Pneumatic Cylinders vs. Electric Rod Actuators 14

How to Make Hydraulic Filter Sizing Simpler 20

Maintenance Deserves a Seat at the Table 24

September 2022

powermotiontech.com

POWER&MOTION™

How Intelligent Hydraulics, Pneumatics and Electronics Propel the Modern World

Heavy Equipment Gets An Electromechanical Alternative

The RISE™ Cylinder continues to demonstrate performance benefits over hydraulics. *10*

TOUGHER WITH EVERY TEST.

Tompkins® INDUSTRIES, INC.

ALWAYS ADAPTING.

tompkinsind.com
800-255-1008

VELJAN

High Performance Fluid Power

System Saver

(Pumps with factory fitted flange mounted valving kits that save you space, costs and time)

VC5 Check Valve

Series : VC5 V06, V08, V10, V12, V16,
Size: 3/4", 1", 1¼", 1½", 2" (20, 25, 32, 38, 50 mm)
Flow : 26, 53, 106, 198, 198 gpm / 100, 200, 400, 750, 750 lpm
Pressure: 3050 psi / 210 bar
Mounting : Flange (Poppet & Ball Type)

* V - Relief, U - Unloader, S - Sequence, R - Reducing

VR4 Valve

Series : VR4 03, VR4 06, VR4 10
Size: 3/8", 3/4", 1¼" (10, 20, 32 mm)
Flow : 24, 80, 159 gpm, 90, 300, 600 lpm
Pressure: 5000 psi / 350 bar
Mounting : Subplate / Threaded / Cartridge

Please contact us:

Veljan Hydrair Inc.

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

55 Years of Excellence

We help you see your ideas work

Inside

FEATURES

DEPARTMENTS

Motion control this easy and affordable is soooo sweet!

CLICK PLUS PLCs provide control simplicity combined with advanced capabilities including Wi-Fi communication, MQTT support, data logging, and now motion control. Any CLICK PLUS CPU can be configured as a 3-axis PTO/PWM motion controller with 100kHz high-speed input and outputs (requires DC option slot I/O module placed in slot 0 of the CPU). With the easy-to-use configuration GUI built into the FREE software and the three new motion instructions (Velocity Move, Position Move and Home), CLICK PLUS makes it's a cinch to control simple motion applications.

CLICK PLUS

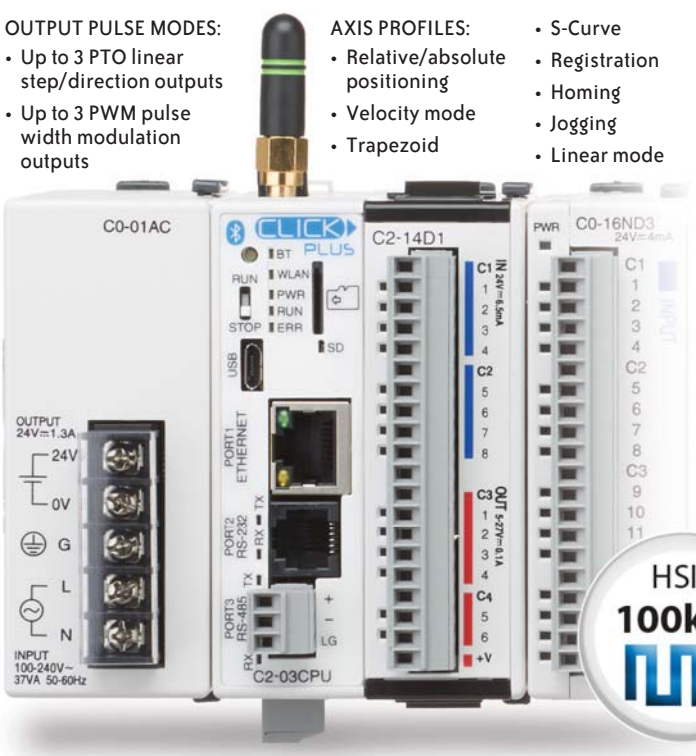
3-AXIS PTO/PWM MOTION CONTROLLER

STARTING AT ONLY $149.00

(C2-01CPU + C2-14D1)

