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IFPE & CONEXPO 2023:

Fluid Power & Electronic Motion Control Trends in Mobile Equipment

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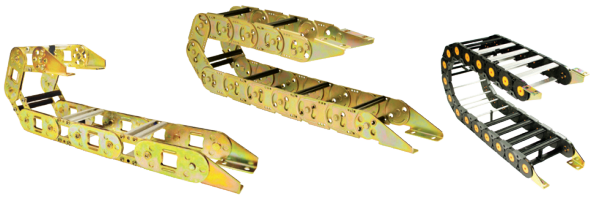

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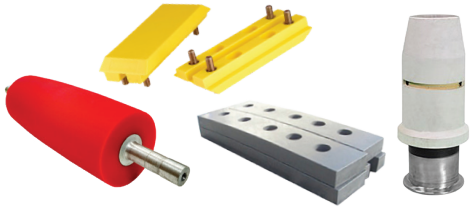

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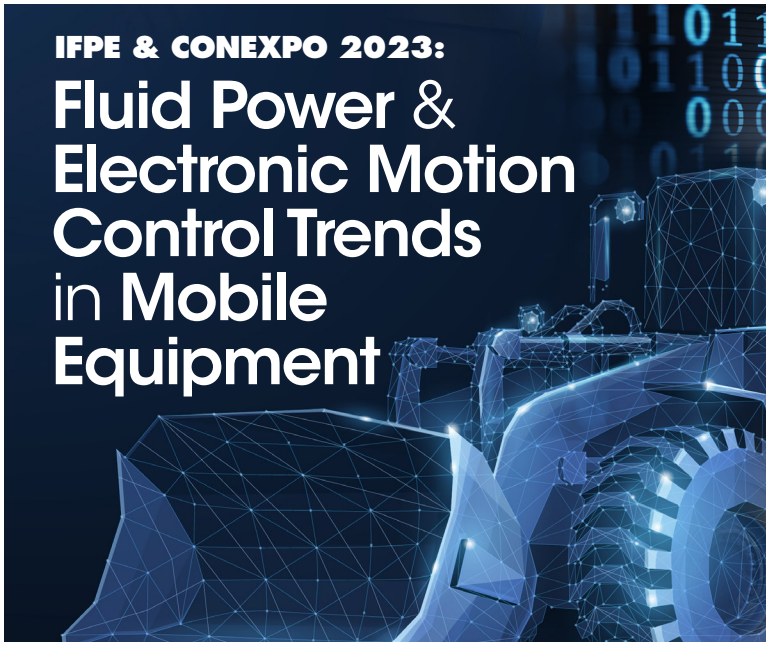

CONTINUED ADVANCEMENTS IN FLUID POWER AND ELECTRONICS

Sara Jensen,
Technical Editor,
Power & Motion

The 2023 edition of the International Fluid Power Exposition (IFPE) and co-located CONEXPO-CON/AGG demonstrated the many advancements taking place in the fluid power and motion control sectors, and how these are benefiting construction equipment designs.

Construction equipment is a key market for fluid power, particularly hydraulics, and many of the trends taking place in this segment are also impacting other sectors served by fluid power and electric motion control.

In this eBook you'll find details on key technologies and trends highlighted at IFPE & CONEXPO and how they are being utilized in the construction and other mobile equipment markets.

CONTENTS

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image credit: Sara Jensen

CHAPTER 1:

IFPE 2023 Demonstrates Push Toward More Efficient, Digital Fluid Power Industry

SARA JENSEN, Technical Editor, *Power & Motion*

The hydraulics and pneumatics industry showcased the innovation taking place which will aid with the growing trends toward electrification, automation and digitalization.

The 2023 edition of the International Fluid Power Exposition (IFPE) and co-located CONEXPO-CON/AGG can best be described as having an atmosphere of excitement around it. After the 2020 show, which ended a day early and had several exhibitors pull out due to the onset of the COVID-19 pandemic, it was clear attendees and exhibitors alike were ready to be back together to discuss the latest technologies and trends.

The Association of Equipment Manufacturers (AEM) which manages CONEXPO & IFPE, the latter in conjunction with the National Fluid Power Association (NFPA), reports the 2023 show broke records. During the show's run March 14-18 over 139,000 attendees from 133 countries visited the Las Vegas Convention Center. Over 2,400 exhibitors from 36 countries showcased their latest construction equipment, fluid power components, and other related technologies and services over the show's massive 3 million square feet (10.5% larger than 2020).

According to AEM, these figures helped make the 2023 edition the largest trade show in North America. And from my very sore feet at the end of the week, and the many other events I've attended over the years, I can confirm this CONEXPO & IFPE was the largest I've attended yet.

"IFPE also broke the record for the size of the show, with the greatest total square feet of exhibit space ever recorded, and the highest number of NFPA members among its exhibitors," said Eric Lanke, President and CEO of the NFPA, in the association's press release announcing show figures. "The buzz on the show floor was intoxicating, with high quality attendees there to see the latest electrified and connected fluid power products."

Crowds filled the indoor and outdoor areas of CONEXPO & IFPE, making the 2023 show the largest to date.
image credit: CONEXPO-CON/AGG

"The success of CONEXPO-CON/AGG & IFPE 2023 is a testament to the resilience and strength of the construction and fluid power industries, which has continued to adapt and innovate despite the challenges of the past 3 years," said Marcia Klein, Treasurer of Casappa Corp., and show chair of IFPE, in AEM's post-show press release. "We're proud to have provided a platform for industry professionals from around the world to connect, learn, and discover new solutions for improving their businesses and the world we build."

From the many conversations I had throughout the show, one particular comment stands out which best sums up the direction the fluid power industry is headed, and could also apply to the construction and other sectors represented at CONEXPO & IFPE — for hydraulics to survive, they need to be smarter, more efficient and provide better control.

This comment was made during a discussion with Damien Fetis, President of Fetis Group, a design and system integrator specializing in engines, transmissions, hydraulics and electronics. Fetis' statement also encapsulates some of the key themes of IFPE 2023 which included increasing use of sensors and software to improve precision and control, as well as data collection, and efforts to improve efficiency due in large part to the push toward electrification.

The Push Toward Electrification and Digitalization

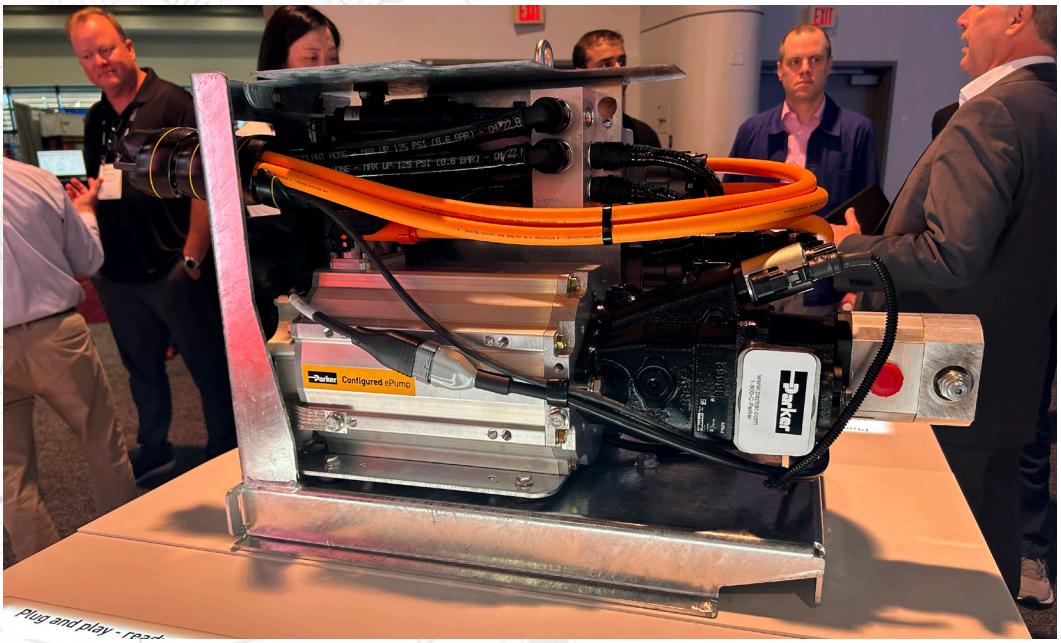
While traversing what accumulated to several miles (I have the Fitbit stats to prove it) of the CONEXPO & IFPE show floors, there was a lot of great technology and conversations with those in the industry to take in. Although our team couldn't see everything, as much as we tried, it was evident that OEMs and component suppliers alike have spent that last 3 years making great strides in technology advancements.

The construction and fluid power industries are not typically thought of as being innovative,

CASE Construction Equipment was one of several OEMs which debuted new battery-electric machines, demonstrating the continued growth of electrification in the construction industry. image credit: Sara Jensen

but as those in these segments know, nothing could be further from the truth especially in recent years as electrification, automation and other major trends have entered the markets. IFPE in particular showcased the impact these trends is having on hydraulic and pneumatic designs. Though we've covered them before, I wasn't quite prepared for how strong the impacts now are on the industry.

Among Parker Hannifin's electrification products was its ePTO which provides an electrified power source capable of powering machine hydraulics. image credit: Sara Jensen



Electrification was probably the most evident trend at IFPE and CONEXPO. Several fluid power manufacturers exhibited solutions to aid with electrification efforts while many OEMs unveiled new battery-electric machines, including concepts and those ready to enter the marketplace. At the last show I could probably count on one hand the number of manufacturers exhibiting electrification related products but this time around it was too many to count, demonstrating the rapid growth and desire for more sustainable options.

Like bauma, held in October 2022, CONEXPO & IFPE 2023 was likely a turning point for electrification in the construction and fluid power industries.

Component suppliers like Danfoss, Bosch Rexroth, Parker Hannifin, Poclain Hydraulics and many others exhibited the electric powertrain solutions they've developed, such as electric motors, inverters and controls. By developing these technologies themselves, they can not only ensure their continued relevance as the construction and other heavy equipment industries move to electrification but also use their hydraulics expertise to ensure all systems will work together as required. Hydraulics will still be necessary in many cases, but changes will be needed to guarantee they continue to provide the desired performance in electric machines.

On the subject of necessary design changes, this was another area in which several manufacturers demonstrated their technological development efforts. Efficiency improvements in particular are a key focus for many hydraulic component manufacturers. Providing more efficient operation will be key not only for electric vehicles but the construction equipment industry in general as OEMs and their customers are becoming more concerned about overall machine efficiency to help reduce fuel use and emissions.

Also evident during my time at the show was the growing integration of sensors, software and other digital technologies. With this move toward more digitalization, an array of benefits can be achieved such as improved system monitoring and maintenance. For the latter, there is a greater emphasis being applied to oil condition monitoring and the ability to help end use customers become more proactive about their maintenance practices due to the amount of data which can be collected, analyzed and sent to maintenance personnel.

Proactive maintenance has been a topic of discussion over the several years I have now been covering the heavy equipment and component engineering field, but now feels like it is actually becoming viable due to the technology advancements taking place and ability to integrate digital solutions into so many parts of a machine, such as the hydraulic and

Sun Hydraulics, a Helios Technologies brand, showcased its eSense hydraulic cylinder equipped with pressure sensors to help improve balance and stability as well as reduce energy use.
image credit: Sara Jensen

A range of hydraulic and pneumatic technologies were on display at IFPE 2023.
image credit: IFPE 2023

pneumatic systems.

IFPE and CONEXPO 2023 were too filled with advanced technologies and trends to properly cover in-depth in a single piece of content —don't worry, there will be a lot more coming in the following weeks — but if there was one key takeaway from this year's event it would be the fluid power industry, and the heavy equipment and other markets it serves, is in a period of innovation which will bring about changes to the performance, maintenance and capabilities of hydraulic and pneumatic systems.

That said, I can't wait to see what's in store for the next IFPE and CONEXPO currently set to take place March 3-7, 2026.

We want to hear from you!

Did you attend IFPE & CONEXPO 2023? If so, what were your favorite things to see at the show? What further technology developments do you see on the horizon for the fluid power industry? What do you think will be the top trends at IFPE 2026?

Let us know! Email me at editor@pmtmag.com or reach out to us on social media.

