of the industry agrees there will remain a need for fluid power components in many applications even as electrification increases.

Exhibitors at IFPE will showcase a range of fluid power products.
S. JENSEN

There is yet to be a technology which can provide the power density of hydraulics, benefiting its ongoing use particularly in larger machines. With the advent of electrification, there are opportunities to improve the efficiency of hydraulic systems.

When Danfoss' Editron division developed a proof-of-concept fully electric wheel loader, it found efficiency gains could be achieved in the hydraulics system. The company was able to do so by rethinking the system architecture and separating some of the machine functions, leading to reduced power consumption and improved efficiency.

The pairing of fluid power and electric components will become more commonplace as electrification progresses. This will be necessary to achieve the efficiency gains desired for electric-powered machines while also helping to improve the performance of fluid power systems.

In a white paper from IFPE organizers, Poclain Hydraulics discussed how there will be a need for intelligent engineering going forward to bring together electric and hydraulic components which will be necessary to optimize performance of electrified machines.

Poclain is currently working on various electro-hydraulic solutions which it intends to show at IFPE 2023. Among these will be the only opportunity in North America to see its electro-hydraulic smart articulated mini loader which utilizes many of the technologies Poclain is developing which combine electric and hydraulic components.

Bosch Rexroth is also developing components for electric machinery and intends to show its eLION electrification platform at IFPE 2023. Developed specifically for heavy-duty off-highway equipment, the platform includes electric motor-generators, inverters and accessories as well as gearboxes, hydraulics and software components. Components within the platform can be scaled as necessary to help OEMs create hybrid- and full-electric machines.

Additive manufacturing presents the opportunity to rethink the design of hydraulic components.
AIDRO HYDRAULICS & 3D PRINTING (A DESKTOP METAL COMPANY)

Like Danfoss and Poclain, Bosch Rexroth is able to bring its hydraulics expertise and knowledge of the heavy equipment industry to the development of products for electric-powered machines. This helps to ensure components and

At CONEXPO 2020, CASE CE introduced its electric backhoe.
S. JENSEN

systems will work well together and machine performance is optimized.

Despite the uptick in recent years in electrified machine launches, the transition to electrification is expected to be a gradual one. Currently there are a few models commercially available but they are mostly compact machines as those are easier to electrify with today's technology. Most OEMs are now working to electrify machines of various sizes, but it will take time to do so.

Automation Brings Technologies Together

With electrification has come the integration of more electronic components in systems and individual components. This is bringing the ability to collect data on performance as well as provide new functionalities such as automation.

Integration of sensors and software is enabling automation of systems and components, including hydraulics and pneumatics. As Peter Bleday, head of autonomy at Danfoss Power Solutions, explained in an interview with *Power & Motion*, many hydraulic components in mobile equipment are now controlled by electronics and software. This enables autonomy to be brought in to control various machine functions—many of which are hydraulically controlled.

Bleday said autonomy is a system-level problem bringing together various components which can include hydraulics and pneumatics. Electrohydraulic, steer-by-wire technology such as Danfoss' EHi steering valves, for instance, will be integral for enabling autonomous driving.

Danfoss understands the impacts autonomy can have on machines and their systems, which is why it is developing components to work with autonomous systems. It has also developed the PLUS+1 Autonomy Solution which brings together hardware and software to help OEMs with their machine automation. It provides manufacturers with software

blocks containing the necessary information to create autonomous and semi-autonomous systems, helping reduce their development time.

Automation can take many forms, from machines capable of working without an operator in the cab to the automation of certain machine movements, such as digging. The latter is the form currently most common in the construction industry. Automating tasks like digging helps to minimize the input necessary from operators, enabling them to focus on other work and be more comfortable.

By automating certain machine functions, the skills necessary to operate an excavator or other piece of equipment can be reduced. This is becoming an increasingly important aspect due to the lack of skilled labor entering the construction and other heavy equipment markets. The easier a piece of equipment is to use, the faster a new—or even seasoned—operator can get working in a safe, productive and efficient manner.

Improved Data and Maintenance Through Digitalization

In tandem with automation, the increased use of sensors and software is enabling digitalization of fluid power systems. The IFPE white paper describes digitalization as the use of digital technologies to enable or improve a process.

Bosch Rexroth's eLION portfolio includes a range of electronic, hydraulic and other components to enable electrification of heavy machinery.
BOSCH REXROTH

For fluid power applications, this can already be seen through increased data collection and analysis. The white paper also notes digitalization as an important part of achieving the full benefits of electrification.

Collecting and analyzing data on component and system performance makes it easier to monitor when a part is starting to wear or fail so machine owners can be more proactive with their maintenance routines.

HydraForce recently partnered with Tan Delta and Elevāt to improve maintenance of hydraulic systems. Tan Delta's oil conditioning sensor will be integrated into manifold assemblies equipped with HydraForce's cartridge valves for continuous monitoring of hydraulic oil conditions. Information will then be analyzed within Elevāt's telematics technology and sent to machine owner's so they can take timely action on any potential maintenance needs.

Communication of maintenance needs from physical parts is possible due to the Internet of Things (IoT) which enables automatic alerts to be sent based on information collected by the sensors, software and processing built into a system.

At IFPE 2023, Casappa is planning to show its smart piston pump featuring the pump, electronic control unit (ECU) and sensors integrated into a single unit. As explained in the IFPE white paper, this design is intended to help enhance digital control of the pump as well as improve efficiency by measuring drain pressure and temperature, speed and load sensing. Performance data collected by the pump's sensors will be analyzed to help optimize hydraulic power management and provide condition monitoring. The data can also be used to aid with predictive maintenance.

All of these trends—electrification, automation and digitalization—will work together to help make systems and overall machines more efficient. Efficiency has become increasingly more important to OEMs and their end customers, and further advancements related to these key IFPE themes will only continue due to the benefits which can be provided for both fluid power manufacturers and their customers. P&M

Find Them at IFPE

If you'll be attending IFPE 2023, be sure to look for the companies and technologies featured in this article in South Hall 3.

- Aidro Hydraulics and 3D Printing: S83343
- Bosch Rexroth: S80215
- Casappa Corp.: S81629
- Danfoss Power Solutions: S80515
- Elevat Inc.: S80058
- HydraForce Inc.: S80207
- Poclain Hydraulics: S80841

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BEYOND IFPE 2023:
Additional Exhibitors to Visit at CONEXPO-CON/AGG

There are several exhibitors outside of the IFPE portion of CONEXPO featuring technology applicable to the fluid power and motion control industries.

by Sara Jensen

While the majority of companies related to the fluid power and motion control sectors will be exhibiting in IFPE, South Hall 3, and the adjoining South Hall 4, several other companies of interest can be found around the Las Vegas Convention Center as well.

OEMs are scattered throughout the show in almost every hall and the outdoor lots, as are many component and system suppliers.

To help make those of potential interest easier to find, we've collected the following list of exhibitors most applicable to the *Power & Motion* audience—including manufacturers and suppliers of batteries, sensors, automation solutions and more which could be incorporated with hydraulic and pneumatic systems.