OUTPUT PULSE MODES:
- Up to 3 PTO linear step/direction outputs
- Up to 3 PWM pulse width modulation outputs

AXIS PROFILES:
- Relative/absolute positioning
- Velocity mode
- Trapezoid
- S-Curve
- Registration
- Homing
- Jogging
- Linear mode



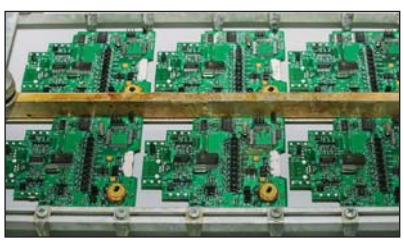
FREE SOFTWARE

with simple motion profile setup and 3 new easy-to-use motion instructions:
- Velocity Move
- Position Move
- Home

Research, price, buy at: www.CLICKPLCS.com

P&M Online

IDEA Awards Voting is Now Open
The nominees have been announced, so it's time to pick 2022's best products. Voting closes Sept. 16.
powermotiontech.com/21248397



How the CHIPS and Science Act Will Benefit Fluid Power and Motion Control Manufacturers
New federal funding aims to increase semiconductor manufacturing, science and technology research as well as STEM education and workforce development.
powermotiontech.com/21248475

Fluid Power Market to Continue in Positive Direction
The NFPA's annual Industry & Economic Outlook Conference provided a look at the market and economic trends likely to impact fluid power manufacturers in the years ahead.
powermotiontech.com/21247968

POWER&MOTION
VOLUME 75, ISSUE 6

ENDEAVOR BUSINESS MEDIA

ENDEAVOR BUSINESS MEDIA, LLC
30 BURTON HILLS BLVD. SUITE 185, NASHVILLE, TN 37215, U.S. | WWW.ENDEAVORBUSINESSMEDIA.COM
CEO: **CHRIS FERRELL**
PRESIDENT: **JUNE GRIFFIN**
CFO: **MARK ZADELL**
COO: **PATRICK RAINS**
CHIEF ADMINISTRATIVE AND LEGAL OFFICER: **TRACY KANE**
EVP, SPECIAL PROJECTS: **KRISTINE RUSSELL**
ELECTRONIC DESIGN | MACHINE DESIGN | MICROWAVES & RF | POWER & MOTION |
SOURCE ESB | SOURCE TODAY

NFPA MEMBER · THE FPDA MOTION & CONTROL NETWORK · NAHAD

ISSN 2831-4883 Print. ISSN 2831-4891 Online.

FluiDyne™
FLUID POWER

FluiDyne A4V Pumps,
truly versatile.

Call, Email or LiveChat

Get Instant Answers.

Providing solutions that work.

Powered by Customer Service

FluiDyne
FLUID POWER

586-296-7200

sales@fluidynefp.com

www.fluidynefp.com

FLUIDYNE FLUID POWER OVER 45 YEARS OF QUALITY 1976-2022

THE FPDA MOTION & CONTROL NETWORK MEMBER

Visit Us At: Waste EXPO an event by Waste360 Booth #3524

SARA JENSEN
Technical Editor
sjensen@endeavorb2b.com

What are the Impacts of Industry Consolidation?

Company mergers and acquisitions are a common occurrence in the business world. However, they can sometimes bring about mixed feelings. On the one hand, for the companies involved they can offer benefits such as increasing manufacturing capacity or financial capital as well as technological capabilities. But on the other hand—especially for those on the outside—it can feel like an industry or sector is shrinking.

Over the last several years, the fluid power and related industries have seen a number of mergers which brings to light the question: How will the industry be impacted?

Most recently, it was announced Bosch Rexroth is acquiring HydraForce Inc. (read more, pg. 8). The companies both touted in their announcements about the acquisition the complementary nature of their products as well as the further development opportunities now possible by bringing together their collective engineering expertise.

Another major acquisition which took place in the fluid power industry was the announcement of Danfoss acquiring Eaton's hydraulics business in early 2020. Both companies had a strong presence in the global hydraulics market; bringing them together enabled an even stronger market footprint as well as the entry of Danfoss into the industrial hydraulics market.