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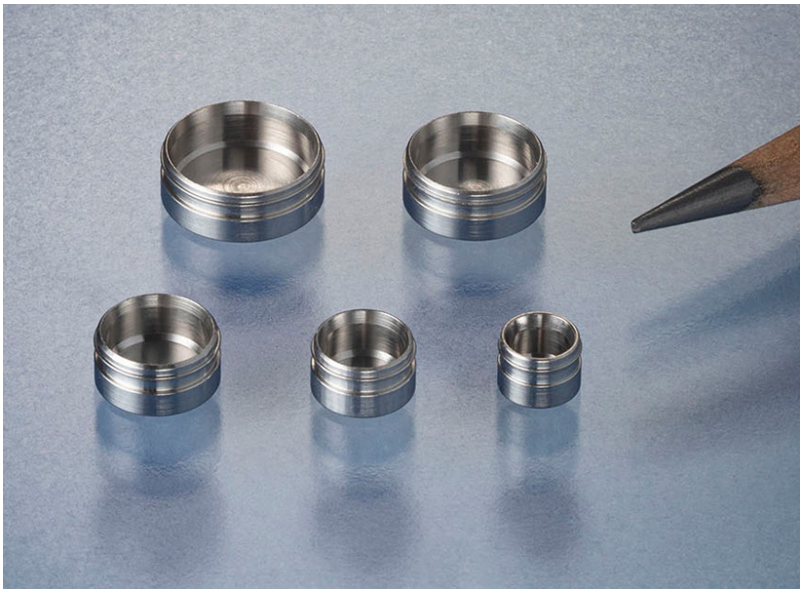
THE LEE COMPANY



The Lee Company is excited to introduce the new DL Series Plug, the latest addition to our plug product lines. The DL Series Plug is a single-piece, stainless steel plug engineered to provide leak-tight performance in aluminum housings without the use of threads, sealants, or O-rings. The DL Series Plug utilizes new Drive Locking™ technology to reliably seal passages for life. This new locking end includes an Installation Indicator™ feature that allows customers to visually verify that the DL Series Plug was properly installed. The Installation Indicator feature provides additional information for critical assembly processes and enables manufacturers to automate both the installation and the verification process. Overall, the DL Series Plug helps our customers to reduce scrap and labor costs while improving reliability. Thanks to its compact size, competitive price point, and easy-to-automate installation process, the DL Series Plug meets the demands of the automotive, industrial, and medical industries. The shallow body of the plug provides several benefits for designers, including saved space, reduced manifold size and weight, and minimized dead volume. The DL Series Plug is rated for pressures up to 69 bar (1000 psi) in aluminum manifolds and designed to perform exceptionally well under adverse conditions. The DL Series Plug is ideally suited for high volume applications where performance, quality, and reliability are critical to success.

Product Specs/Features:

- Reliable performance
  - Rated for pressures up to 69 bar (1000 psi) in aluminum
- One-piece assembly
  - Facilitates reliable automated or manual installation
  - Installation Indicator feature enables visual verification of proper installation
- Drive Locking technology creates a permanent seal without threads, sealants, or O-rings

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image credit: Bosch Rexroth

CHAPTER 2:

3 Key Technology Trends at IFPE 2023

SARA JENSEN, Technical Editor, *Power & Motion*

Advancements in hydraulics and pneumatics shown at IFPE demonstrated an increasing focus on sustainability, automation and digitalization in the fluid power industry.

Once every 3 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 once again highlighted 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.

See what companies exhibited at CONEXPO which can aid with these trends including sensor and battery suppliers.

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

The IFPE show floor was filled with attendees looking to learn more about the latest fluid power, motion control and power transmission technologies.
image credit: IFPE 2023

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 displayed its Dextreme system for excavators; at the heart of the system is the company's Digital Displacement pump (DDP). In place of a standard hydraulic pump is the DDP and a digital pump controller. Leif Bruhn, head of Digital Displacement at Danfoss Power Solutions said in an interview with *Power & Motion* that this configuration enables up to a 15% fuel savings as well as increases in productivity.

Digital control of the DDP enables more efficient and controlled hydraulic flow which leads to improved system efficiency and faster operator response times. The faster response times and digital control also allows for an excavator's engine loading to be controlled and thus a significant reduction in fuel consumption without negative impacts to productivity, increasing overall efficiency of an excavator.

The Dextreme system is currently undergoing field trials in England where it will be used in three Volvo excavators. Three versions of the system will be available for customers as well with varying system architectures; each version will provide additional gains in energy efficiency. Danfoss predicts its system will improve excavator efficiency 15-50%, regardless of the machine's power source.

Additive manufacturing, 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.

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

Aidro's new pneumatic valve was designed for additive manufacturing, providing OEM customers with a compact and lightweight component.
image credit: Sara Jensen

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.

Aidro displayed several fluid power components it has developed using additive manufacturing at IFPE, including a new pneumatic valve for use in explosion-proof environments. Use of additive manufacturing enables the valve to be lightweight and compact, easing integration into a range of machines.

The company is also expanding into use of binder jet 3D printing which will enable higher volume production of hydraulic and pneumatic components.

Also benefiting sustainability initiatives is the development of products from more sustainable materials. This is a key area of development for Hallite Seals; at IFPE the company introduced three new sealing products, all of which can be made from recycled materials. Investments in the company's manufacturing capabilities is also helping to improve the sustainability of its products.

WATCH our video interview with Hallite to learn more about its efforts to provide more sustainable solutions to the fluid power market.

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.

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.

Watch our video interview with Kimmo Rauma, vice president of Danfoss Editron, to learn more about the electric wheel loader project.

At CONEXPO, CASE was among the OEMs to unveil new electric-powered construction equipment. Pictured is the company's new CL36EV electrified compact wheel loader.

At CONEXPO, CASE was among the OEMs to unveil new electric-powered construction equipment. Pictured is the company's new CL36EV electrified compact wheel loader.

image credit: CASE Construction Equipment

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.

At IFPE, Helios Technologies displayed its recently introduced ENERGEN cartridge valve which converts hydraulic flow into electric energy. During a discussion with *Power & Motion* at the show, the company said the valve is sort of like regenerative braking for fluid power applications because it enables the conversion of what would be otherwise wasted energy into useful energy.

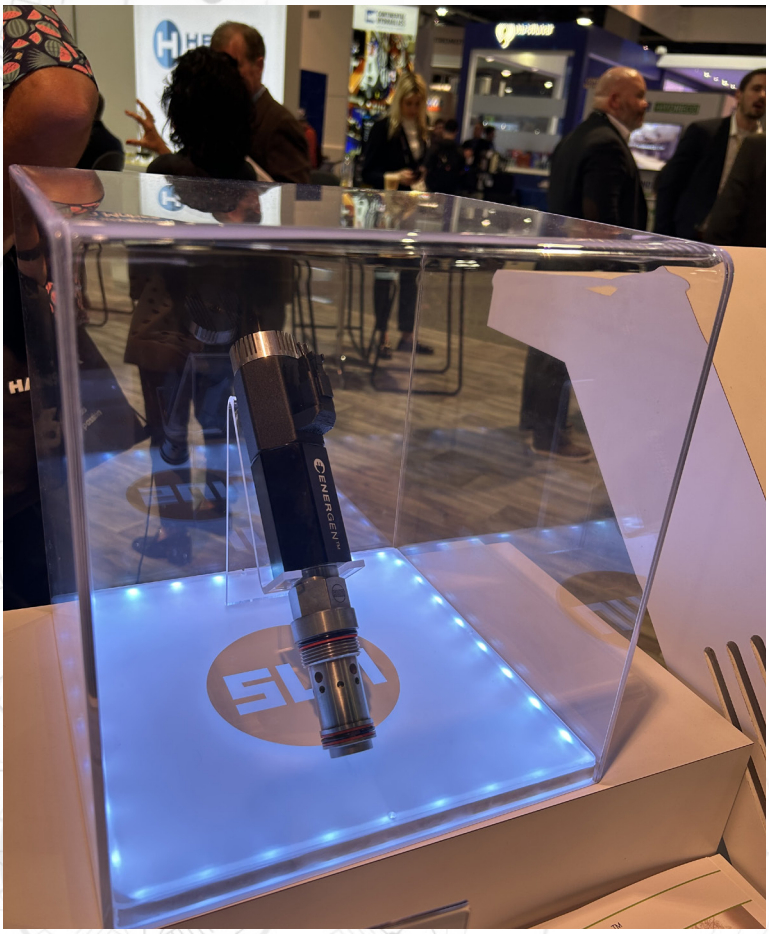


image credit: Sara Jensen

Several OEMs, particularly those for attachments — which tend to be hydraulically driven — have already expressed interest in the technology the company noted due in part to the growing trend toward electrification.

Bosch Rexroth is one of several fluid power manufacturers which has expanded into the realm of electrification with its eLION platform. 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.

The company announced at IFPE the addition of a single-phase onboard charger to the eLION platform, enabling use with charging infrastructure in North America.

By developing components for electrified machines themselves, companies like Bosch Rexroth are able to bring their hydraulics expertise and knowledge of the heavy equipment industry. This helps to ensure components and systems will work well together and machine performance is optimized.

The growth of electrification in the construction equipment industry was evident throughout CONEXPO with several OEMs launching new electric-powered machines at the show. Compact machines remain the most common as they are still easier to electrify, but there are efforts to bring electrification to larger machines as well. Volvo Construction Equipment, for instance, showed its electric mid-range excavator, currently undergoing testing in Europe, which it plans to bring to market in 2024.

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 which it displayed at IFPE. 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.

Several companies, including Husco and Helios Technologies, noted during IFPE the growth of electrohydraulics in recent years due in part to rise in automation. Because elec-

Autonomy is a system-level problem bringing together various components which can include hydraulics and pneumatics. image credit: Danfoss Power Solutions

tronics are built into electrohydraulic components, it is easier to integrate them with other electronic components such as those used for autonomous systems.

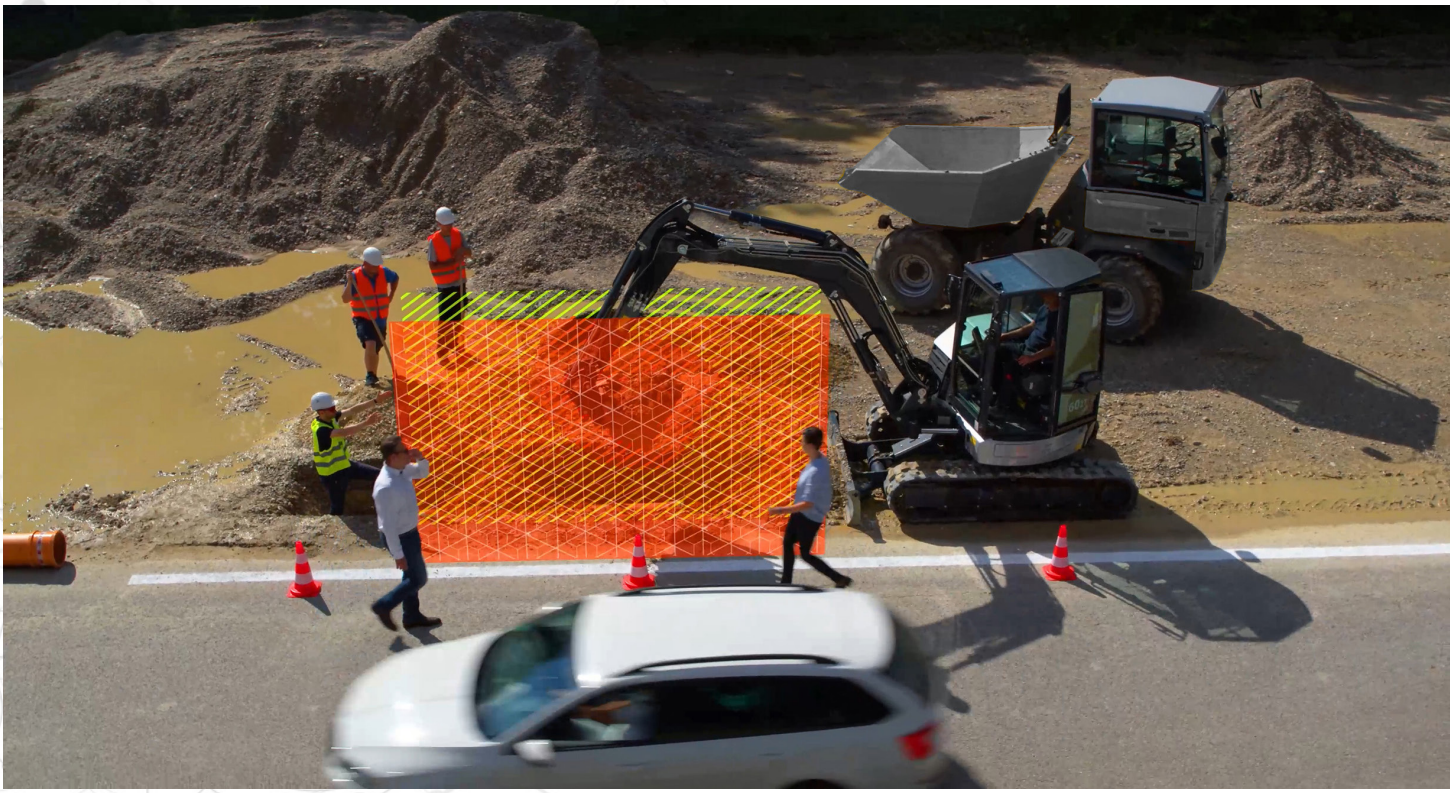
Automation can take many forms, from machines capable of working without an operator in the cab to the automation of certain machine movements, such as digging. The latter is the form currently most common in the construction industry. Automating tasks like digging help to minimize the input necessary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

Bosch Rexroth also showcased its technology to aid automation at IFPE which includes integrated technology capable of providing assistance functions for various types of machines. Sensors and software work together with hydraulics to provide driver assistance functions as well as virtual walls — essentially a set barrier which machines cannot move past — and emergency braking capabilities.