West Hall

- Schaeffler Group – *W41574*

Diamond Lot

- Lincoln Electric Co. – *D1701*
- Moog Construction – *D2739*
- Vanguard/Briggs & Stratton – *D1033*

North Hall

- Appareo – *N10963*
- ARi – *N10035*
- Autonomous Solutions Inc. – *N10226*
- Brigade Electronics – *N10851*
- Continental AG – *N11251*
- DISTek Integration Inc. – *N10136*
- Mobileye – *N12173*
- Montanhydraulik Group (HYCO NA LLC) – *N11011*
- Sensata – *N11155*
- Timken – *N10015*

Central Hall

- Blue Ascend Hydraulics – *C22328*
- Gorman-Rupp Pumps – *C30016*
- ORTAKLAR HYDRAULICS – *C22229*
- Regal Rexnord – *C32490*

South Hall 1st Level

- Baumer Ltd. – *S61558*
- CrossControl AB/Maximatecc – *S60329*
- Eaton – *S60228*
- Ewellix – *S62629*
- igus – *S62829*
- JW Winco – *S61913*
- Pressure Connections – *S61851*
- SMC Corporation of America – *S61106*

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A range of other technologies and equipment applications can be found in the other halls and lots of CONEXPO.

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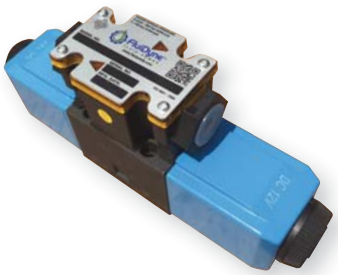

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IFPE 2023 to Shine Light on the Future of Motion Control

Marcia Klein of Casappa Corp. and chairperson for IFPE 2023 discusses highlights attendees can look forward to at the year's largest fluid power and motion control event.

by Sara Jensen

The International Fluid Power Exposition (IFPE) 2023 will be host to an array of technologies from the fluid power, motion control and power transmission industries. Held once every three years, it provides the opportunity to see the latest innovations from these segments alongside the machines into which they can be integrated due to the co-location with CONEXPO-CON/AGG, one of the largest construction industry shows.

The 2023 show is shaping up to be the largest yet, with show organizers reporting it to be 5% larger than the last edition in 2020.


Marcia Klein

There are sure to be a lot of great technologies, equipment and educational opportunities to take advantage of at IFPE 2023. In preparation for the industry's largest event of the year, *Power & Motion* spoke with Marica Klein, Treasurer at Casappa Corp. and chairperson of IFPE 2023, to get a sense of what attendees can expect at the show.

***Power & Motion*: What are some things those attending IFPE can look forward to seeing at the 2023 event?**

Marcia Klein (MK): Advanced technologies and innovation focused on improving the way we use energy. Industry leaders will be showcasing intelligent components and systems, talking about what the future holds in modern motion control.

***P&M*: We know there have been updates to the Las Vegas Convention Center. Are there any new features or exhibits for the IFPE portion of the show?**

MK: Certainly the Las Vegas Convention Center will look different with the brand new West Hall and Diamond Lot, which were under construction in 2020. IFPE will be much easier to reach in 2023 with the addition of the Vegas Loop South Hall Station.

We also want to make sure everyone knows about the Fluid Power Hour Networking Reception on Wednesday night. From 4 to 6 p.m. the IFPE floor will be filled with world class entertainers and will be a perfect opportunity for attendees and IFPE exhibitors to roam the IFPE aisles and mingle with their peers before heading out to functions on Wednesday evening.

***P&M*: How are educational sessions shaping up for 2023? What are some of the themes for the sessions, and how do they demonstrate what is going on in the fluid power/motion control industries?**

MK: IFPE's education program will once again be covering the latest technical topics, trends and challenges we are all facing as we drive toward automation and better use of data analytics. We all expect to see technical sessions, but there are sessions addressing things like cybersecurity and the workforce gap.

***P&M*: What has been most exciting to you during the planning of IFPE 2023?**

MK: The momentum that builds throughout the process, the camaraderie that it affords. Meeting with friends, colleagues and peers who all share the same love of our industry. I have learned so much from everyone.

***P&M*: What would you say are the key themes or technology trends for the 2023 event?**

MK: Sustainability, automation, digitalization. How these trends are impacting the fluid power industry, the benefits they will bring.

***P&M*: What are you most looking forward to seeing or attending at IFPE 2023?**

MK: There is nothing more rewarding than seeing the end result, to watch it come to life. I can't wait to walk the floor on opening day and see everyone back face to face! P&M

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- KOBELCO Construction Machinery USA
- LBX Company

"There's no other show in the world I think that brings the OEM machine manufacturers and the suppliers as close together as this show. It's a good place to meet and learn about what's going on. In the Americas, in the Western Hemisphere, this is the show for fluid power."

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Uptime and Energy Efficiency to Drive Fluid Power Market in 2023

Ongoing technology advancements will enable a reduction in downtime and energy use for hydraulic and pneumatic components.

by Sara Jensen

In 2023, the fluid power industry will continue to advance technologically while working to ensure customers have the products they need for their applications as supply chains are still a factor for many. The International Fluid Power Exposition (IFPE) will provide the opportunity to see these advancements and where the fluid power as well as motion control and power transmission sectors are headed in the future.

Ahead of IFPE 2023, Power & Motion spoke with Alan McCay, CFPS, senior product sales manager – fluid power, Motion and Jim Verona, director of operations, Mi Fluid Power Solutions, about current trends within the fluid power market.

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

This fluid power test stand, built by Mi Fluid Power Solutions, allows users to leverage predictive maintenance via IIoT.
COURTESY OF MOTION

Power & Motion: What are some of the major trends Motion is seeing for hydraulics and pneumatics used in mobile equipment applications?

Alan McCay (AM): Trends are created by customer drivers that can provide product availability and uptime, increased productivity, energy efficiency and predictive maintenance. This is true not only for mobile fluid power but also industrial. Fluid power seeks to provide precise operator control, power management and efficiency to address productivity improvements.

There is also a focus on developing sensor technologies integrated into self-diagnostic systems that can help predict potential problems in a fluid power system. This will prevent damage to the system and allow for scheduled maintenance.

_P&M_: Are there any key features customers are looking for from their fluid power components, and how is Motion helping provide those?

AM: Due to continuing supply chain delays, increased availability of components has been the No. 1 requirement. However, key product features, including reduced weight, increased energy efficiency and lower cost, are all very important considerations.

Providing products equipped with predictive maintenance components to support IIoT (Industrial Internet of Things) technology continues to be a significant factor.

_P&M_: How has Motion seen electrification or other major industry trends impact the design of fluid power components?

Jim Verona: Industrial and mobile applications for fluid power equipment and systems require some type of control. Electrification of these systems continues to evolve into smaller, more energy-efficient, smarter controls. Due to the technology enhancements, these systems are more intelligent in how they are managed and in how they communicate their "health" and performance.

_P&M_: What are some of the technologies the company is interested to see or learn more about at IFPE 2023?

AM: We would like to see new technologies in IIoT and how we can integrate that into serving our customers. Motion's predictive maintenance program lets our customers leverage the manufacturer's technology and software in addition to our own dashboard, enabling the monitoring and tracking of assets. This allows for integration into Motion's supply chain to provide replacement parts if necessary.

_P&M_: Are you able to share what technologies or industry trends will be highlighted at Motion's IFPE booth?

AM: Motion is planning to highlight our engineering, integration and fabrication capabilities at IFPE. This should include the latest in proportional valve products coupled with predictive maintenance technology. We will also show the simple but necessary benefits of fluid power system filtration.