The acquisition was finalized in 2021, at which time Eric Alström, president of Danfoss Power Solutions, suggested the merger of the companies would benefit the technological innovation taking place in the hydraulics industry. Alström stated in an interview with *Power & Motion* that hydraulics have been a strong core business for Danfoss and the inclusion of Eaton Hydraulics would help further strengthen that core business.

When asked what customers could expect from the merger, Alström said combining the capabilities of the two companies would allow better and faster customer support. In addition, a broader range of products would be available and new hydraulic component developments could be expected in the future.

While these and many other company mergers may make it feel as though the fluid power industry is getting smaller, there are also new companies entering the space. Many of these are expanding the capabilities of hydraulics and pneumatics through the incorporation of electronics, bringing mechatronics and other motion control solutions into the mix which will benefit the ongoing transition toward electrification, automation and more. *Read an extended version of this Editor's Note at powermotiontech.com/21247879.*

We want to hear from you!

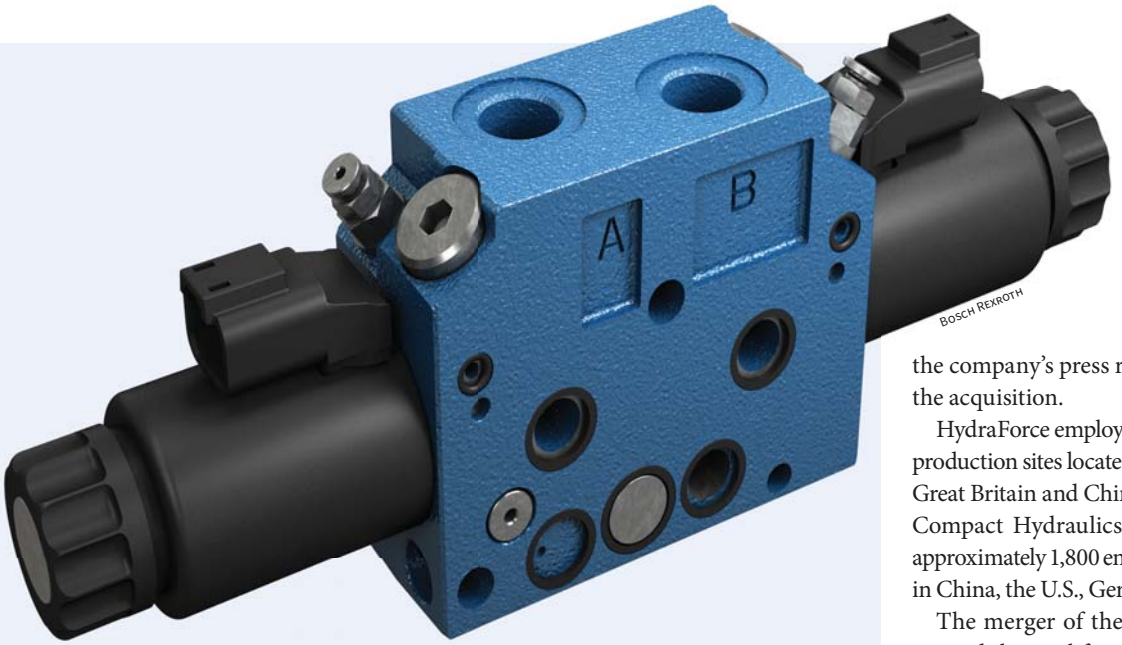
How have you seen company mergers and acquisitions impact the industry? Are there additional opportunities that could be achieved? Let us know!

MiMOTION®

Motion.com

PARTNERS.
THE BEST **PART** OF ALL.®

Motion is a leader in delivering the services and supplies that keep essential industries up and running.



BOSCH REXROTH

Bosch Rexroth to Acquire HydraForce

HydraForce will become a part of Bosch Rexroth's compact hydraulics business.

by Sara Jensen

HydraForce Inc. has signed an agreement to be acquired by Bosch Rexroth. It will join Bosch Rexroth's Compact Hydraulics portfolio, helping to further expand the business unit's product offering and customer support.

The companies signed the agreement on July 15, 2022.