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. Digitalization is described as the use of digital technologies to



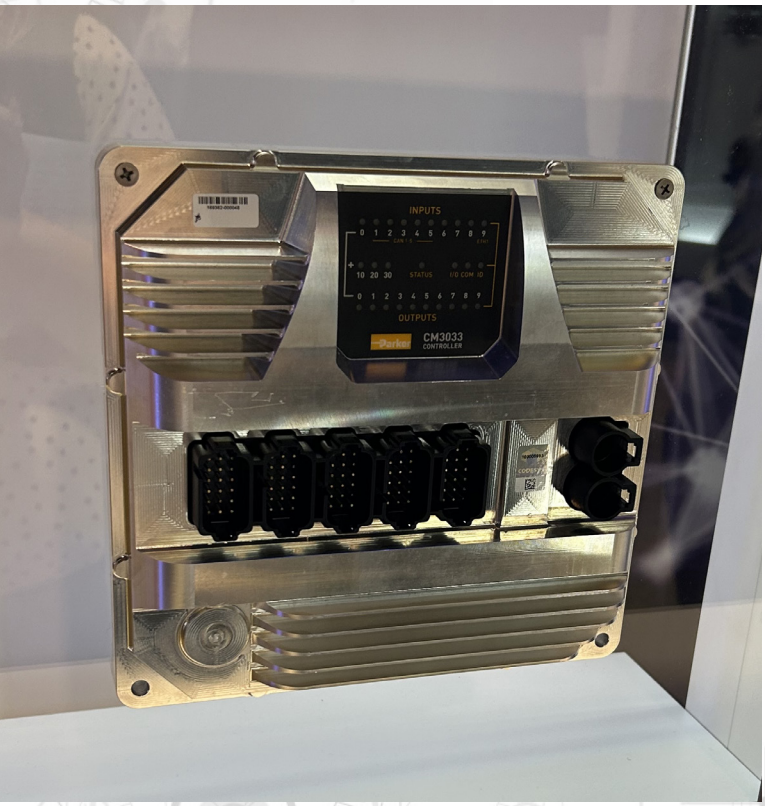
Integration of sensors and software with hydraulics is enabling various automation capabilities like Bosch Rexroth's Easy Grade which creates virtual walls to keep machine movements within a designated space.

image credit: Bosch Rexroth

enable or improve a process. For fluid power applications, this can already be seen through increased data collection and analysis.

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.

At IFPE 2023, Casappa showed its smart piston pump featuring the pump, electronic control unit (ECU) and sensors integrated into a single unit. As explained in the previously mentioned 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.



Parker Hannifin's IQAN controller is part of its portfolio of products to aid with implementation of IoT.

image credit: Sara Jensen

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 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, it was indicated during several conversations that oil condition monitoring and interest in IoT have increased immensely since the last show just 3 years ago. With these technologies, enabled in part by the increasing integration of sensors and software, machine owners can better monitor the performance of their machines. Doing so enables them to be more proactive with maintenance, preventing unplanned downtime which can be costly.

Digitalization will work together with electrification and automation to help make systems and overall machines more efficient. Efficiency has become increasingly more important to OEMs and their end-use 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.

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CHAPTER 3:

Software Brings Efficiency Gains and Ease of Use

SARA JENSEN, Technical Editor, *Power & Motion*

Use of software is on the rise to ease development of fluid power and electric motion control solutions for construction equipment as well as increase efficiency of these systems.

Software is playing an increasingly more important role in the development of hydraulic, pneumatic, and electric motion control systems. As evidenced at the International Fluid Power Exposition (IFPE) 2023, it is being used to not only ease the design process for heavy equipment manufacturers but also bring performance enhancements to fluid power and electronic systems.

The role and benefits of software are varied, which is aiding with the continued advancement of construction equipment and their motion control systems.

Performance Enhancements Achieved

Software can play a valuable role in enabling new functionalities and connectivity between systems. Algorithms built into the software can be used to improve the control of components, such as hydraulic valves, which can lead to efficiency gains, an increasingly important factor for OEMs and their customers.

Increased efficiency is a key benefit of Bosch Rexroth's eOC (electronic Open Circuit) hydraulic architecture which consists of software and hydraulic components. According to the company, moving control functions for components from the hydromechanical controller to software improves control and flexibility for productivity and efficiency gains.

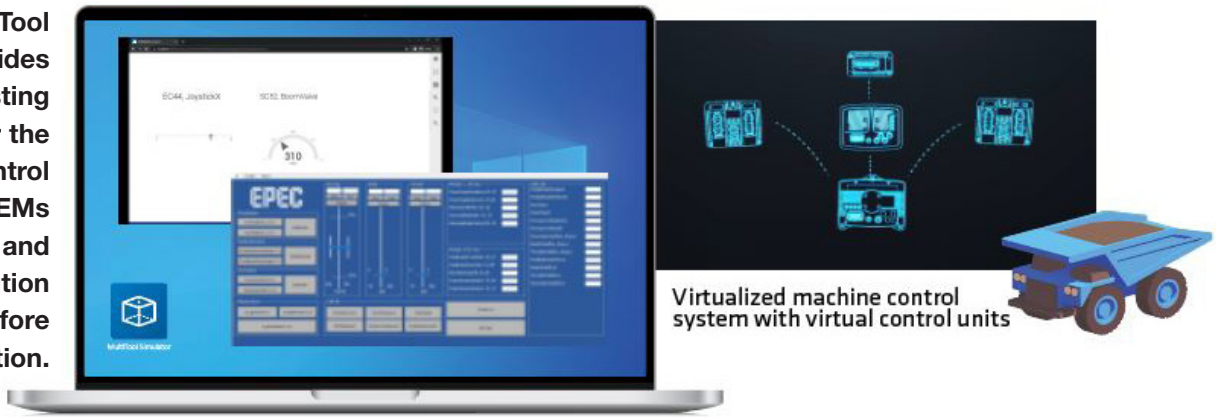
The eOC software allows control parameters to be set during operation. Control modes can also be changed individually and combined during operation, allowing for adaptability to working conditions. Aspects such as pressure, torque and flow can be controlled independently of one another as well. Predefined parameters are built into the software to ensure hydraulic components work in an optimal manner as part of the entire hydraulic system, regardless of the functions they are performing. This ensures efficient operation at all times.

Auto-calibration is now possible with the eOC software on a machine. Calibration of the

component is done cyclically during machine operation instead of on the OEM's production line. Specific calibration data is recorded by the eOC software each time the machine is started, and additional data is recorded when machine operating conditions allow. This enables up-to-date data on aging effects or temperature to be collected, among others, and operating parameters to be automatically adjusted as necessary, keeping the hydraulic system and machine working in an optimal manner.

Bosch Rexroth's digital myBODAS platform allows OEMs to download validated software packages from its BODAS software portfolio to test and adapt them to suit their own requirements as a means of helping improve the design process for construction equipment manufacturers. image credit: Bosch Rexroth

Bosch Rexroth's eOC architecture uses software to improve the control, and thus efficiency, of hydraulic components. image credit: Bosch Rexroth



Epec's MultiTool Simulator provides a virtual testing environment for the company's control systems, enabling OEMs to quickly test and validate the right solution for their machines before implementation.
image credit: Epec Oy

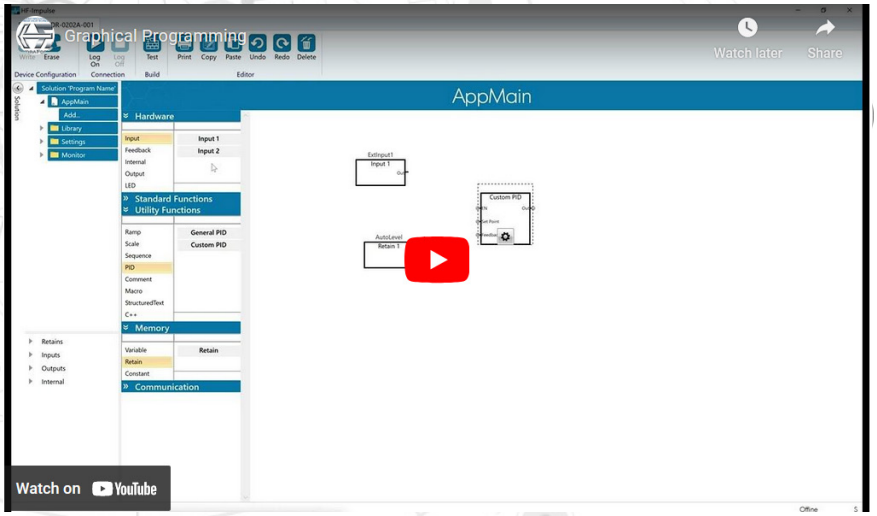
Software to Aid Configuration and Programming

Given the number of components and systems in today's machines, it can be difficult for heavy equipment manufacturers to have the expertise in-house required to integrate them. As such, several fluid power and electronics suppliers have developed software tools to ease development for OEM customers.

Epec Oy – a system supplier which is part of Ponsse Group – for instance introduced its Epec MultiTool Simulator (MTS) at IFPE. MTS provides a virtual testing environment in which OEMs can evaluate various Epec control systems before implementing them in a machine. Virtual versions of the control system hardware allow heavy equipment manufacturers to develop and test numerous iterations as well as automate tests. This helps to speed up the development process because design iterations can be quickly tested and the appropriate solution found, reducing rework or the need for physical testing.

HydraForce has also introduced software to aid with the programming and configuration of its electronic controllers, HF-Impulse 2.0. The software features easy-to-use diagram configurations, a C++ Editor and Structured Text (ST) Editor.

HF-Impulse was originally developed as the hydraulics industry began to transition to the use of electronic controls said Russ Schneidewind, OEM Sales Manager at HydraForce, in an interview with *Power & Motion* (see article pg. 28.) The software was designed to simplify the programming of these controls which were new to many in the industry.



This is achieved through use of function block diagram programming in which all necessary features for traditional hydraulic systems are provided in modular function blocks. The function blocks contain inputs and outputs that are then connected to create the hydraulic system's program logic. Users can easily drag and drop the function blocks to create their system diagram, and the software continuously evaluates the design to ensure accuracy.

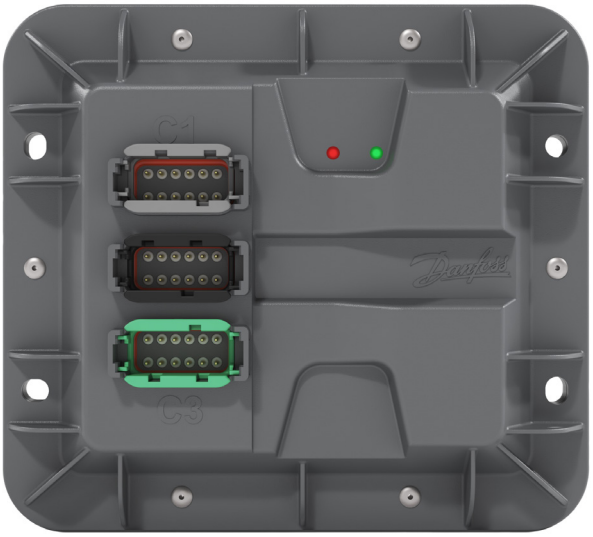
Use of electronic controls has become more common for hydraulic systems. As such, HydraForce updated HF-Impulse to now include more in-depth and customizable programming capabilities, while retaining the easier diagram

programming to serve both beginners and more experienced developers.

At IFPE, Danfoss Power Solutions introduced its PC-GO propel solution for single pump/motor hydrostatic transmissions. It is designed to be a ready-to-use platform which easily plugs into machines of all types to provide control for the transmission's pump and motor.

The platform is comprised of the newly developed PC036 safety controller and PC-GO propel software. With this software OEMs can easily configure the propel system to their application requirements; multiple adjustable drive modes are included, aiding with machine configuration.

According to Danfoss, the software can reduce system development time up to 35% for OEMs. This is because all necessary intelligence is already built into the software which is housed on the controller. Essentially, all an OEM has to do is pick the features it wants to incorporate into its propel system and the controller will dictate those to the pump and motor.



The PC036 safety controller houses the PC-GO propel software which provides easy integration of hydrostatic pumps and motors for OEMs. image credit: Danfoss Power Solutions

With software like this, an OEM does not have to spend hours developing the necessary software code but can instead focus on what it is good at – developing a valuable piece of equipment for its customers.

"PC-GO's validated software package and preconfigured parameters enable machine startup in less than 3 days. Comparatively speaking, it could easily take 2 years to write a program like this from scratch," said Aaron Rodriguez, product application engineer, Danfoss Power Solutions, in the company's press release introducing PC-GO.

Beyond efficiency improvements and design, software can aid with a number of other aspects as well including diagnosis of potential issues, providing integrated safety as well as being a key component of automated systems. It was evident at IFPE 2023 the use of software in fluid power and electric motion control systems is on the rise, and this is likely to continue further as the industry looks to continue advancing its capabilities.

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image credit: Komatsu

CHAPTER 4:

Construction Equipment Digs Deeper into Electrification

SARA JENSEN, Technical Editor, *Power & Motion*

Advancements in fluid power, motion control and other technologies are aiding the rise of electrified construction equipment.

The construction equipment industry's continued push toward electrification was evident throughout CONEXPO-CON/AGG and co-located International Fluid Power Exposition (IFPE). While development of electric-powered machines and the necessary components has increased in recent years, the 2023 show demonstrated just how far technology has advanced since the last show 3 years prior.

OEMs and component manufacturers alike exhibited electrification related products, with many debuting new solutions at the show. Volvo Construction Equipment (Volvo CE), for instance, announced prior to CONEXPO & IFPE its plan to debut two new electric machines, a short swing radius mini excavator and conventional swing small excavator. It also exhibited its first electrified mid-range excavator, demonstrating the company's growing lineup of electric-powered machines.

Volvo CE currently offers five electrified machines commercially and will make the two new smaller machines available in 2023. The mid-range excavator is planned to be available in 2024.

While smaller machines are currently the more feasible use case for electrification, the applications and machine sizes in which it can be deployed is increasing.