The extended interview can be found at powermotiontech.com/21258615. P&M

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Danfoss Thorx Cam Lobe Motors

Danfoss Power Solutions has launched the Thorx family of cam lobe motors. The motors are designed for use in construction equipment with chain drives, such as skid steers. The first available model is the CLM 8 S motor.

Key features of the cam lobe motors include:

- compact design
- two-speed technology
- 70% shock reduction when shifting speeds
- 5% higher efficiency
- integrated parking brake.

powermotiontech.com/21257881

Bosch Rexroth eLION Electrification Platform

The Bosch Rexroth eLION electrification platform aids the development of electric-powered off-highway equipment. A full range of electric motor-generators, inverters and accessories, as well as tailored gearboxes, hydraulics and software are included in the platform.

Key features of the platform include:

- meets demands of heavy-duty mobile equipment
- available in four different sizes
- scales to meet compact and large machines
- integrated safety technology
- can be used for both travel and work functions.

powermotiontech.com/21245687

Ewellix SmartX Platform for Linear Motion

Ewellix has launched the SmartX digital platform to aid with the development of motion, robotic and automation systems. SmartX will enable the creation of advanced linear motion solutions.

Key features of SmartX include:

- integrated digital control, sensor and communication technologies
- twin CPU controller with onboard software and electronics
- allows integration of range of sensors
- can be used in various applications.

powermotiontech.com/21257895

Hallite 730 Double-Acting Piston Seal

The Hallite 730 double-acting piston seal features a four-part assembly and is designed for use in heavy-duty applications. It is beneficial for use in applications requiring position-holding capabilities.

Key features of the piston seal include:

- face seal comprised of wear-resistant thermoplastic polyester elastomer (TPE)
- suitable for maximum pressures of 700 Bar
- compatible with various fluids, including hydraulic oils and water-based fluids
- contains a pair of rectangular polyacetal anti-extrusion rings.

powermotiontech.com/21258319

J.R. Merritt Controls Merritt Evolve Joystick

J.R. Merritt Controls is adding the Merritt Evolve joystick to its lineup which offers a range of customization options. Featuring a new performance-driven handle design, face plates and other aspects can be customized to meet specific application needs.

Key features of the joystick include:

- spring return handle action in single- or dual-axis operation
- can be supplied with J1939, CANOpen, or a Hall Effect output
- constructed for use in harsh environments
- enables left- or right-hand mounting.

powermotiontech.com/21258566

HED Sunlight Readable Displays

HED Inc. has introduced a new generation of rugged, sunlight readable displays for mobile equipment. The displays are available in 5, 7, 12 and 15 in. sizes and feature an array of interface options.

Key features of the next-generation displays include:

- 1,000 nit IPS display with optically bonded AR lens
- in-cab and external mounting options
- open Linux based operating system for programming tool options
- enables multiple applications and interfaces with different vehicle communications.

powermotiontech.com/21258572

HYDRAFORCE PARTNERS with Tan Delta and Elevāt to Optimize Hydraulic System Maintenance

HydraForce is collaborating with Tan Delta and Elevāt to incorporate sensors and telematics for real-time monitoring of hydraulic systems.

by Sara Jensen

HydraForce is collaborating with Tan Delta and Elevāt, a provider of IoT connected machine applications, to improve maintenance of hydraulic systems in mobile equipment. Elevāt telematics solution will be integrated into hydraulic systems utilizing HydraForce technology, allowing the monitoring of system performance.

In October, the company announced a partnership with Tan Delta Systems—a manufacturer of real-time oil quality monitoring sensors. Through this partnership, Tan Delta's oil conditioning sensor can be integrated into manifold assemblies equipped with HydraForce's cartridge valves. This enables continuous monitoring of hydraulic oil conditions.

Adding Elevāt's technology to the mix will help machine users be more proactive with their maintenance practices. Its telematics solution provides a centralized portal through which hydraulic system information can be collected, analyzed and sent to machine owners and maintenance personnel as necessary. Email and text alerts can be sent, helping to ensure timely action for any hydraulic system maintenance needs.

Elevāt's Machine Connect application is paired with the Tan Delta oil conditioning sensors to provide operators with machine operational data and deliver customized alerts to inform the operator or owner when hydraulic fluids require maintenance. The combination of an electronic controller architecture with telematics provides multiple benefits to users, including real-time data and ongoing alerts of oil conditions. The reported information will prevent excessive wear of hydraulic components and catastrophic failures that can occur when machines are in operation, thus, leading to increased productivity, and reductions in machine downtimes and maintenance costs," said Russ Schneidewind, director of business development, HydraForce, in the press release announcing the new partnership.

"Through accurate monitoring of oil health, maintenance scheduling can also be optimized as equipment is serviced only when required, and operators can rest assured that any unexpected changes in the oil condition will be immediately detected and reported. This can also extend the operational life of equipment and overall machine health, as optimal oil conditions prevent unnecessary wear and tear," explained

Elevāt is partaking in a growing number of partnerships with technology suppliers and OEMs to improve monitoring of machine and component performance and enable predictive maintenance. Most recently it announced a collaboration with Cummins, STW and agricultural equipment manufacturer Versatile (depicted in the image).
ELEVĀT

Chris Greenwood, managing director, Tan Delta Systems.

Power & Motion spoke with Adam Livesay, co-founder, Elevāt, about the partnership and how the technologies can work together to improve maintenance and monitoring of hydraulic systems.

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

***Power & Motion*: How does the Elevāt telematics solution integrate with the HydraForce and Tan Delta technologies?**

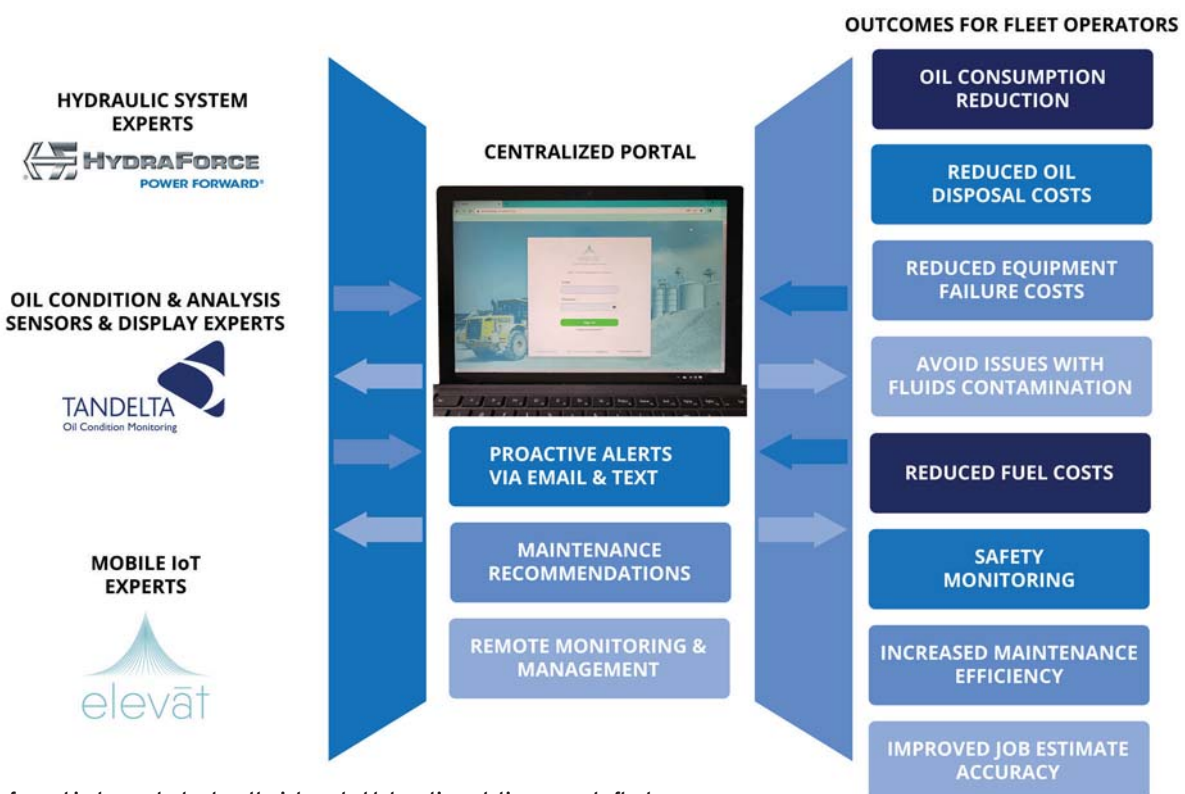
Adam Livesay: We share a lot of the same OEM and channel partners as HydraForce, so we have been working together inside partners and OEMs for a number of years now. We started working with HydraForce on their telematics strategy early this year, late last year. They take a unique approach in which they provide more of their subject matter expertise to their components and the applications their components power. They have a lot of history, data and information to give customers.