HydraForce manufactures compact hydraulic valves and other hydraulic solutions which are complementary to those in Bosch Rexroth's Compact Hydraulics Business Unit (such as the EDG proportional directional valve pictured above). According to Bosch Rexroth, the merger of the two companies' products will enable a broader range of offerings to meet varied customer needs.

"With Bosch Rexroth, we found a great partner who values and shares similar views on innovation, customer focus, application expertise and culture. I believe the new ownership will create great opportunities for our customers, partners and employees and lead to sustained growth," said Mike Terzich, president and CEO of HydraForce.

Combined Expertise will aid Market Growth

The acquisition of HydraForce will enable Bosch Rexroth to expand its footprint in North America by growing its sales network and gaining access to more markets. "By acquiring HydraForce, we are expanding our presence in complementary geographies and developing a more balanced footprint in Europe and North America, while also enabling growth in Asia," said Rolf Najork, member of the board of management of Robert Bosch GmbH and CEO of Bosch Rexroth AG, in the company's press release announcing the acquisition.

HydraForce employs 2,100 people at six production sites located in the U.S., Brazil, Great Britain and China. Bosch Rexroth's Compact Hydraulics business includes approximately 1,800 employees at locations in China, the U.S., Germany and Italy.

The merger of these companies will expand the workforce and manufacturing capacity to help meet ongoing demand for hydraulic components, particularly in heavy-duty mobile equipment applications which is a strong market segment for both companies. This market is also expected to see continued growth in the coming years.

In addition, HydraForce noted in its press release announcing the acquisition the companies' regional sales structures are also complementary to one another. Bringing their sales activities together will create a well-balanced entity in North/South America and Europe, as well as support further growth in Asia Pacific stated HydraForce in its press release.

HydraForce will also help improve global market access for Bosch Rexroth to indirect sales channels such as dealers and system integrators which benefits the company's long-term goals.

"With its diversified portfolio and international setup, Bosch Rexroth has a strong foundation. The acquisition of HydraForce expands our global market access through indirect sales channels: Sales partners and system integrators will become important target groups. In these challenging times, we are also helping to stabilize regional supply chains so that we can support our customers even better," said Frank Hess, vice president, Compact Hydraulics Business Unit of Bosch Rexroth. **P&M**

Terzo Power Systems Supplying Electrohydraulic Steering Units for Electric Commercial Vehicles

The Hydrapulse EHSU will be paired with SEA Electric's SEA-Drive power system to provide electrohydraulic steering in electric-powered commercial vehicles.

by Sara Jensen

Terzo Power Systems has announced it will supply its Hydrapulse electrohydraulic steering pump units (EHSU) to electric vehicle (EV) manufacturer SEA Electric. It will be used in conjunction with SEA Electric's all-electric chassis, the SEA-Drive power system.

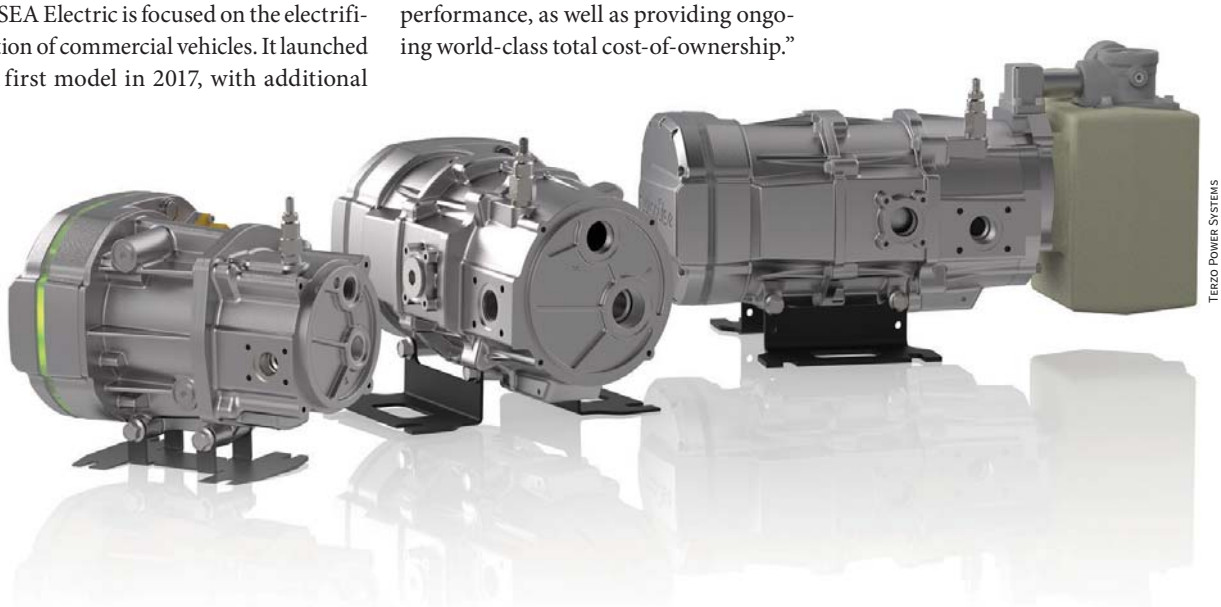
Hydrapulse EHSU is a compact unit containing an integrated motor, controller and closed-loop feedback. It was specifically designed for electric steering applications and mobile steering assist. Low- and high-voltage options are available, as are various pump displacements and power levels.