A Shift Toward Larger Heavy Equipment Applications

About 5 years ago, Delta-Q Technologies saw a shift in the construction equipment industry – as well as material handling, agriculture and other mobile applications – toward implementation of electrification on bigger machines. This shift required more power and faster on-board chargers said Mourad Chergui, Senior Product Manager at Delta-Q, during an interview with *Power & Motion* at IFPE 2023.

As such, the company began developing its 3.3 kW battery charger which it debuted at

The DD25 Electric asphalt compactor, introduced at CONEXPO 2023, is the latest machine to join Volvo CE's lineup of electric-powered equipment.

image credit: Volvo Construction Equipment

the show. The charger can be used in parallel with multiple chargers to achieve up to 10 kW, benefitting use in larger machines. In addition, the XV3300 includes a DC/DC converter to help power auxiliary loads, such as lights and heaters, as well as an electric vehicle (EV) charging station interface to make it easier for machine owners to utilize standard charging stations already available in the marketplace.

Chergui said now is the best time to be in the electrification market. "We are seeing tremendous growth across several industry segments," he said, and that the company's XV3300 is hitting the market at the right time due to demand it sees for the product in several global markets as electrification continues to grow.

Construction equipment in par-

The XV3300 onboard battery charger was developed to meet the needs of increasingly larger electrified construction equipment. image credit: Delta-Q Technologies

ticular is experiencing a high rate of growth, as well as agricultural machinery he said. Chergui sees the material handling segment as one which is quite mature at this stage with its transition to electrification.

Electrification of machinery in these and other industries is being driven in large part by global emissions regulations which are expected to become more strict and widespread in the coming years. Also driving the move to electrified machinery is customers' desire to be more sustainable. Projects contractors may be bidding on could have stipulations which require use of more environmentally friendly equipment as well.

WATCH MORE: 3 Drivers of Off-Highway Electrification

The additional benefits of electric-powered machines is also helping drive the market, such as their lower operating costs and reduced maintenance. Given construction equipment is used for business purposes the majority of the time, and the costs associated with owning and operating these machines, being able to provide a business case for moving to electric machines will aid their uptake.

Additionally, their lower noise and lack of emissions expands the applications in which these machines can be utilized. Both aspects benefit use indoors as well as city centers and overnight work.

Hydraulics and Pneumatics Expands into Electrification

The components within a machine play a key role in enabling electrification of construction equipment. Because of this, many manufacturers within the fluid power industry have diversified their product portfolios to include components for electric-powered machines. Not only does this enable them to stay relevant in an evolving industry but also help OEMs

The eLION portfolio includes inverters and electric motors which can be used separately or as part of full system solutions to enable machine electrification.

image credit: Bosch Rexroth

create optimized machines as changes to the hydraulics and pneumatics will be necessary with the move to electrification.

It was evident at IFPE 2023 just how much of an impact electrification is having on the fluid power sector with a large number of manufacturers displaying technology to aid with this trend as well as discussing how their expertise can help to assure all fluid power and electric systems will work appropriately with one another.

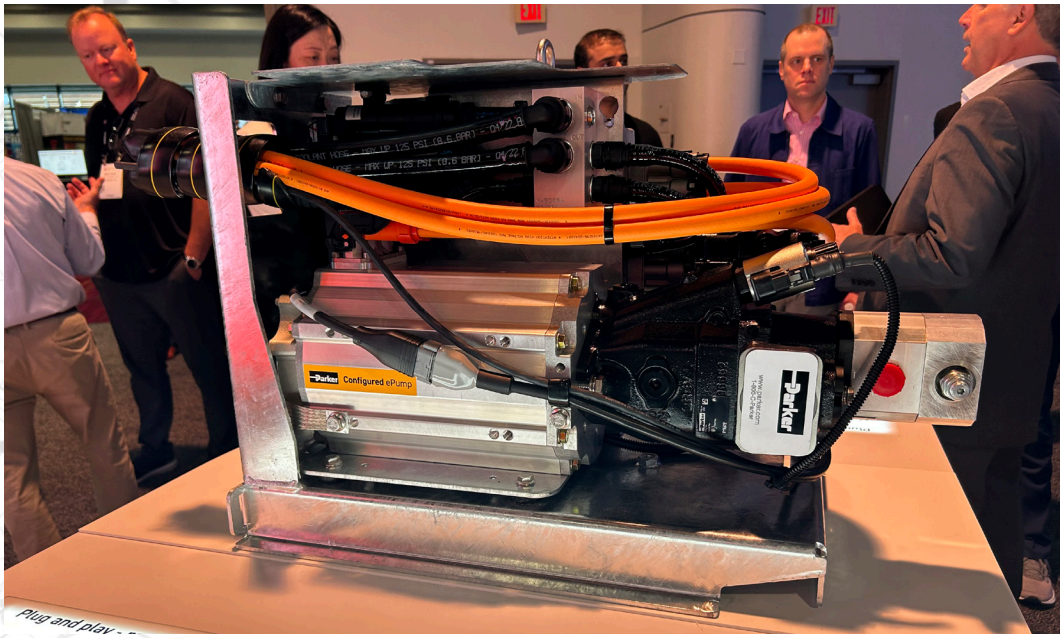
Bosch Rexroth, for instance, discussed its eLION portfolio of electrification products designed specifically for off-highway equipment during its press conference at IFPE. Most recently the company has added a single-phase onboard charger for compatibility with North American charging infrastructure.

Peter Dschida, Senior Vice President – Sales at Bosch Rexroth, said during the press conference that the mobile equipment industry is transforming, and everyone is talking about carbon neutrality. He said the challenge currently for OEM customers is determining which direction to go to achieve zero emissions performance in their machines – hydrogen, battery-electric or a combination of both.

Because of this, Dschida said OEMs are having to extend their knowledge and technological capabilities as do component suppliers like Bosch Rexroth.

With the move to electrification – and greater concern for fuel efficiency in diesel-driven machines – improved efficiency of hydraulic and other components is becoming increasingly critical. As such, several manufacturers demonstrated at IFPE the increased use of sensors and software to improve flow and pressure control of hydraulic components, leading to efficiency gains.

Parker Hannifin highlighted its SMART Electrification products which include hydraulic and electric components to provide heavy equipment manufacturers with complete system solutions. The availability of electronic control for the hydraulic components in this portfolio



Parker Hannifin's ePTO enables hydraulic work functions to be powered by a machine's battery instead of the engine, allowing for a reduction in emissions and fuel consumption. image credit: Sara Jensen

At IFPE 2023, Bucher Hydraulics demonstrated the performance capabilities of its Smart PowerPack S which includes quieter operation, an important feature for electric-powered equipment. image credit: Sara Jensen

offers improved control and thus efficiency to aid the performance of electrified construction equipment.

Included in Parker Hannifin's electrification portfolio, and displayed at IFPE, is an electric power take-off, or ePTO. Consisting of an electric motor, inverter or motor controller and a hydraulic pump powered by a DC power source, such as a battery, the ePTO enables hydraulic work functions to be powered by a machine's battery instead of an engine. It can be utilized in battery-electric or engine powered equipment and enables the electrification of work functions to reduce emissions, noise and fuel consumption.

Noise is a major factor which needs to be considered with electric machines as well. While they tend to operate more quietly when the engine is replaced by a battery-electric power system, noises made by other components, such as the hydraulics, can become more audible.

To help overcome this, Bucher Hydraulics has developed the Smart PowerPack S (SPP S), an intelligent electrified power unit. It features an electronically controlled variable pressure-balanced hydraulic pump, a single power input connection, and an integrated Negative Bypass Control cartridge valve. It is designed to provide a small, power-on-demand system which can easily plug into a range of machine types and replace engine powered systems.

Doing so not only allows the electrification of hydraulic systems but also helps to reduce noise levels on job sites. Inclusion of the company's AX pump in the SPP S enables quieter operation as it is able to operate almost silently as well as efficiently. The pump has 24 pistons which help to keep pulsations, and thus noise levels, at a low volume.

Motion Control and Power Transmission Solutions Aid Transition to Electric Power

Although IFPE has a large focus on hydraulic and pneumatic technologies, it also provides a showcase for other motion control and power transmission solutions which are just as vital to the operation of construction equipment. Advancements in these product categories, shown at IFPE and throughout the CONEXPO portions of the event, are enabling the electrification of heavy machinery as well.

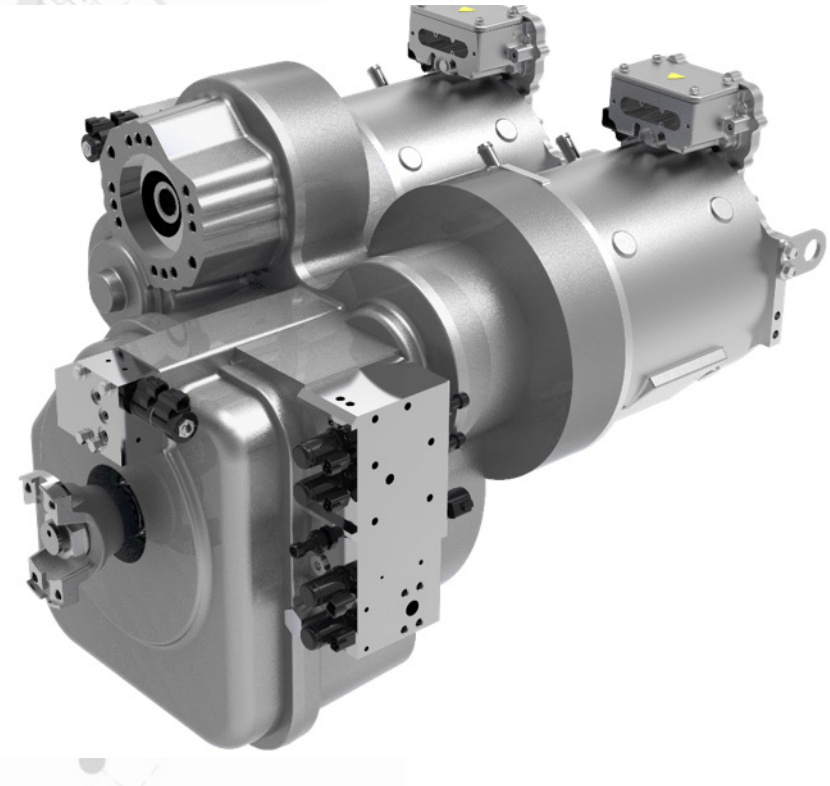
Schaeffler's electric motor can be customized to meet specific OEM machine requirements.

image credit: Schaeffler

Schaeffler, for example, displayed its electric motor technology which it describes as an e-machine because it can be used as a traction motor or a generator. It uses permanent magnet technology which enables the highest levels of efficiency.

Enhancements to the company's manufacturing capabilities enabled it to not only develop

Moog's TerraTech ecosystem includes the various components necessary for electrification of heavy-duty equipment. image credit: Moog Construction



The Spicer Electrified eSP502 e-Transmission is designed to support the electrification of mid-sized wheel loaders, rough terrain cranes, and other off-highway vehicles. image credit: Dana Inc.

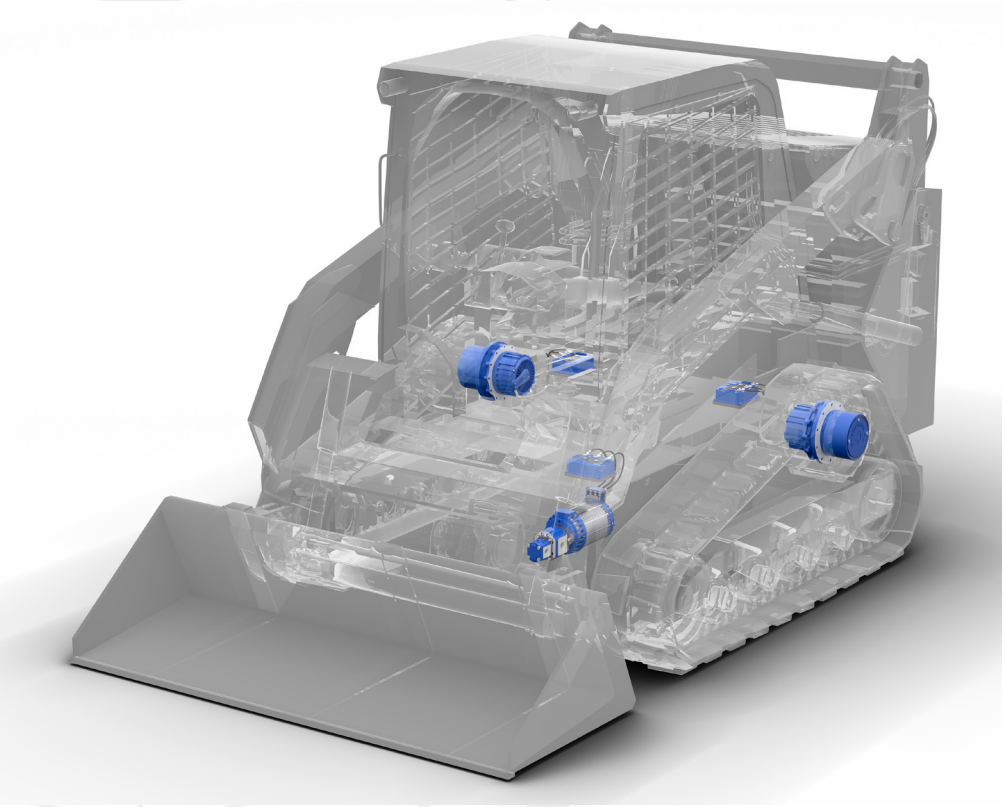
the electric motor in house but also allow customization to meet OEM customer requirements. The axial length and windings of the motor can be adjusted as necessary to provide desired performance.