Bringing telematics and sensors together into hydraulic systems will help to improve maintenance planning. ELEVĀT

The Internet of Things (IoT) accelerates that because now they can share what they as a supplier know about the way their components are operating with the OEM or channel partner and ultimately the end-user. Five years ago, that was not really the case with fluid power suppliers. That was kept internal. We've seen this change with our [various] partnerships.

I think we both have the same vision that companies are going to partner together to provide value and information to the OEM, and ultimately the end user, to drive better machines, maintenance outcomes, you name it.

HydraForce has a unique partnership with Tan Delta [to use its] oil condition monitoring sensor. In fluid power, oil



The infographic demonstrates how the integrated telematics solution supports fleet managers in remotely monitoring and managing field-deployed mobile assets. ELEVĀT

condition monitoring is always one of the pinnacles for preventative and predictive maintenance. One of the major barriers to entry is the cost. [Previously HydraForce] was not able to get accurate and repeatable information packaged in a sensor solution like Tan Delta offers. Tan Delta's sensor is the first I've seen that meets a commercial price point as well as [level of] accuracy [beneficial to the market].

We are really excited about this because we've been asked as an IoT company how we can get information about the oil in the hydraulic system, information about the health of the oil in gearboxes, all these different things on a machine but in a cost-effective way. And Tan Delta seems to be the answer.

By bringing these three partnerships together, where HydraForce works really closely with Tan Delta, they work closely with us, we work closely with the OEMs and HydraForce, we [can say] here's another piece of the puzzle, another piece of this ecosystem has been created of companies that are providing the next generation IoT solutions to their customer.

***P&M:* Can you talk about how bringing all of these technologies together will help with remote diagnostics and predictive maintenance?**

AL: There are [several] sensors on a piece of machinery…[those for the] hydraulics are all connected through a HydraForce gateway. The gateway connects to Elevāt.

One of those sensors is this Tan Delta oil quality sensor. It can give a read on current hydraulic oil condition and temperature. It will [provide this information] and the rate that those things are changing over time. This gives the fleet owner or machine operator immediate visibility into the current state of the oil within the hydraulic system. They can take immediate action if the oil condition starts to deteriorate because that is a major leading indicator of wear and component failure.

Two of the major use cases here are going to be reducing unplanned downtime and managing part and repair schedules for machines which is a big deal right now because of allocation of parts and service costs going up.

Oil quality is probably the most important thing to determine the health of a hydraulic system. Right now if a machine goes down, a service company goes to [inspect it] and brings big, bulky oil monitoring and filtration systems to determine the health of the oil and diagnose the problem. Now that can be done remotely [with the HydraForce, Tan Delta and Elevāt technology].

***P&M:* And the telematics system is analyzing the information?**

AL: Yes. The first step in the process is data collection. We have implemented best-in-class sensors from Tan Delta and software, which is the Elevāt portion,

along with the HydraForce gateways. We are capturing machine data across all assets.

Next, we would provide data visualization. Customers will see their equipment health and the performance impact across all of their equipment that has these sensors on it. Step three is automating alerts. Based on the data coming off that sensor, we can implement known thresholds or performance and send that information to the right people in a fleet's organization.

The final step, the cool part with Tan Delta, is we have the predictive intelligence. When we see rates of change in that hydraulic oil condition and temperature, we can start making predictions on the degradation of that component or machine.

***P&M:* Was there anything special done on the design side of things to make sure the technologies from HydraForce, Tan Delta and Elevāt work together?**

AL: The three companies have all been working closely together for this past year. What we have been doing is deploying the Elevāt software on HydraForce gateways and hardware. Tan Delta has their own internal software and data sets we have integrated into. Therefore, we can get the sensor flowing seamlessly—from the machine to the sensor to the gateway to the Elevāt cloud.

Once that data is there [in the cloud], we can read that information and use the proprietary Tan Delta database, datasets and algorithms to perform predictive maintenance and automate alerts to customers. There is collaboration from all three of us to get tight integration into an ecosystem which provides results to the end customer.

***P&M:* Do you see partnerships like this, and the integration of telematics and IoT into fluid power systems, becoming more prevalent for mobile equipment?**

AL: I see it [has] accelerated for sure. We have a number of other partnerships we are working through right now around component manufacturers, sensor companies, and traditional fluid power component manufacturers.

A couple of years ago, one company would try to provide the entire solution. That has shifted. Now the power is in the OEM's hands and suppliers are figuring out how to build ecosystem partnerships so the OEM ultimately has the highest value of [technologies] coming together. And they are not forced into one type of product.

This is a [situation where] the sum of the parts are greater than the one company. We are excited about it because we always believed this was going to be the case; sometimes you are going to be the solution, other times a puzzle piece of the solution. And it seems the market has really shifted that way. **P&M**

NEW IOWA STATE
Dynamometer Lab to Benefit Heavy Equipment Development

The Off-Highway Vehicle Chassis Dynamometer Laboratory enables testing and validation to be conducted on various heavy-duty machines.

by Sara Jensen

Iowa State University recently completed building an Off-Highway Vehicle Chassis Dynamometer Laboratory (Dyno Lab) at its BioCentury Research Farm located between Ames and Boone, Iowa. The facility allows for controlled, dynamic testing of heavy-duty mobile equipment such as construction and agricultural machinery.

Danfoss Power Solutions donated $1.8 million for the building of the Dyno Lab as well as provided technical support for its development. The company has a facility in Ames, which includes one of its three Application Development Centers (ADC), and has partnered with the university on a variety of projects over the past 45 years.

By supporting this project, Danfoss is helping not only with the training of future engineers but also gaining an additional testing resource as the Dyno Lab will be available for use by manufacturers of various types.

A ribbon cutting ceremony was held Nov. 17, 2022 for the new Dyno Lab, marking its availability for use by the university and industry partners.

A ribbon cutting ceremony for the new dynamometer laboratory was attended by officials from Danfoss and Iowa State University.
DANFOSS POWER SOLUTIONS

A State-of-the-Art Test Lab

The new Dyno Lab is administered by Iowa State University's Department of Agricultural and Biosystems Engineering (ISU ABE). It features a state-of-the-art dynamometer capable of testing the power control and transmission systems of large machinery, and is the only one of its kind at a public institution in the U.S.