SEA Electric is focused on the electrification of commercial vehicles. It launched its first model in 2017, with additional models brought to market in various regions around the world since then. Four versions of the SEA-Drive power system are available to meet the power needs of a range of commercial vehicle applications such as trucks, buses and vans.

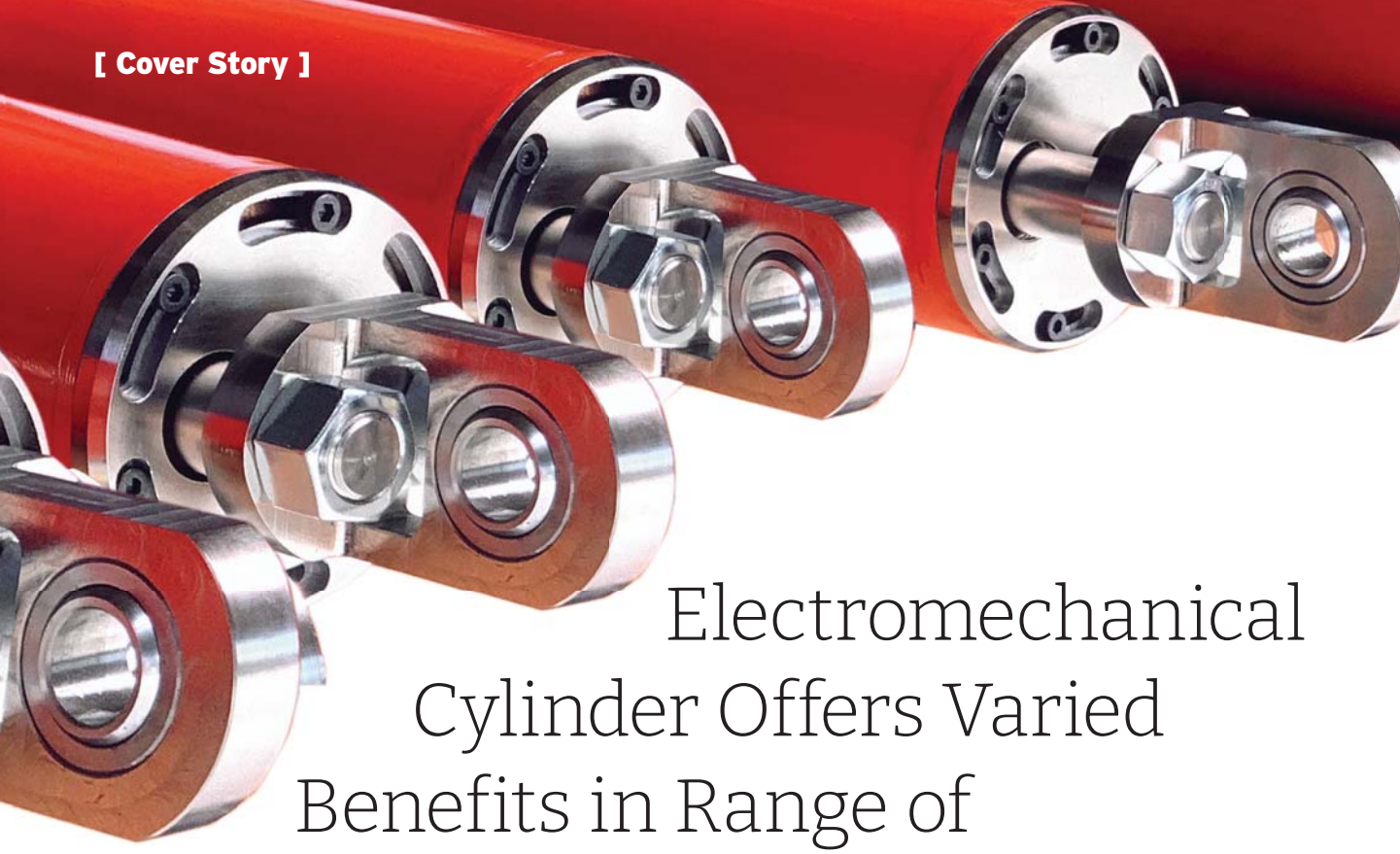
"One of the challenges of modern EV development is ensuring that all systems are as energy efficient as possible, something Terzo brings to the party," said Tony Fairweather, SEA Electric CEO and founder, in Terzo Power Systems' press release announcing the integration partnership. "Incorporating Terzo's cutting-edge Hydrapulse steering units in our SEA-Drive power-system will help us to continue pushing the envelope on EV performance, as well as providing ongoing world-class total cost-of-ownership."