Moog Construction, part of Moog Inc., launched its TerraTech ecosystem of components which will help compact construction equipment manufacturers quickly develop all-electric machines. The portfolio includes motion control software, hardware such as electric cylinders and vehicle control modules, energy and battery management, and digital insights through the Internet of Things (IoT).

TerraTech is a fully integrated system solution that can help OEMs develop electric machines in as short as 6 months. Providing a full system like this ensures all of the components will work as required with one another and perform as desired; it also eases component sourcing by providing OEMs with a single supplier from which to get necessary technology.

The system can work on a range of machines, some of which have already been demonstrated in the market. Doosan Bobcat's all-electric T7X compact track loader uses elements of the system; the company also unveiled at CONEXPO its S7X all-electric skid steel loader which incorporates TerraTech technology as well. Moog also collaborated with Komatsu on a full-electric compact wheel loader concept featuring this system which allowed the companies to quickly develop the machine and begin testing of it.

In addition to aiding electrification of machines, the TerraTech system enables digital insights into machine performance as well as make it easy to add updates or new features. It also prepares machines for



Dana provides full e-propulsion systems to OEMs, ensuring optimized performance and efficiency. image credit: Dana Inc.

incorporation of future technologies such as automation. Bobcat demonstrated this capability with the unveiling of its RogueX autonomous concept compact track loader at CONEXPO which is equipped with the TerraTech system.

Dana Inc. has developed several driveline and other technologies for electric machines in recent years. At CONEXPO, the company unveiled its eSP502 e-Transmission featuring a dual-motor, two-speed design built on a flexible platform to optimize performance and efficiency in a compact package. It is designed to perform like a conventional powershift transmission, ensuring machine performance with which operators will be familiar.

Next generation control software and functional safety readiness helps to facilitate installation and integration for OEMs, ensuring the e-Transmission will work as required while meeting safety standards where necessary.

The e-Transmission and other electrification components are available as part of a full system solution. Dana noted this capability can be seen in the e-propulsion system it is providing to Wacker Neuson for use in Kramer branded electric machines which include a wheel loader and telehandler. An e-Transmission, motor and inverter, controller and energy management software are included as part of the e-propulsion system and help to ensure optimized machine performance.

Rapid Growth Ahead for Electric Construction Equipment

Chergui concluded the conversation at IFPE by noting that Delta-Q is seeing a high level of customer growth in the area of electrification around the globe, such as in Asia and Europe. But in North America the company is also witnessing many companies embarking on their electrification journeys.

He said Delta-Q estimates electrification will be more mainstream in the heavy-duty equipment markets by 2025, and that by 2035 a large share of machines, possibly as much as 50% or more, will be electrified.

With this will come electrification of larger machines as well as higher voltages. Today, 48 and 96V are common but there already have been steps toward 400 and 800V to provide the power necessary for larger machines.

Dschida said during Bosch Rexroth's press conference that over the next 5-8 years it is unclear which machine functions will still be hydraulic and which electric. He says a small volume of machines may go full-electric, i.e. there will be no hydraulics, while the majority will feature a combination of electric and hydraulic.

This is why Bosch Rexroth and other component manufacturers are designing their technologies to be flexible and modular – enabling them to meet the varied needs of OEM customers in the coming years.

How OEMs and component suppliers go about achieving their electrification goals – whether that be full-electric, hybrid, fuel cells or other methods – remains to be seen. But it is clear the value the construction equipment industry foresees in going electric and how it can benefit customers as well as the environment.

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Q&A

CHAPTER 5:

Increased Demand for Electronic Controls Driving Hydraulic System Designs

SARA JENSEN, Technical Editor, *Power & Motion*

Growing use of electronic controls is enabling hydraulics to meet the performance requirements of increasingly electrified and automated mobile equipment.

A variety of industry trends are impacting the design of hydraulic components and systems used in mobile equipment – from electrification and automation to remote monitoring via telematics systems.

With these trends has come a need for hydraulics to be more efficient and precise. To achieve these goals, there is an increased effort to integrate electronics, including sensors, as well as software which can help to improve the performance of hydraulics as well as monitoring capabilities.

Power & Motion spoke with Russ Schneidewind, OEM Sales Manager at HydraForce, about these trends, what the company looks forward to seeing at IFPE 2023 and how the recent acquisition by Bosch Rexroth will aid future compact hydraulic developments.

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

Power & Motion (P&M): What are some of the major trends HydraForce is seeing for hydraulics used in mobile equipment applications?

Russ Schneidewind (RS): We're seeing increased demand in electronic controls. More electronics are being added to machines and we're seeing less dependency on mechanical manual lever type controls for the hydraulics as well as even hydraulic pilot controls. I think there's a lot of advantages that the OEMs are reaping from that change to electronics as they become more affordable. Also, it offers more opportunity for the operators; some of the attachments that are being used on equipment are electronically driven or managed, and so the controllers are starting to become more powerful and therefore driving hydraulics toward

more electric over hydraulic control.

And with that we're also seeing a trend toward increased demand for precision in proportional control. And sometimes this even includes sensors for feedback so they can get more precise control of their hydraulic actuators or motors.

In addition, there's this increased demand for improved energy efficiency. Hydraulics has been kind of spoiled over the years, I think, in that we always had this big diesel-powered engine on all the mobile equipment. And now with more and more stringent regulations and higher costs for fuel we're getting to the point where hydraulics has to really change and become more efficient as part of the system on those vehicles.

P&M: Are there any key features OEM customers are looking for from their hydraulic components, and how is HydraForce helping to provide those?

RS: The OEMs are clearly prioritizing increased availability and uptime for their machines as well as productivity and performance, along with lower total cost of ownership and compliance with regulations. Hydraulic components are going to need to provide more precise proportional control and that's going to require us to reduce hysteresis and improve response time and repeatability not only from valve to valve but even within the valve performance.

Additionally, customers are looking for improvements in power density, more power and less weight. And they're also considering connectivity – how can they take data from the machines. And since hydraulics is an integral part of operation of the machine, there's got to be data being provided from some of those hydraulics.

At HydraForce we're continuing to focus on developing new cartridge valve products where we integrate more electronic controls [and] some sensor technology as well. That allows us to decrease hysteresis and improve our valve-to-valve repeatability. The cartridge valve style has always been a component that facilitates compact and lightweight designs and systems to optimize the power density. So, that's some of the stuff we're focusing on as well as looking at materials that can handle higher pressures or designs; manifold designs that can be more compact and more robust for higher pressures and longer cycles as well.

P&M: How has HydraForce seen electrification, automation or other major industry trends impact the design of hydraulic components?

RS: One of the major trends that a lot of people are talking about is electrification. That's really going to require that step improvement in energy efficiency for hydraulic systems because when we had that big diesel engine with all the excess power, wasted energy in the form of heat or pressure drop, in terms of hydraulics, wasn't a big concern. We use pressure drop to enhance control in a lot of cases, especially when we're looking at proportional control.

Now with electrification, as an example, or even a different power source, like hydrogen, it's just not quite as [power] dense as a diesel engine. So we have to find ways to reduce energy consumption to be more efficient so the machines can still operate a typical work cycle without having to be recharged. [Otherwise] that's just going to be an annoyance for operators of construction equipment, as an example, if they have to either change batteries during a work cycle or trade machines [by] putting one machine in a by to charge while the other one goes back out to do some work. That's going to be a really big change.

Also, regarding automation, hydraulic components in order to function within that automation [will need to advance]. Right now we have manual operators who are making lots

of corrections and overcoming some changes in the valve performance. Hydraulic components are going to need to improve response time, repeatability, and lower hysteresis in order to really achieve the types of goals that automation is going to require.

P&M: How does HydraForce foresee the recent acquisition by Bosch Rexroth benefiting the company and its ongoing technology developments?

RS: HydraForce and Bosch Rexroth coming together and joining forces, it's really a combination of complementary strengths in customer focus and application expertise and our industry knowhow. It'll mean excellent support and innovation for our customers and stronger relationships with our partners. We also see greater opportunities for our employees.

HydraForce over its history has really focused on mechanical and electrical cartridge valves, and hydraulic integrated circuits, or manifold. And Bosch Rexroth, when added to HydraForce, offers a wider range of compact hydraulic components and systems. When we look at it as a combined portfolio, it's a strong offering for our customers; it really helps them to build better machines. They don't have to necessarily make a choice [between] one type of product or the other, we're going to be offering and showing the industry how we can combine the technologies to really offer an optimal solution. The other thing is these product portfolios coming together really complement each other very well.

Even when we look at our sales support, the compact hydraulics group of Bosch Rexroth has been strong in Europe and HydraForce has a strong footprint in North America. The combination of these activities with our company and our sales organization is going to further the growth in both regions for us, as well as Asia Pacific; we both have pretty good presence in Asia Pacific and we think the combined entity is going to be very strong. We also see with the combination of the two companies we're going to have increased strength in supply chain and logistics. We believe we'll see synergies that secure a better position for us in the global market, and expand and increase capacity that will increase the availability of our products to our customers.

We see the merger is a complementary alignment for our technology developments. Each company is bringing technology developments that don't really conflict, they actually complement each other. We're looking at addressing the same market trends, market opportunities, and the diversity of thought and potential solutions we can come up with now together as a combined entity will really give us a unique position for compact hydraulics.

P&M: What are some of the technologies the company is interested to see or learn more about at the International Fluid Power Exposition (IFPE) 2023?

RS: We're really interested to see what kind of sensing technology is out there. Bosch Rexroth, as now we're part of that organization, already has a strong lineup of sensing technologies. We're also just interested to see what else the industry has developed over the years since the last show in 2020.

And we're looking for stuff that we can integrate into HICs or manifolds and also into cartridge valves. We're also kind of interested to see where companies are progressing with respect to telematics and remote access technologies. Bosch Rexroth has the BODAS system that they've been offering the marketplace for some time and HydraForce as well has been entering the marketplace for telematics and remote access. There are some things that we hope to see at the show that might give us better vision into what's going to happen

in the marketplace for construction equipment and what's being developed by some other companies within our industry in that technology as well.

Visit our IFPE channel for more news, interviews and other content related to the year's largest event for the fluid power and motion control industries.

P&M: Are you able to share what technologies or industry trends will be highlighted at HydraForce's IFPE booth?

RS: At HydraForce's booth we'll be showcasing our new Innercept Digital Proportional Control product line. It is the integration of a position sensor and LVDT, as well as a PID loop controller and a really clever and easy-to-use graphic user interface (GUI) based on our HF Impulse software. That [product] is addressing some of the trends we already discussed of needing more precise proportional control. Also, it can provide information back through the CANbus network [which] enhances the information that might be stored or relayed over the telematics systems that are being developed.

We're also going to be showcasing our HF Impulse GUI software, but it's [version] 2.0 this year. Originally, we developed HF Impulse for those hydraulic engineers who maybe weren't so comfortable with programming controllers. This was at a time where we were seeing a transition in what types of hydraulics were being used [related to the] trend of electronic controls. The original HF Impulse is a way to program or configure already compiled programs. Now, we still have that option available in Impulse 2.0, but we're also expanding it so that people who are have become more comfortable with programming can do more in-depth and customized programming in C++ or even structured text where you can copy and paste the program into it as well and also be able to store these as their own library for future use and other projects. The ultimate goal of that software is to really speed up development for customers who are integrating electronics and hydraulics.

We're also going to be showing a new product that is our first step into a load holding or motion control market that hydro force typically hasn't been involved in. It's called an EHBL – it's an electrohydraulic boom lock valve. And it's based on a different type of technology than what's typically used in the industry today. We want to show customers how it can improve performance and energy efficiency through lower pressure drop, and maybe even some potential for storage of energy for reuse in hydraulic systems on construction equipment.

Now that we're integrated with the compact hydraulics business unit of Bosch Rexroth we're going to have some products in our booth related to compact directional valves, compact power modules, and compact motion control products. And also showing how we're going to be able to integrate the wide product range of HydraForce's cartridge valves and HIC capabilities with those products as well.

Lastly, we're kind of excited to have what we're calling a collaboration zone. And we're inviting original equipment manufacturers (OEMs) to come over to our booth in IFPE and meet with some of our highly talented application engineers and have real discussions about problems they're seeing on their machine and solutions that we can provide. In that collaboration zone we'll be demoing HF Impulse 2.0 and our manifold software package i-Design as well as the [Bosch Rexroth] CHoose, their program for putting together compact directional valves and compact power modules as well as HICs. And just trying to use that time and space to come up with good business solutions for customers.

P&M: What trend or other factors does the company foresee will have the largest impact on the fluid power industry in 2023?

RS: I think one of the biggest impacts on fluid power is the continually increasing greenhouse gas (GHG) regulations that's driving OEMs to different power sources. It's really requiring an increase in energy efficiency and precision of fluid power applications in mobile equipment.