Off-highway equipment featuring tracks or tires can be tested on the dynamometer. Vehicles can be tested up to 450 kW (600 hp) per corner at speeds of up to 80 km/h (50 mph), enabling a range of small to large size machinery to be evaluated. Independent monitoring and loading of the traction system at each vehicle corner is possible, benefiting a variety of testing projects.

Tests which can be conducted at the Dyno Lab include:

- Drawbar power
- Dynamic braking
- Hill cresting
- Fuel-to-wheel energy efficiency and more.

With the various tests possible, Iowa State and industry partners can better evaluate overall performance and efficiency of a vehicle as well as component and control system interactions. Use of the dynamometer will enable the collection of accurate, repeatable data which may not be possible with outdoor testing.

"We are excited to see how the new dynamometer fosters breakthroughs in off-highway vehicle technology," said Jeff Herrin, senior vice president of research and development, Danfoss Power Solutions, in the company's press release announcing the completion of the Dyno Lab. "Comprehensive testing can reduce design cycles and speed up research and development, enabling us and our customers to implement industry-leading solutions at a faster rate."

The new dynamometer at Iowa State is capable of testing wheeled or tracked machines ranging from 50-600 hp.
DANFOSS POWER SOLUTIONS

More Data Brings Better Performance Evaluation

Machines ranging from 50-600 hp can be tested at the new Dyno Lab. The dynamometer is designed so that each of the four corners of a vehicle can be independently controlled and tested. One corner could be in a motoring state while another in absorption, allowing for a range of testing and data to be gained.

This is achieved through the use of four independently controlled regenerative AC dynamometers. The dynamometers can absorb power from vehicles during the testing process and put it back onto the electrical grid. Or during a motoring state energy can be put back into the vehicle system through the wheels, helping to reduce overall energy use throughout the testing process.

A PTO and a hydraulics dynamometer are available at the lab as well, providing further testing capabilities.

Brian Steward, professor, Department of Agricultural and Biosystems Engineering at Iowa State, said in an interview with *Power & Motion* at the ribbon cutting for the Dyno Lab that the dynamometer was built to be flexible. Six large rollers enable testing of tracked machines while wheeled equipment can be lowered and cradled in the well of the dynamometer. The dynamometer can be adjusted to accommodate wheelbases from 60-170 in.

The dynamometer has been up and running for about a month (at the time of publishing) and Steward said five different machine types have been tested on it so far and it has proven to be a highly capable piece of testing equipment.

Steward said it is exciting to see the amount of data that can be collected. "For those of us who are researchers, once you have data, then you can think of all sorts of possibilities of what you can do," he said. "We couldn't collect that data in this sort of control environment before."

During initial tests, university researchers found they could test machinery to its maximum capacity. With the amount of testing and data possible at the new lab, researchers and industry partners can start to get a better understanding of what is happening to an entire machine, not just the components within it. This will enable the ability to understand how certain performance issues may arise and how to fix them or how to go about further improving efficiency.

"We face a situation where the efficiency of these [heavy equipment] platforms is very important," said Steward. "There are so many innovations happening right now that provide opportunities for testing. And we're right at the center of that."

Danfoss Power Solutions

The Value of Testing Accessibility

Having the new Dyno Lab at Iowa State helps to put the university at the forefront of agricultural machinery innovation, said Steward. Agriculture is an important industry for feeding the global population, and like other industries trends such as electrification and automation are bringing about technological changes to the equipment used in this industry. Having the ability to conduct various tests on an array of agricultural and other heavy machinery will help to advance these machines and the work they do.

A range of construction, agricultural and other heavy-duty machinery can be tested on the new dynamometer.
S. JENSEN

Dave Wohlsdorf, senior director, sales and innovation operations at Danfoss Power Solutions said during the ribbon cutting ceremony that it was an easy decision for the company to support the creation of the Dyno Lab. He noted Danfoss intends to use the facility to complement the field testing it does at its ADC in Ames.

In addition to the tests possible with the dynamometer, Wohlsdorf said Danfoss expects "testing will include some unique tests such as independent loading and monitoring of

Dave Wohlsdorf, senior director, sales and innovation operations at Danfoss Power Solutions, said the company is excited not only to utilize the new dynamometer but also for the hands-on training it will provide engineering students.
S. JENSEN

Brian Steward, professor, Department of Agricultural and Biosystems Engineering at Iowa State, said the range of data that can be collected with the new dynamometer will provide a range of possibilities.
S. JENSEN

each wheel on a vehicle. This will allow us to fully understand the overall vehicle performance…and will help us reduce the time required to design and develop new solutions, which in turn enables Danfoss and our customers to design better performing vehicles and get them to market faster."

Besides aiding industry, and possibly most importantly, the new laboratory facility will benefit the engineering students at Iowa State by providing them testing and validation skills which may be necessary for their future employment.

"All of us at Danfoss are excited about the possibilities this new laboratory provides to educate future engineers," said Wohlsdorf. Danfoss hires many students from Iowa State as interns each year, and has several alum working at the company. The new laboratory will equip students with even more hands-on experience they can bring to their future careers.

"We look forward to continuing to work closely together [with Iowa State] to expand utilization of this laboratory to many equipment manufacturers… from all across North America. And together we'll utilize this capability to foster innovation in off-highway vehicle technology," concluded Wohlsdorf. **P&M**

Electrohydraulics

Benefit Tool Leveling for Telehandlers

New Holland Agriculture's Electro-Hydraulic Self Leveling Tool Carrier system utilizes sensors to provide more precise movement and leveling of machine attachments.

by Sara Jensen

In an effort to help improve telehandler operation, New Holland Agriculture has developed an Electro-Hydraulic Self Leveling Tool Carrier system. Moving from the traditional mechanical system which has become industry standard to an electrohydraulic alternative provides the opportunity to improve attachment leveling and reduce operator input, among other benefits.

This was achieved through the incorporation of angle sensors and communication with onboard electronics, enabling more precise movement and leveling of attachments.

Sensors at the front and rear of the telehandler boom provide real-time information on its position as it is raised and lowered.
NEW HOLLAND AGRICULTURE

A Transition from Purely Mechanical Systems

Traditionally, telehandlers equipped with attachments such as buckets or forks utilize a system based on hydraulic compensation to keep the tool parallel to the ground when lifting or lowering the machine's boom. As the boom moves, oil flows from a compensation cylinder to a tilt cylinder to maintain the attachment's position.

Mark Howell, New Holland global product manager, alternative fuels & telehandlers, said in an interview with *Power & Motion* that this is an industry standard method employed since telehandlers entered the market. However, it was developed when everything was mechanical which is not the case today.

Like many machines, New Holland's telehandlers now feature more electronics. For instance, electrohydraulic valves are used for controlling telehandler attachments and electronic joysticks have become the norm in operator cabs. And the company continues to look for ways to further improve its machine designs.

"We've been asking for more advanced features for the vehicle and having a mechanical compensation valve limits some of the ideas that we had," said Howell.

To achieve these advanced features, it was determined there could be benefits to removing the telehandler's compensation cylinder. Instead, two angle sensors are attached to the boom to aid with attachment leveling:

- one at the rear to monitor boom angle relative to the machine
- one at the front, on the tool carrier, to monitor its angle in relation to the boom.