The Hydrapulse EHSU is ruggedly designed, enabling it to meet the heavy-duty requirements of commercial vehicles and other similar applications. Terzo Power Systems states on its website that its EHSU is tested to SAE J1455 automotive standards, which ensures reliability and durability.

Use of permanent magnet technology in the Hydrapulse EHSU enables the unit to provide instant response and power-on-demand for optimized and efficient performance which will benefit productivity for commercial vehicle owners. In addition, the fully-integrated design of the steering unit provides an easy-to-install product for customers like SEA Electric, as all components are contained in a single unit. This also helps to reduce complexity and cost as there are fewer components to install. **P&M**



TERZO POWER SYSTEMS



Electromechanical Cylinder Offers Varied Benefits in Range of HEAVY EQUIPMENT APPLICATIONS

RISE™ Robotics' electromechanical cylinder continues to demonstrate performance benefits over hydraulics such as improved efficiency and precision in new and expanding applications. **by Sara Jensen**

RISE™ Robotics began developing its electromechanical alternative to hydraulics, the RISE™ Cylinder, in 2011. Since then, the company has advanced the technology and formed several industry partnerships to bring the RISE™ Cylinder to market.

"The RISE™ Cylinder is the most advanced yet familiar linear actuator technology," said Arron Acosta, CEO, RISE™ Robotics in an interview with *Power & Motion*. This is because it provides similar performance to hydraulics in regards to its high force, high speed, long stroke, and push and pull motion.

"But it is the most advanced because it leverages advanced belt technology, with a novel way to apply that belt technology so that we can efficiently convert power from the motion of a motor into the push and pull motion in a rod," he explained.

The RISE Difference

The RISE™ Cylinder is a direct mechanical transmission solution which is what enables it to perform in a more efficient manner than hydraulic alternatives. As there is no fluid utilized to create motion, there is also no heat generated or energy wasted which provides more efficient operation.

OEMs who are electrifying their vehicles and equipment are currently challenged with reducing battery size, extending run times, and ensuring durability in heavy-duty applications. With the efficiency provided by the RISE™ Cylinder, Acosta said manufacturers can achieve these goals. "In short, the benefit of the RISE™ Cylinder is smaller batteries and longer run times," he said. "But unlike other electromechanical solutions, it is the most affordable and the longest lasting technology."

The cylinder is durably designed and capable of providing high forces as well as long strokes in the range of 100,000 lbs. and 10 m, respectively, which benefits use in heavy-duty mobile applications such as forklifts and construction equipment.