We're also seeing this decrease in availability of skilled labor. And that's really going to require improvements in machine performance and productivity, [which is] probably going to require more automation assistance in machines that are today driven by humans. Not to say that they're going to go fully automated, but to say that some functions are going to be automated, [such as] repetitive functions. We did this on a skid steer loader, for example, and made a return to dig/return to dump[function] which is just a repetitive operation if you're going into a pile and digging into a pile with the skid steer loader and then dumping it into a truck. We demonstrate[d] how that could be automated and the benefit to not only the operator but also energy efficiency, because if we take out some of the variable of an unskilled worker in a machine and we automate some of that repetitive motion, then the machine itself can optimize use of that function and see some potential energy savings as well.

This decrease of available skilled labor is also going to affect the machine owners' capability to repair some of this equipment, especially quickly repair it. Today, we're in a place where the machine just breaks down and then it must be fixed quickly in the field, or we just basically can't use that machine. And then there's a day maybe loss of work or even more. With telematics and remote access, information can be watched or monitored, and we can see trends and how the machine is operating. What we're hoping to do from the hydraulic system is be able to show trends and how the hydraulic oil is changing or how the functions are operating in the hydraulic system and then give operators and owners an advanced notice that something's going to need to be repaired so that they can get the part ahead of time or at a time when it's going to be convenient to make the repair. [Possibly] there's going to be required some training on how to fix something before making that repair. And maybe that person on site can do it easier once they've had that training ahead of time. Ideally, if it's a software-related issue, it's something that could be addressed remotely.

I think those are some key trends that we're going to be seeing in the future.

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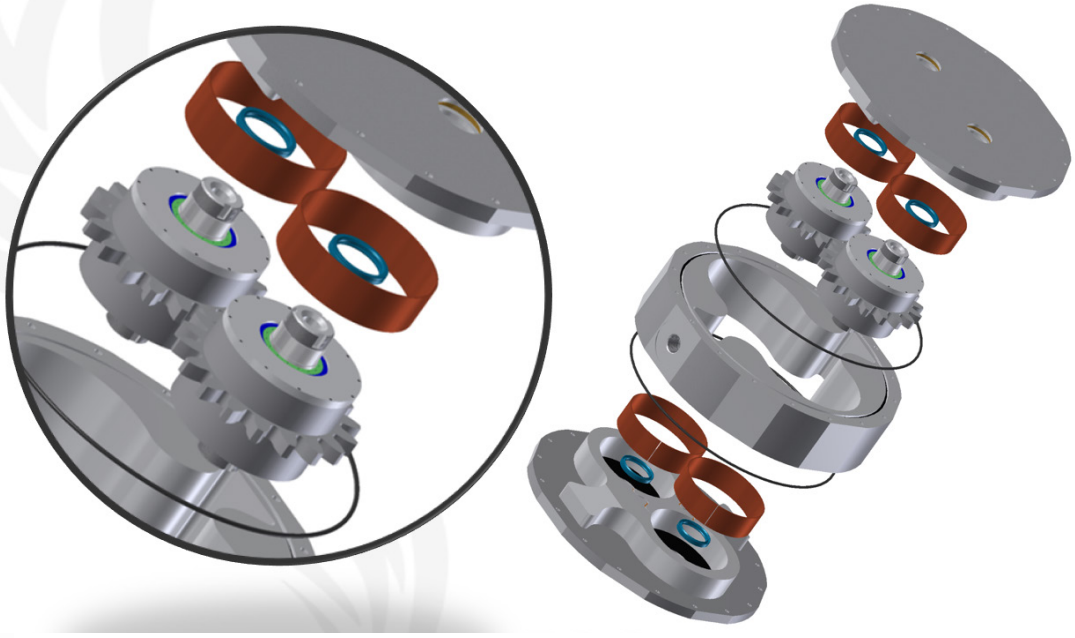


all image credits: DriveDrive Power

CHAPTER 6:

Electrohydraulic System Improves Efficiency Through Use of Drive-Drive Design

SARA JENSEN, Technical Editor, *Power & Motion*

DriveDrive Power's Independent Electrohydraulic System utilizes drive-drive motor technology to provide efficiency and precision improvements over traditional hydraulic systems.

After 8 years of development, DriveDrive Power (formerly known as Project Phoenix LLC) is ready to bring its Independent Electrohydraulic System (IES) to the market. IES is an intelligent electrohydraulic solution designed to replace traditional hydraulic control systems.

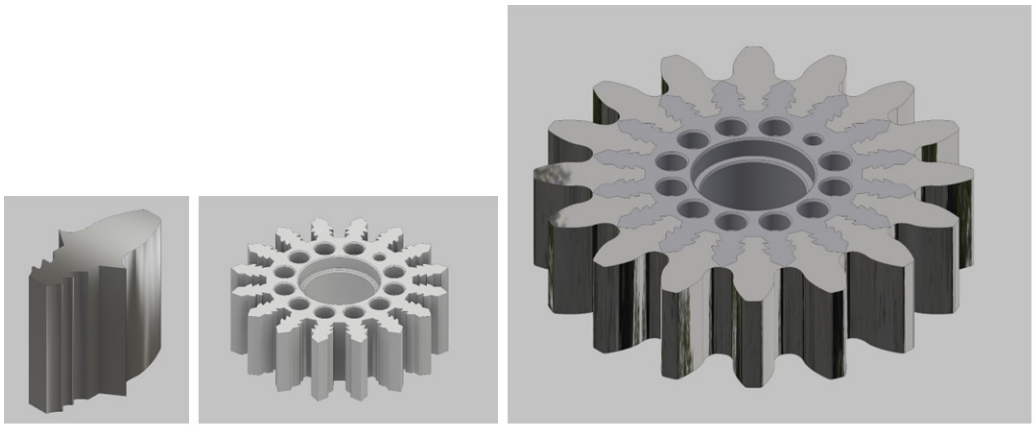
In essence, it is a servo-driven, drive-drive hydraulic gear pump with integrated electronics and software which is designed to provide a 15x improvement upon traditional hydraulic systems currently available in the market.

The IES is comprised of the following components:

- one e-pump,
- two e-valves,
- one e-accumulator,
- a motion control package,
- a power supply, and
- one Energy Regeneration and Storage Unit (ERSU).

The system is compactly designed with the majority of the components installed within the pump housing which provides mounting flexibility.

It features "fly-by-wire" control technology which means everything is electronically controlled explained Tom Afshari, Chief Design Engineer at DriveDrive Power, in an interview with *Power & Motion*. There is no hydraulic line feedback, everything is controlled by electronic signals. "The hydraulics are completely segregated from the control loop which is



DriveDrive Power's chosen motor design provides redundancy so that if one motor should fail the other can continue to operate for a limited time.

100% electric," he said.

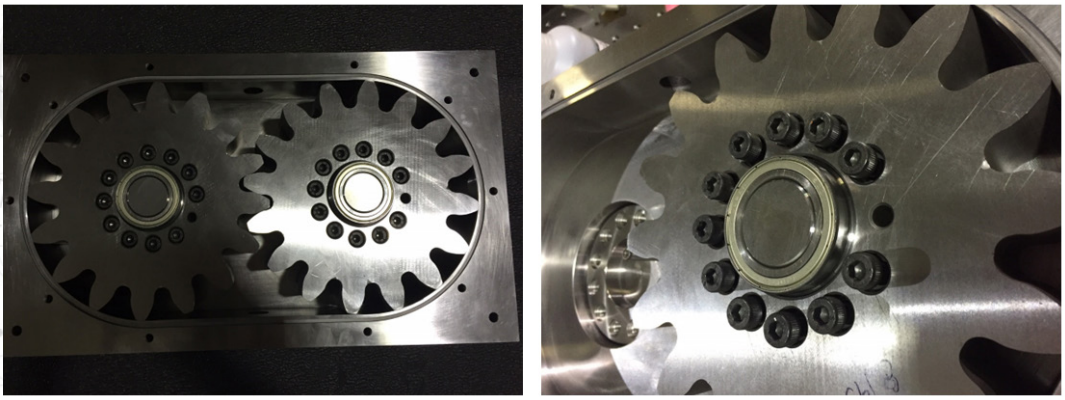
This enables high-performance responses within the system as well as built-in redundancy to optimize operation.

New Motor Design Improves Precision and Efficiency

According to Afshari, the IES came about after the company invested in transverse flux motor technology. This high torque motor type provides high power at low rpms, typically around 900 rpm. He noted it is also a reverse motor in which the stator is the core of the motor and the rotor is on the outside diameter.

While working with the transverse flux motor, Afshari said he began thinking about how it could be utilized in the field of hydraulics. During his years of working in the hydraulics industry he heard from people that hydraulics is powerful but not precise. But he knew the industry could do better to improve the precision of hydraulics; once he saw the capabilities of the transverse flux motor Afshari said he knew that was the solution.

The IES features two of these high-torque motors integrated inside the e-pump casing, and their rotating outside diameter is what creates displacement said Afshari. The e-pump is described by DriveDrive Power as a positive-displacement external gear pump. It is a drive-drive hydraulic pump powered by the integrated motors which are directly connected to spur gears.



Use of a drive-drive concept enables the integrated motors to equally contribute to the creation of displacement.

Afshari said this design enables a transition from fluid power to motion control. New software algorithms were developed and work in tandem with the motors to provide more precise control of gear teeth movement.

Using these algorithms allows the synchronization of the motor and gear movements to ensure consistent pump efficiency. Afshari

explained that in a traditional system one motor-gear combination essentially runs the other and as pressure goes up, the main motor pushes the other so hard that wear and tear begins to occur, as well as other potential issues. But by going to a drive-drive system instead like the one utilized by the IES, that push of one motor-gear unit on another is eliminated and the motors equally contribute to the creation of displacement.

The motors are synchronized at about 5 Nm. If they go below this force level due to contamination, viscosity drop, or another issue the pump automatically indexes itself to return to an appropriate working force said Afshari.

There are many efficiency gains which can be achieved with the IES. Its slip coefficient, for instance, is under 5% equating to 90-95% hydraulic efficiency at the pump he said. While pressure drops or other phenomenon are common with pumps used in the field, "port to port you have a significant improvement in efficiency," said Afshari. "Mechanical losses are put back in the system as energy savings due to the gear systems not rubbing or pushing each other [but instead being] independently driven."

Redundancy is another benefit offered by the chosen motor design. If something happens to one of the motors, the other can continue running the pump for a limited time which helps to reduce unplanned downtime.

Built-In Intelligence Benefits Performance and Maintenance

Electronics built into the IES—including pressure, flow and temperature sensors—as well as the software algorithms developed by DriveDrive Power help to provide improved control of the system and its various components.

"That creates this very clean, very simple loop of information cycling through the system, and keeps giving the motion controller which runs the pump enough information to make determinations on how adjustments need to be made," said Afshari.

He explained that it is a closed loop communication system in which substantial amounts of information and data are being shared both within the IES and with other machine systems. This provides improved performance and maintenance capabilities. For instance, during testing the company found it could more accurately move hydraulic cylinders using the IES because of its built-in electronics and algorithms. And it can do so in a smoother manner than traditional hydraulic pump systems would.

This is possible because of the ability to control the pressurized fluid coming out of the pump, said Afshari. "We measure and know the flow, viscosity, pressure, and temperature; everything is calculated and based on that can determine the appropriate displacement to move the cylinder."

Multiple IES can be used in series or parallel as well. Doing so is an easier set up for design teams because the pump is able to automatically determine if something is not configured or working as it should whereas with a traditional hydraulic system when it is set up incorrectly catastrophic failures can occur.

The IES, on the other hand, is able to provide an alarm and let users know what the issue is—such as pressure dropping on one pump but increasing on another which alerts them to the fact the ports are wrong. "It is very easy to determine what you are doing right or wrong because of the amount of data built into the system," said Afshari.