Incorporation of the sensors enables real-time position information of the boom to be determined as it is raised and lowered. This information is provided to the telehandler's ECU (electronic control unit) where software uses it to calculate the hydraulic flow needed to maintain a level position of the attachment.

Incorporation of electrohydraulic valves and sensors benefit ease of use as well as future automation and other technology developments.
NEW HOLLAND AGRICULTURE

Electronics Aid Ease of Use

With the telehandler's onboard electronics, attachments can be kept at a level position without much effort from an operator. "What would happen normally is the driver would be lifting the boom and then, without being conscious about it, gently nudge the joystick to maintain the level [of the attachment]," said Howell.

Removing the need for operators to level the attachment themselves allows them to stay better focused on the work in front of them while also improving their comfort.

This capability is particularly beneficial for operators who may use different types of attachments. Howell explained the industry standard for telehandlers is the use of fork tines (also referred to as pallet forks); therefore, most come out of the factory equipped and tuned for this type of attachment.

The Electro-Hydraulic Self Levelling Tool Carrier system for telehandlers improves leveling accuracy for attachments.
NEW HOLLAND AGRICULTURE

Traditional machines equipped with a compensation cylinder will have that cylinder set to meet the needs of a fork tines attachment. But if another type of tool is attached, such as a bucket, the cylinder may actually overcompensate and cause undesired movements which could cause dirt or other materials being moved to be lost.

In these situations, telehandler operators are having to adjust the joystick to keep the tool level instead of concentrating on more important aspects of the job such as moving or positioning the machine or monitoring what is happening around them. While there is not a huge complaint from the market about this, Howell said it is a hassle.

However, with New Holland's electrohydraulic system, the onboard electronics can ensure the appropriate oil flow and leveling necessary for the tool without operator interaction. No matter the type of tool or its manufacturer, the system is able to compensate appropriately because of the electronic components used. "All [the system] knows is the headstock position at the point of lifting is maintained automatically, and all the customer then does is just pull backwards [on the joystick], lift the boom and the electronics take over," said Howell.

He added the most clever aspect of the system is not necessarily the components or design itself but the fact that New Holland decided it was not happy with the norm and wanted to make its machine better as well as the daily use of it easier for customers.

Making equipment easier to use is becoming increasingly important in agriculture and other off-highway industries in which telehandlers are utilized to help with the lack of skilled labor entering the market. The easier a machine is to use, the faster it is to learn how to properly operate it and do so in a productive manner. Ease of use can also benefit those who have been operating for a long period of time by making it more comfortable which also leads to improved productivity and general employee satisfaction.

Enabling Future Technology

Howell said a key driver for the development of the Electro-Hydraulic Self Leveling Tool Carrier system was determining how to take today's telehandler design forward into the future. "We've got a good machine. It's quite an advanced machine," he said. "But how do we take a path to the future?"

As such, the company is continually looking at the longer-term possibilities as well as technology from other areas of the New Holland business, such as the construction equipment side.

For instance, return to dig functionality available on some New Holland Construction machines is a concept which could be applied to telehandlers equipped with the electrohydraulic leveling system. "What you can do with this technology is it now knows where the boom is, at any point in time. [An operator] can then press a button and the boom returns to angle X and the headstock to angle X," said Howell.

Movement of the telehandler's boom and attachment can be preset, enabling operators to simply press a button to maneuver them as needed—lifting or dropping the boom, leveling the attachment. This again eases use and allows operators to focus on correctly positioning the machine and moving material where it is needed.

The use of an electronics-based system also enables machine information to be fed into the telehandler's telematics system. This enables New Holland to better understand how the machine is being used and how to provide any necessary support to customers.

Use of sensors, software and other onboard electronics keep attachments at a level position without much effort from an operator.
NEW HOLLAND AGRICULTURE

"Where we can digitize actions, we can respond and do something about it," said Howell. This applies to both collection of performance data as well as enabling more flexibility for other technologies and power systems to be utilized as they become available.

Continued efforts to ease use of machinery will help drive increased use of electrohydraulics. While aiding the workforce shortage in agriculture and other similar industries, Howell said it is more about ensuring productivity throughout the workday. Having more automation—possible through incorporation of more electronics—ensures machine operators are as efficient at 7 a.m. as they are at 7 p.m.

"[We're] just trying to make people's lives easier. And electrohydraulics allow us to use algorithms and software that simplify some repetitive tasks which are essential for the running of a business," concluded Howell. **P&M**

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Moog and Komatsu
Develop All-Electric Wheel Loader

Replacing hydraulics with Moog's intelligent machine electrification system enabled an all-electric design and efficiency gains.

by Sara Jensen

Replacing hydraulic components with electric versions provides improved control and efficiency.
MOOG INC.

Moog Inc. recently partnered with construction and mining machinery OEM Komatsu on the development of a fully electric compact wheel loader.

Electrification of the wheel loader is possible through the use of Moog's intelligent machine electrification system, which contains many of the electronic components necessary for full-electric operation.

For this project, the companies worked closely together said David Grabau, key account manager at Moog Construction, a division of Moog Inc., in an interview with *Power & Motion*. "Our goal working with Komatsu is to de-risk their development journey," he said. "We have a very close relationship with our customers and take a system approach. We know that all of our subcomponents work together as a complete system and that allows us to quickly enable a fully electric vehicle."

He said Moog strives to become an extension of its customers' engineering and development teams. This

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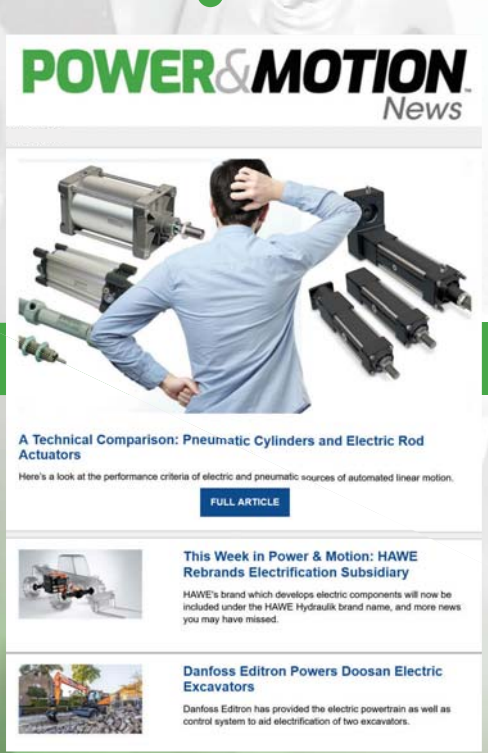

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Moog's intelligent machine electrification system enables a high level of efficiency and controllability.
MOOG INC.

benefitted the overall design as well as the ability to quickly modify Komatsu's wheel loader to accommodate the batteries and electric actuators required for full-electric operation.

Also aiding the speed of development is the fact Moog provides a full system which is designed to the latest standards of safety interlocks between the components. "Therefore, each component is verifying its interconnectivity and allows for quick and safe integration in the field," said Grabau.

Electronics Replace Hydraulics

To enable full-electric operation of the Komatsu wheel loader, Moog provided the following components as part of its intelligent machine electrification system:

- electric traction motor,
- electric cylinders for lift, tilt and steering,
- all power electronics,
- system controller computer, also called the ECVM, and
- battery and battery management system (BMS).