He noted the majority of the alarms the DriveDrive Power team has seen with the system are from cavitations, wear and contamination. "The system is very sensitive. If suddenly there is a shaved metal piece which enters between the gears, an alarm goes out that

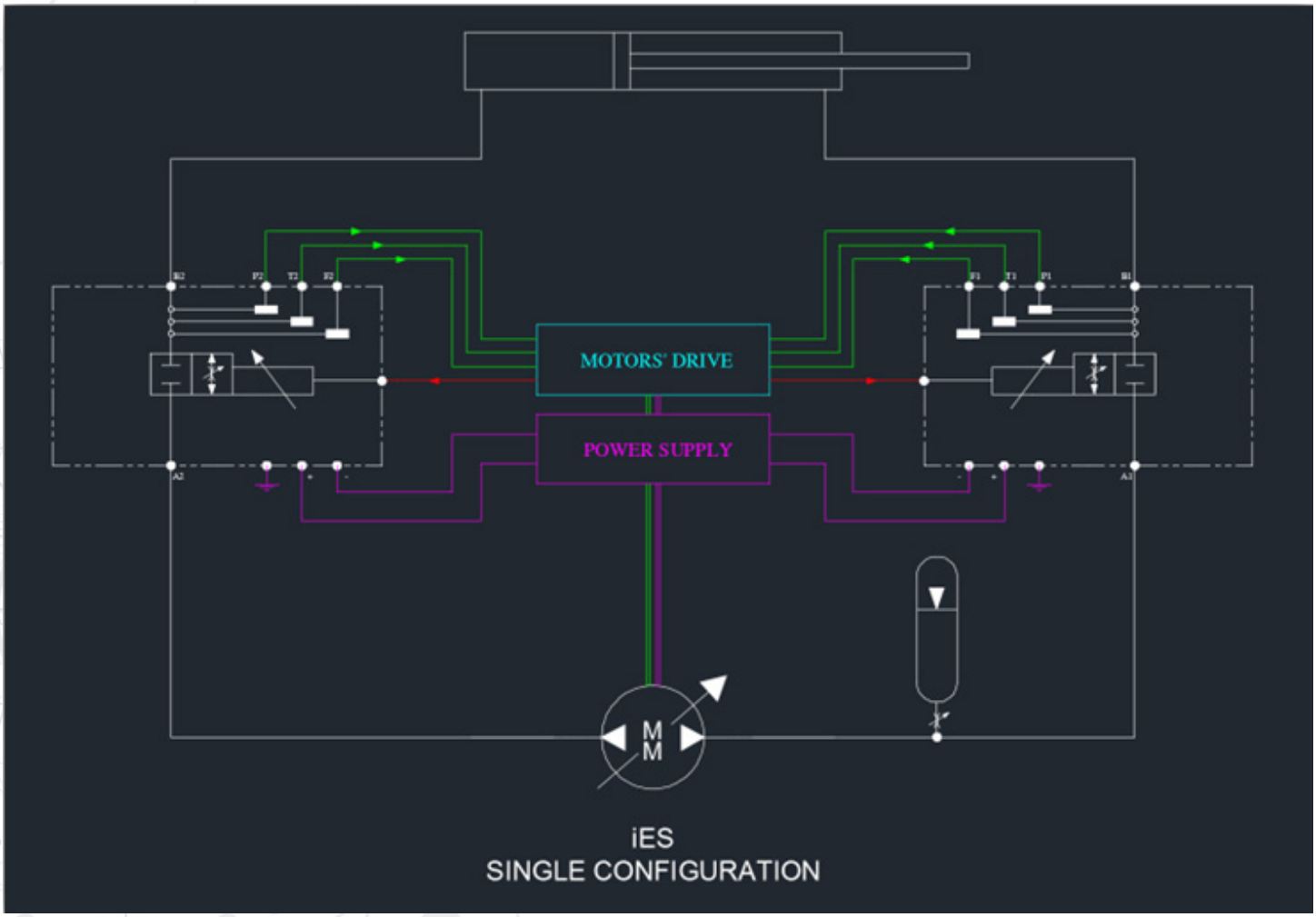
something is out of balance."

One of the pumps the company has been testing has 6,000 hours on it and there are no marks on the gears, said Afshari. But if you were to look at a traditional hydraulic pump after 6,000 hours it would be a different story.

The pump's ability to improve precision and alert users the moment an issue is detected helps to reduce wear, and thus maintenance. How much lower maintenance will be is yet to be determined because the pump will need to be run 200,000-300,000 hours based on the work done so far. "6,000 hours would be just right for a traditional hydraulic system to measure the wear," explained Ashfari. "We cannot measure anywhere within this timeframe right now."

He said the pump housing will always have wear because it is usually made from a softer metal, but the core of it will remain intact.

In addition to the intelligence built into the IES, it can collect data as well throughout its operating life building up further performance metrics. With this information users can be more proactive with their maintenance. Should there be a potential issue, Afshari said users can look up the collected data to determine what is happening without having to stop the



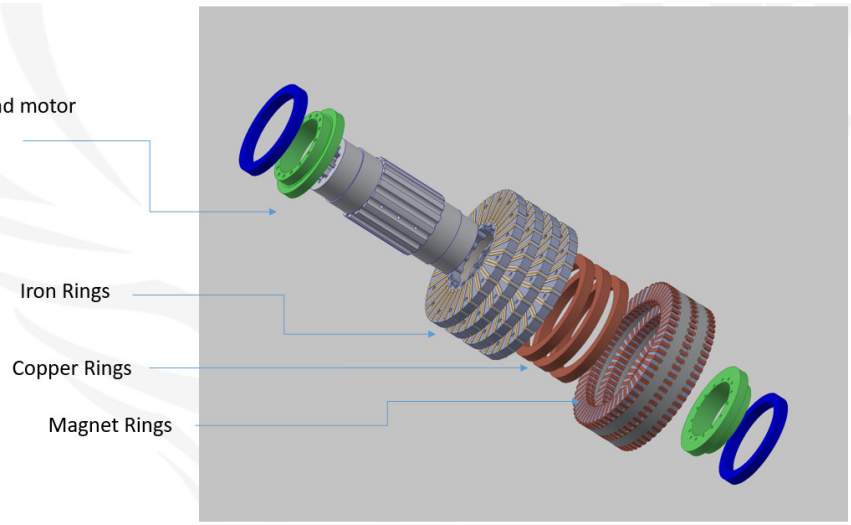
A schematic of the Independent Electrohydraulic System circuit.

working machine to do so. This helps to minimize downtime, particularly in critical applications such as military or autonomous vehicles.

A Variety of Applications and Use Cases

Afshari said the IES can be used in applications where direct-drive hydraulic or other fluid driven systems are typically used—everything from prosthetics to the brakes in a car to the flight control system of a space shuttle.

As an example, he noted the benefit of using the IES for leveling systems whether in a car, ambulance or other application. Today, these use hydraulics but if a leak occurs the system can lose its balance. The IES, however, is constantly adjusting itself to ensure it is performing correctly so even if a leak were to occur the leveling system would remain balanced said Afshari.



A view of components within the Independent Electrohydraulic System.

The IES could also be beneficial for use in electric-powered applications as it can easily be plugged into a vehicle or machine's electronics system. It can also be used as an on-board generator as it is capable of collecting and reusing energy.

Afshari noted the use of two electric motors benefits use in electric vehicle applications, as well. "It is very difficult to power up the hydraulics with a 100 hp electric motor as it requires a lot of initial amperage. But it is very easy to power up two motors slowly" which enables the on-board generator to be right sized for the application he explained.

DriveDrive Power debuted the IES during the International Fluid Power Exposition (IFPE) 2023. Afshari said the system is at the development stage where it is ready for production and use in various applications. The goal is to partner with hydraulics companies and pair the IES with products such as hydraulic power units or cylinders to bring increased intelligence and precision to the industry.

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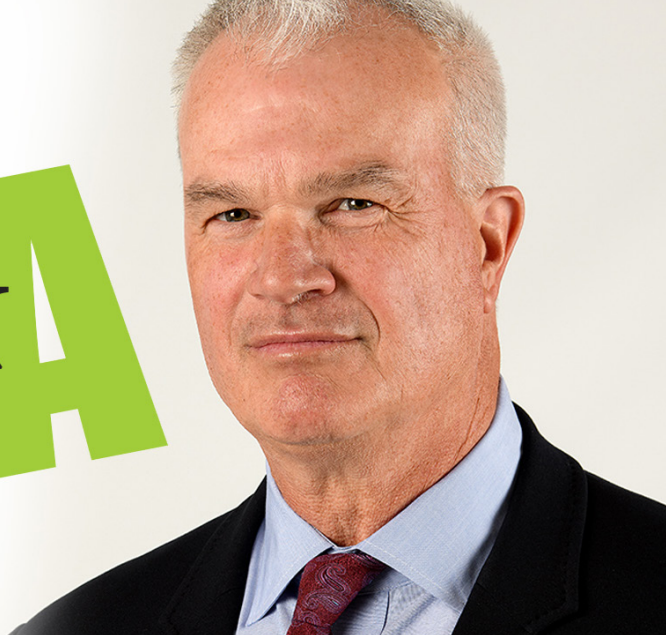
Q&A



CHAPTER 7:

Electric Actuators with Integrated Control Technology Provide Seamless Installation

SARA JENSEN, Technical Editor, *Power & Motion*

The Ewellix SmartX platform eliminates the need for a separate controller, easing installation of electric actuators in various applications.

Ewellix has developed the SmartX digital platform which integrates control technology directly into linear motion devices. Doing so not only helps to provide improved control of the device but also simplified installation for OEMs.

Power & Motion spoke with Kirk Martin, Sector Sales Director Mobile Machinery at Ewellix to learn more about the SmartX platform and the benefits it can provide in various applications.

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

Power & Motion (P&M): Could you provide an overview of the SmartX digital platform – what it entails and how it works or can be applied to linear motion devices?

Kirk Martin (KM): The Ewellix SmartX platform is a CANbus control package with absolute position control, and that's integrated into our CAHB electric actuator product line which has a push force of about 2,500 lbs. What's nice about this is the machine designer can use this platform to control the electric actuator without having to have a separate controller in their system. Typically, you need some type of control mechanism to help drive [and control] the actuator. This integrated control system takes care of that for you; thus, you can simplify your overall machine and not [need] to have a separate controller module.

[The platform also] includes multiple functions, such as parallel mode, soft starts, soft stop, force profiles, and a few others. Those are the main [benefits] that really help designers apply and install linear actuators into their systems.

Ewellix's SmartX platform is currently integrated into its CAHB electric actuator product line which provides a push force of 2,500 lbs.

image credit: Ewellix

P&M: What prompted the company to develop SmartX, and what benefits will it bring to the industry?

KM: We saw demand [for it]. Customers are installing more and more electric actuators and having to control them [and creation of] more complex systems, we really saw demand for an integrated package with absolute position control. In fact, that's a major difference for ours. Absolute position control really allows you to get good position feedback for your system. So, we think we met that demand with this SmartX platform.

Also, we expanded upon that absolute position control with some of the other key features I mentioned previously such as parallel mode and soft starts. You can do some onboard monitoring of your conditions [as well].

P&M: Do you have any examples you could share demonstrating how the technology has been utilized in a heavy-duty mobile equipment or other application?

KM: Main applications so far have been in steering functions for slab scissor lifts. [In that application] they're using SmartX to communicate with the main machine control. Also, there's some built in safety functionality for a steering function. Some other [applications] where people have used it so far are passenger stairs for the airport market. We also have some small dump trucks in the municipal equipment market, street sweepers and various applications in the in the on-road equipment, work truck space.

P&M: Are you able to go into a little more detail about how the SmartX platform is being used in some of these applications?

KM: For the scissor lift, it was predominantly a steering function. The customer wanted to have electronic smart steering functionality instead of a hydraulic system. They eliminated an entire hydraulic system and utilized an electric smart steering actuator with the built-in controller and that allowed them to eliminate the separate controller they had for their traditional steering function. There are some built-in SIL (safety integrity level) safety protocols in the actuator so that helped them apply it for steering where obviously safety is very important.

On the passenger stairs, that was [an instance] where they wanted to use [SmartX] to stabilize [the stairs]. It engages with the ground and allows stabilization of the system while passengers are going up and down the stairs [used] for the airport market.

On the dump trucks, they [the customer] use the actuator in parallel; they needed the parallel function of the SmartX to lift and lower the dump bed of a small dump truck [deployed]

in Europe.

P&M: What, if any, challenges are associated with integrating or even just developing smart devices like those part of the SmartX platform, and how can those challenges be overcome?

KM: Some of the biggest challenges in the mobile market is, as electrification develops and becomes more prevalent, what voltage does the actuator need to be able to accommodate? So, what are the machine voltages? That's all over the gamut today. There's anywhere from 12V to 800V systems out there [and] the challenge is trying to accommodate a SmartX platform into all these different voltage ranges. We're still coming up with ways to do that.

For an OEM, the SmartX platform offers [fewer] challenges because it really is a seamless integration process as there is no separate controller; it eliminates components and wiring from the machine, thus simplifying the whole design.

P&M: Is that something you're seeing more, OEMs wanting to simplify their designs?

KM: Yes, absolutely. People want to have less components in the machine. Plug and play [solutions], smart capabilities are very prevalent. They [OEMs] like that plug-and-play, easy-to-use application and installation in their machine.

P&M: How do you see the use and integration of smart technologies like SmartX progressing in the coming years?

KM: We definitely have plans to expand it beyond our standard CAHB product that we have it in today and into our larger actuators [with] up to 15 tons of push force. We want to be able to have this functionality and the SmartX platform across the gamut for all of our product ranges.

That's the challenge we're taking on now. As we talked a little about previously, accommodating the different voltages…is a tough challenge right now [and decide] which voltages and what kilowatt range motors we need to accommodate.

P&M: Is Ewellix working closely with OEMs or other industry partners to help overcome those challenges?

KM: Predominantly we're working with several different OEMs on the mobile machine platform and really relied on them. Obviously, they design and develop what voltage they want for their machines and then we try to help them come up with an actuator for that particular application.

As we develop this database [of customer applications] and see where the market is heading, we'll be able to better design and plan for our SmartX platform and all of our load ranges.

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image credit: Ewellix

CHAPTER 8:

New Hydraulic and Electric Motion Control Solutions for Construction Equipment

SARA JENSEN, Technical Editor, *Power & Motion*

Hydraulic and electronic components launched at CONEXPO & IFPE 2023 demonstrate the continued advancements taking place in the fluid power and motion control industries.

The 2023 International Fluid Power Exposition (IFPE) and co-located CONEXPO-CON/AGG was filled with new product launches from manufacturers in the fluid power and electric motion control industries. These products included so-called traditional hydraulic and pneumatic components as well as advancements in electric actuators, electrification solutions and more.

With the range of products launched at IFPE & CONEXPO, it is evident that the fluid power and electric motion control industries continue to innovate in order to meet the needs of OEM customers in the construction equipment and other heavy machinery industries. The array of new technologies introduced also shows just how much the mobile equipment industry is changing, with trends such as electrification and automation bringing about the need for new components and system architectures.

Also driving technology designs is the increased desire from OEMs and their customers to improve the efficiency of their machines as well as increasing connectivity and data collection.