According to Grabau, the ECVM is the brains of the system. It contains all system communications, including IoT (Internet of Things) modems as well as power distribution. The latter distributes the bus voltage power from the battery to the rest of the components in the system.

What helps make the wheel loader fully electric is the fact there are no hydraulics on it. Similar to the Doosan Bobcat T7X electric compact track loader—which Moog helped develop and was introduced in early 2022—the Komatsu machine only contains a small volume of eco-friendly coolant said Grabau.

In place of hydraulic components are high-torque servo motors for both traction and driving of the ball screws on each of the axes. In the case of the

> "We know that all of our subcomponents work together as a complete system... enabling a fully electric vehicle."

Komatsu machine, the traditional hydrostatic transmission that would normally be found on a wheel loader of this size was removed said Grabau. The servo motor used for traction is used instead to provide smooth forward and reverse operation as well as regenerative braking.

Benefits of Going All Electric

Moog's intelligent machine electrification system enables a high level of efficiency and controllability, said Grabau. "That allows you to get more runtime or a reduced battery pack size," he said. "And the higher level of controllability enables future advanced user controls or full autonomy. So, it's basically autonomous ready."

This capability is achieved through the type of actuation used in the machine and being able to close the loop to have a more controllable actuator than a traditional hydraulic ram, he explained. Similarly with the wheel loader's traction drive, control of its forward and reverse motion can be done more accurately.

In terms of efficiency, the all-electric system is in the upper 80% range said Grabau, whereas the efficiency of a diesel-hydraulic system is typically 30-40%. Traditional hydraulic systems may also have significant losses in the 40-60% range but an electric alternative is under 20%.

> "The higher level of controllability enables future advanced user controls or full autonomy."

Improving efficiency benefits end-use customers' total cost of ownership which is vital for construction and other applications in which the wheel loader would be used. This piece of equipment is used for business purposes in most cases and being able to lower operational expenses can be very beneficial to a customer.

Showing this capability can also help the uptake of electric-powered machines—that they're more than just a trend but can also provide actual performance benefits. This is a key goal for Moog and Komatsu, who will be conducting joint testing of the wheel loader.

"Moog is working closely with Komatsu to understand the machine capabilities and performance," said Grabau. "And the goal is to meet or exceed the diesel-hydraulic equivalent of the machine."

Komatsu and Moog will be testing the electric wheel loader over the coming months, as well as highlighting the technologies involved at future trade shows. **P&M**

Learn more about Moog's work with Doosan Bobcat on the T7X Electric Compact Track Loader at powermotiontech.com/21216218.

GFCI-PROTECTED CIRCUITS:
Don't Get Tripped up by VFDs

The growth of single-phase applications create new opportunities and challenges for OEMs.

by Ian Miller

The proliferation of affordable and readily available semiconductors in the industrial space has enabled many innovations, making things easier for manufacturers overall. This is particularly true with the introduction of variable frequency drives (VFDs). Historically, you were stuck with a fixed speed on a prime mover or limited to using non-efficient, cost-prohibitive devices. The advent of VFDs has allowed for an easy, efficient, low-maintenance and cost-effective means for controlling that speed. This added level of control of the prime mover has made equipment operation more efficient and improved automation.

VFD use continues to grow in the OEM space for small and mobile equipment, which needs to be plugged into a single-phase outlet or in a commercial setting where three-phase power is less accessible. Examples include mobile pumping units, hose crimpers, lifts, actuator-driven devices, fans/blowers or any application where a motor is the prime mover and varying that motor's speed would improve that equipment's operation. Aside from the benefits of variable speed control, this increased use is driven by VFDs' ability to use a single-phase power source while outputting a three-phase, current-controlled supply to the motor.

These may seem like small features at face value, but they hold much value, particularly for small-batch production. Outputting three-phase power means

This mobile filter cart uses a VFD to allow for a larger motor and variable flow, which is important for water removal.
COURTESY MOTION

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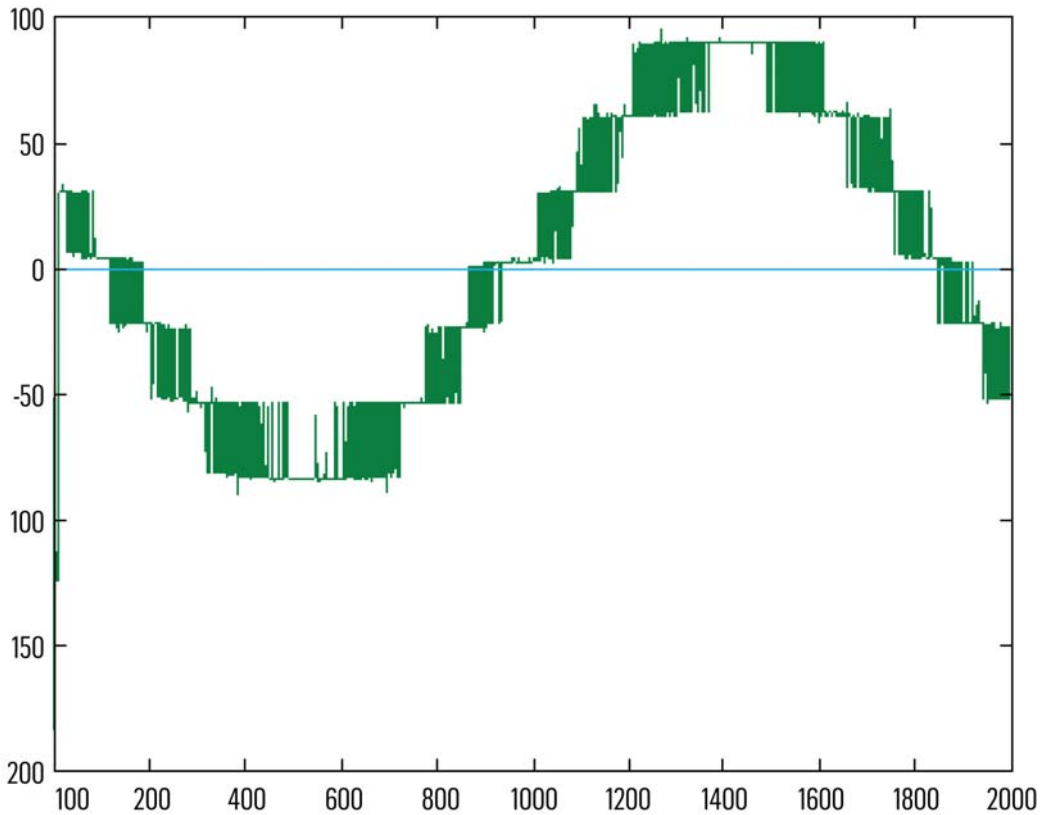

Unfiltered output from seven-level sine wave inverter (single phase).
COURTESY MOTION

that standard three-phase induction motors can be used. These motors are both cost-effective and widely available. Control of the current can allow for many features that aid in the controllability of the motor, but it also allows you to avoid the inrush current that typically comes when starting an induction motor.

In context, when sourcing from a standard duplex 120V 15A receptacle, you would typically cap the motor size at 3/4-hp to avoid nuisance tripping. When using a VFD, a 1.5-hp motor can be used in the exact application sourcing from the same plug. Doubling the available power of your prime mover in a situation like this can have obvious benefits for the functionality or capacity of a piece of equipment.

Together, these benefits make VFDs an ideal way to control motors on small OEM equipment. This has also been recognized by VFD manufacturers, who have started adding features such as expanded IO (additional/configurable inputs and outputs) and basic logic control. Some go as far as integrating CODESYS-based and motion control programming platforms directly into the VFD. These additions mean that many VFDs are an ideal platform for controlling the motor speed and operating the equipment, eliminating the need for an additional onboard microcontroller.

Understand the Limitations

Despite the many benefits, there are also a few limitations to using a VFD in such an application. One of the most common problems OEMs face is using such equipment on a ground fault circuit interrupter (GFCI) breaker or receptacle. A GFCI is a device that prevents users from being electrocuted. It works by monitoring current flowing through the ground conductor.

When a critical threshold is identified, the device assumes that an operator is possibly being shocked, and the circuit is interrupted to protect the potential victim. Because they are so commonly used in the market and VFDs are known to trip GFCIs, this can be a large issue for OEMs.

The reason that VFDs commonly trip GFCIs has to do with VFD construction and how it mimics an AC wave. A VFD can best be thought of in three parts. The first is the front end, which consists of a rectifier circuit. This takes incoming power and rectifies it from AC to DC. After the rectifier comes the DC bus, which feeds the final stage of a VFD: the inverter. This last part uses power from the DC bus to emulate a three-phase AC waveform that will power the motor. The issue that leads to VFDs tripping GFCIs is most closely associated with this inverter stage. This is because of the high-frequency harmonics caused

by the solid-state switches that can lead to ground currents, also known as "common-mode noise."

To understand common-mode noise, you need insight into how VFDs imitate a three-phase AC waveform. First, the frequency of the mimicked waveform is not what develops the noise. Rather, the problem is the switching frequency (also known as the carrier frequency) used to develop the waveform.

In a typical (grid-supplied) three-phase sine wave, you will always have a zero-sum after adding up all three potentials at any given point along all three waveforms. This is because each wave is 120 deg. out of sync. The concept can best be pictured as a circle divided into three equal sections (like a pie with three large slices) with a mark placed at the circumference where each region interfaces. If you centered that circle on a set of Cartesian coordinates with the center set at zero, the top of the circle at 1 and the bottom at –1, the same would be true.

As you spin that circle, you will find that the sum of all three points will always equal zero at any time. This is analogous to what you would see when charting three-phase power; likewise, this happens as you turn a three-phase generator in real time. The common-mode noise issue comes into effect as the waveforms generated by an inverter do not sum to zero in this same manner.

These waveforms do not sum to zero because most inverters use a multilevel chopper circuit to mimic or approximate the waveform. Because of this rough method, the difference between the actual waveforms as charted in real-time will not sum to zero. This leads to a difference of potential at any given instance and will lead to capacitive induced currents. These currents will seek a path to ground, which can trip a GFCI device.

Minimize the Impact

There are several ways to minimize the impact of common-mode noise. The first is to lower the carrier frequency.

> The advent of VFDs has allowed for an easy, efficient means...for controlling [motor] speed.

These frequencies typically range from 1 to 13 kHz and are programmable through the VFD's parameter set. The lower the frequency, the smaller currents will be.

Next, you should keep the cable run from the motor to the VFD as short as possible and, if needed, use shielded cable. Long leads introduce more capacitance into the circuit, making things worse. You can also consult with your VFD manufacturer; some are introducing output chokes and low-leakage filters, which will make for superior VFDs in this application.

If the VFD is equipped with a standard filter (not the low-leakage type), consider removing it. Most VFDs will have a switch or screw that can be moved or removed to isolate the filter from the circuit, which can also help. Finally, evaluate your control mode. Most drives have an option to perform an auto-tune on startup or measure the stator resistance. These activities can lead to a trip, so select an option that avoids adding such complications. An option such as "fixed boost" will often help prevent these issues.

Understanding the factors that lead to GFCI nuisance tripping will help you avoid the problem. It is often not a matter of following just one of the above recommendations; sometimes you need to find the right combination for your application and the specific VFD used.

This article was written and contributed by Ian Miller, P.Eng. national services business development manager for Motion. Based out of Calgary, he has more than a decade's worth of hydraulic and electrical experience in the field, including system design, troubleshooting, on-site installations and technical training/support. P&M

Demand for O-Rings to Remain Strong

Corey Holloway of anyseals provides insight into the current market conditions for O-rings.

by Sara Jensen

SHUTTERSTOCK/1056765536

Seals are an important part of many systems as they help to reduce or eliminate leaks. They can come in many forms, with O-rings being a common type used in a wide range of industries.

O-rings are typically round and available in a range of thicknesses and materials to meet various application requirements. anyseals inc., a supplier of sealing technology, has seen strong growth in recent years for its O-ring products.

Primary factors for determining O-ring material choices include chemical and temperature compatibility, sealing pressure and cost.
ANYSEALS INC.

Power & Motion spoke with Corey Holloway, Sales Manager North America for anyseals, inc., about drivers for this market growth, where the O-ring segment is headed and more.

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

Power & Motion: What is driving the strong demand anyseals is seeing for O-rings? Are there specific applications or markets which are helping drive demand?

Corey Holloway: anyseals has continued to invest in its product inventory, so we stock seals that are in strong demand and otherwise unavailable due to global supply chain constraints. In Ohio, we have millions of seals in stock in both metric and standard sizes. This allows our distributor customers to remain competitive. One of the products helping drive demand is our FFKM O-ring offering, which is applied within the semiconductor market.

P&M: How does anyseals see demand continuing for O-rings, and will the same market factors continue to drive demand in the future?

CH: anyseals sees steady demand for O-rings, primarily attributed to the growth of their use across several industries. For example, from 2022-2028, the FFKM O-ring semiconductor market is projected to grow significantly

P&M: What are some of the key attributes/benefits anyseals' O-rings can provide?

CH: All anyseals suppliers and production plants are certified to ISO (ISO 9001:2015 and IATF 16949). anyseals' high-quality standards also stipulate additional quality inspections in our laboratory. All products and materials can be clearly identified and traced through their batch and material number.

P&M: What are some of the key materials customers are looking to have their O-rings made from, and what factors are determining these material choices?

CH: The materials depend on the customer's application. While customers with high-end applications like those found in the semiconductor market look to FFKM, the NBR, HNBR, and EPDM materials may be suitable for others. anyseals offers a wide range of materials for both standard applications and for very specific challenges.

The primary factors determining O-ring material choices are chemical and temperature compatibility, sealing pressure, durometer, size, and cost. Additionally, electrical properties, dynamic resistance, tear resistance, and ozone resistance should be considered depending on the application.

P&M: Are there any markets where the company sees future growth potential for O-rings?

CH: Several markets are expected to grow due to various factors, including the robust growth of the aerospace and automotive industries, the use of advanced materials in manufacturing O-ring seals for critical applications, technological advancements, and strict regulations concerning automobile emissions.

P&M: We know supply chains have been a challenge area for many companies over the past two years–how has anyseals been impacted, and is the company starting to see any alleviation or expect to see any?

CH: We experienced some of the same material and compound shortages that affected global supply chains over the past 2 years. We also saw production times longer than 12 months on certain sizes.

There are still several challenges to overcome as suppliers continue to adapt to new regulations and work through ongoing supply chain issues. At anyseals, we inform our customers that all quoted or confirmed delivery times are estimates based on our understanding of the conditions at the time. All products continue to be subject to unforeseen delays due to continued market challenges. P&M

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