Lee Co. Introduces DL Series Plug

The Lee Company has introduced the DL Series Plug to its product offering. Featuring a patent pending design, the plug permanently seals passages using the company's new Drive Locking technology which retains plug and seal passageways for the life of the application without the need to use pins, sealants or other sealing devices. According to the company, this helps to simplify installation and reduce costs.

Installation is further simplified through the inclusion of an Installation Indicator feature

which provides users with a visual indication of any gaps which means the plug has not been installed correctly. If installed correctly, the Installation Indicator will come in contact with the housing wall and no gaps will be visible.

The DL Series Plug features a single-piece, stainless steel design which is rated for pressures up to 69 bar. Five standard body diameters are available from 4-8 mm. The plug suits use in cross-drilled holes in aluminum manifolds used in transmissions, electric drive units, industrial hydraulic systems and more.

The Lee Company's DL Series Plug is compact and lightweight, aiding installation in space- and weight-constrained applications.

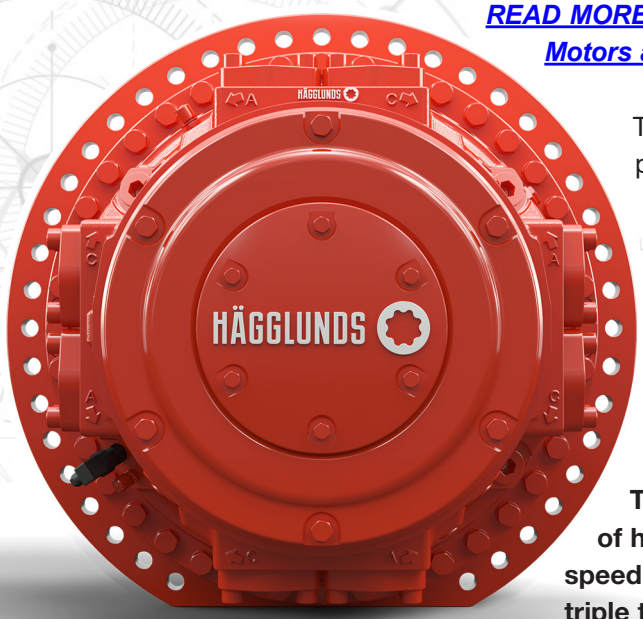
image credit: The Lee Company

Bosch Rexroth Expands Hägglunds Motor Line

At IFPE, Bosch Rexroth introduced its Hägglunds Quantum range of hydraulic motors. The motors are designed to improve torque and speed capabilities while maintaining efficiency for direct drive applications in heavy-duty equipment.

The Quantum motors provide a top speed of over 150 rpm and maximum torque of more than 350 kNm. Changes to the design and materials used enabled the increases in speed and torque, as well as a longer lifespan while ensuring efficient operation.

READ MORE about the Hägglunds line and its Atom motor, a winner in the Motors and Drives category of the 2022 IDEA! awards.



The Hägglunds Quantum range of hydraulic motors offers increased speed and torque capabilities as well as triple the life expectancy.

image credit: Bosch Rexroth

Two motors are included in the Quantum range, which replaces the previous Hägglunds CB, the Hägglunds Quantum and Hägglunds Quantum Power. The motors have a similar design although the latter is able to achieve particularly high speeds at full torque capacity and high levels of efficiency. It is able to do so due to the use of a new slim connection block which works together with the motor's additional ports and optimized channel geometry to improve upon the performance of previous versions. All of this is possible without adding size or weight.

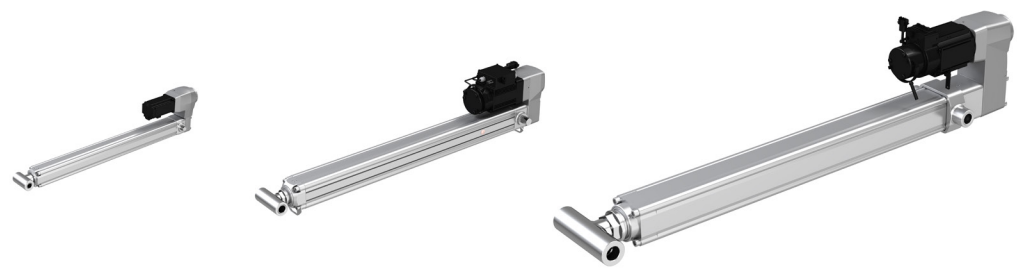
Environmentally friendly fluids can be used with the new Hägglunds motors which was a key design criterion for the company said Wolfram Ulrich, Vice

President Sales, Hägglunds, during Bosch Rexroth's press conference at IFPE where it introduced the hydraulic motors.

Ewellix Launches New Electric Actuators, Assembly Kit

Linear motion technology provider Ewellix launched a new generation of electric actuators as well as a kit to aid the assembly and specification of electric linear actuation systems at CONEXPO. The company's new electric actuators are designed specifically for use in mobile equipment applications, providing the power density and motion control needed in construction, agricultural and other heavy machinery.

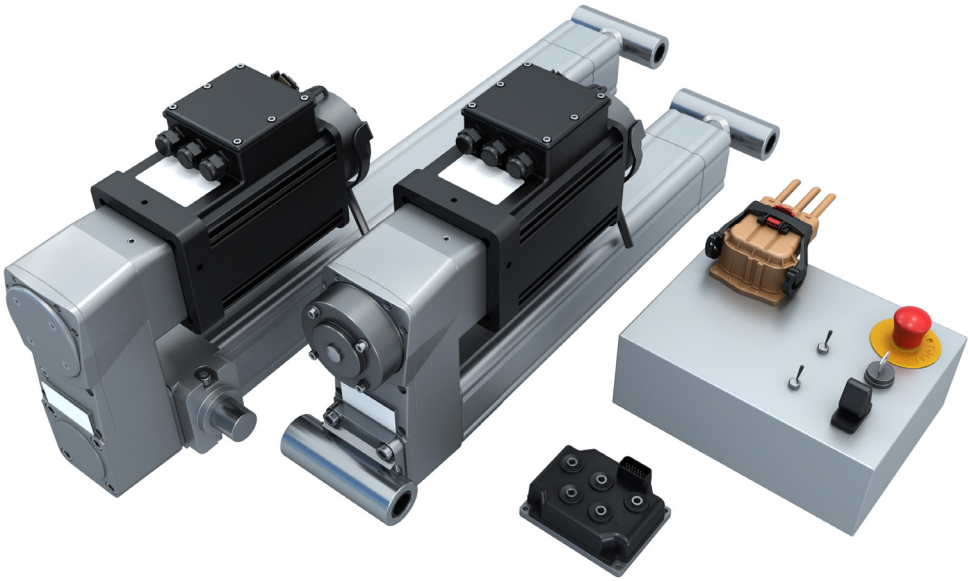
Ewellix plans to initially release actuators with 3- and 15-ton lift capacities. Future models will provide additional capacities and a steer-by-wire option. The actuators will provide OEMs with an alternative to hydraulics which the company says is clean, easy to install and offers a lower total cost of ownership. These new actuators are based on Ewellix's CASM series and can be equipped with safety features such as a descent speed limiter, back-up nut and electromechanical motor braking which help to provide similar functionality as a hydraulic cylinder.



The first three versions of the next generation CASM electric actuators from Ewellix will provide 3-, 6- and 15-ton lifting capabilities in a range of mobile equipment applications. image credit: Ewellix

While the new electric actuators will feature the same robust and modular construction as the CASM series, they will also offer a more compact design and wider range of end attachments. A higher efficiency motor package with IP ratings suitable for off-highway equipment applications will also be available. Maximum linear speeds (unloaded) up to 300 mm/sec, at accelerations of up to 6 m/sec, and stroke lengths of up to 2 m will be possible, depending on the application and configuration.

Ewellix also introduced its eMOVEKIT as a means of reducing design and validation time for OEM customers. eMOVEKIT is a complete system with all necessary components for the drive and control of linear motion in mobile equipment with a 24V power source. An Ewellix electric actuator is included as well as the required connectors, cables and mounting attachments.



Ewellix's eMOVEKIT provides all necessary components to help OEMs implement drive and control linear motion in their heavy equipment designs. image credit: Ewellix

Ewellix developed the eMOVEKIT due in part to the

growth of electrification in the off-highway equipment industry. In some cases, electric actuators are being used in place of hydraulics because of the efficiency, power density and reliability they can provide. The company says the kit aims to help both experienced engineers as well as those who are new to electric actuators easily implement them in their machine designs by providing all necessary components. The kit can be used for prototypes and full-scale equipment builds.

Epec Presents Three New ECUs

Technology company Epec, part of Ponsse Group, presented three new electronic control units (ECU) to aid the increasing use of electronics and software in construction equipment. The company says these control units can help OEMs with the implementation of steer- and brake-by-wire systems, edge computing, advanced control systems, electrification and more.

The Epec Core Unit and SL8X Control Unit are designed for control systems requiring real-

Among the products Epec displayed at CONEXPO 2023 were new electronic control units to aid OEMs with development of advanced systems and machines.
image credit: Epec Oy

time control, functional safety and flexible interfaces. Both ECUs are equipped with various programming options including C++ and Ethernet. Connectivity for real-time data exchange is included as well as IP69K compliance to ensure reliability in harsh off-road environments.

Epec also presented the GC44 Responder unit which benefits use for centralized intelligence systems. It is a generic CANopen responder unit and designed to withstand use in harsh operating conditions.

Danfoss Adds Hydraulic Hoses and Connection System to Portfolio

Danfoss Power Solutions has introduced new hydraulic hoses as well as a system aimed at simplifying hydraulic line connections.

READ MORE: Danfoss Remains Invested in Hydraulics

The new Aeroquip by Danfoss FC250H and Weatherhead by Danfoss H250H hoses are designed to exceed SAE 100R5 performance levels; they are tested to 300,000 impulse cycles.

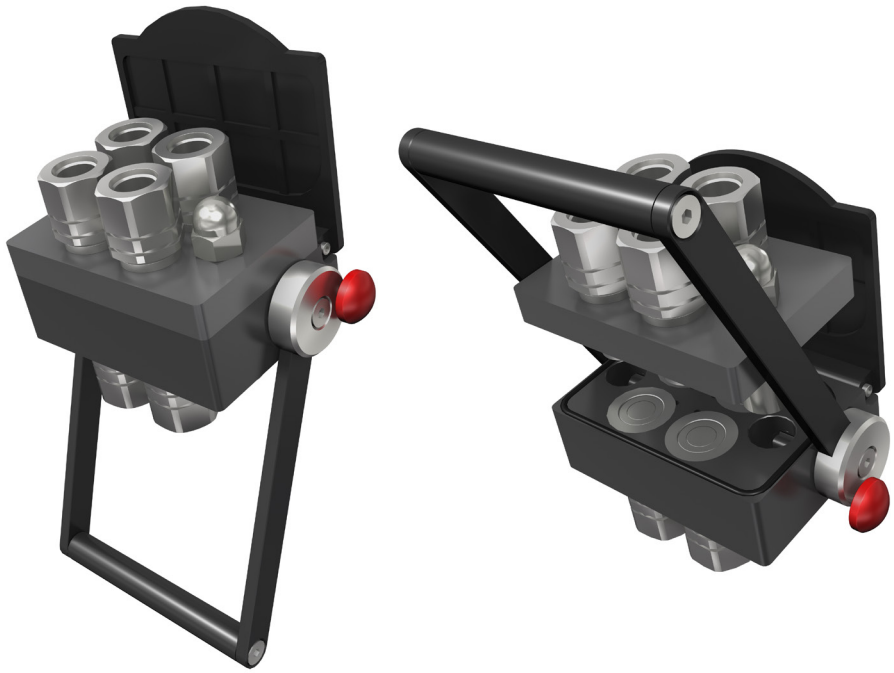
Both hoses feature a two-braid design which helps to reduce their weight and improve flexibility compared to three-braid hoses. According to Danfoss, the hoses weigh 20% less than conventional three-braid versions which helps to reduce overall vehicle weight for improvements in fuel efficiency.

The FC250H and H250H hoses feature a braided cover and chlorinated polyethylene inner tube which ensures suitability for high-temperature fluids such as oil and multi-type fuel. image credit: Danfoss Power Solutions

The bend radius of the hoses is half that of the 100R5 requirement. They also feature a 25% tighter bend radius and 15% smaller outer diameter than the 100R5 maximum, making it easier to route the hoses and use them in the tighter installation spaces common to today's construction equipment.

Installation is aided as well by the use of a universal flat crimp fitting. This provides a smaller profile for reduced installation complexity and saves up to 70% over the cost of bubble crimp tooling states Danfoss in its press release announcing the launch of the hoses.

Danfoss also launched its multiplate system to the North American market at IFPE. A configurable coupling system, it helps users to connect and disconnect up to six hydraulic lines



Danfoss' multiplate system has a modular and flexible design, enabling customization to specific machine requirements. image credit: Danfoss Power Solutions

simultaneously fitted with Danfoss flat face quick-disconnect couplings. This can be done in a single movement, increasing the speed at which assembly, maintenance and attachment changeout can occur.

The multiplate system features a patented internal mechanism capable of withstanding heavy-duty cycles yet lowering the force required for connections by 40%. It can be configured to make connections under pressure, supporting manual connection up to 350 bar.

Safe and reliable connections are assured by eliminating the chance of crossed lines and contamination. Per Danfoss, there is an integrated sealing band between the fixed and movable plates which prevents dirt and dust ingress during operation. A fixed plate with a dust cap which automatically closes provides protection for female couplings during disconnection.

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