Blake Sessions, Chief Technology Officer at RISE™ Robotics, said in an interview with Power & Motion the company aims to improve every possible aspect of how machines perform. In addition to integration of the RISE™ Cylinder, it also

provides battery packs and other system components for electrification. Therefore, he said RISE™ Robotics is more than a cylinder company and instead sees itself as a power transmission company.

During a recent project with Anthony Liftgates, Sessions said RISE™ Robotics "developed everything from the battery terminals through to the motion; all the battery management systems, all of the system architecture, [and] all of the software. This reinforces the point that we're not here to ship a cylinder and sub out one cylinder for another."

Instead, RISE™ Robotics is aiming to be a full system supplier for electrification. This can be beneficial for many OEMs as they may not have the in-house capabilities to develop and integrate the necessary technologies to electrify their vehicles and equipment.

Reduced Energy Draw Increases Liftgate Battery Life

RISE™ Robotics announced its partnership with Anthony Liftgates in September 2021. It incorporated the RISE™ Cylinder and accompanying electrification technology into a liftgate from Anthony which was then exhibited at The Battery Show 2021—an annual trade show highlighting the latest in battery and other electric vehicle technologies.

Sessions said the partnership began a couple of years prior to that when Anthony Liftgates visited RISE™ Robotics at its facility in Somerville, MA. At the time, the RISE™ Cylinder was undergoing heavy-duty testing on a test stand. Anthony Liftgates liked what it was seeing from the cylinder during this testing and expressed interest in the technology.

After the visit, Anthony Liftgates shipped one of its liftgates to the RISE™ Robotics team so they could attempt to integrate the cylinder and associated technology. "We were able to retrofit that machine with our cylinder technology and with our power systems, and really show from the beginning what the end game looks like," said Sessions.

He explained that liftgates are typically accompanied by two box sections which are welded underneath the truck onto which the liftgate is attached. One box contains the batteries for the liftgate and the other the hydraulic components for lifting the gate such as the motor, pump and reservoir valves.

By integrating its electromechanical cylinder into the liftgate, RISE™ Robotics was able to eliminate the hydraulic components and the box which contained them. This reduced system complexity as well as vehicle weight.

Ease of installation was another benefit Sessions noted. "You can install cylinders in a matter of minutes instead of days because it is orders of magnitude faster to bolt and plug in components than it is to set up hydraulic circuits," he explained.

Once RISE™ Robotics demonstrated what was possible with the integration of its technology, it began a more hand-in-hand collaboration with Anthony Liftgates to improve upon their design across the board said Sessions. This included the removal of a cylinder while maintaining the functionality of the liftgate.

By integrating the RISE™ Cylinder, he said the battery problems—keeping them charged and ready to provide power as needed—which often occur in liftgate applications are eliminated. Other solutions in the industry include use of solar panels to provide extra power or even fans under the truck acting as generators. But the RISE™ Cylinder solves "the root of the power consumption problem," said Sessions by operating more efficiently and having a lower power draw.

Beyond that, he noted the electromechanical solution is able to provide safe and smooth movements unlike hydraulics which can sometimes be jerky. As there is no fluid used in the cylinder, its environmental impact is minimal as there is no need to worry about possible contamination caused by oil leaking out of the system. In addition, Sessions said there are not as many materials used for the cylinder which brings additional weight savings to the application.

> The cylinder is durably designed and capable of providing high forces as well as long strokes in the range of 100,000 lbs. and 10 m, respectively, which benefits use in heavy-duty mobile applications such as forklifts and construction equipment.

The final major benefit he said of the RISE™ Cylinder is the quality of telemetry which can be integrated into the liftgate. Integration of telemetry is becoming more common in the industry to better evaluate how components are operating. RISE™ Robotics' technology is a completely solid-state design said Sessions with sensors on everything to enable continuous monitoring of voltage, speed, position and other parameters. This helps to ensure the system is operating correctly at all times and immediately alert the truck owner if an issue is detected.

Improved Precision and Military Vehicle Weight

In recent months, RISE™ Robotics has announced several projects it is working on

ALL PHOTOS COURTESY OF RISE™ ROBOTICS

RISE™ Robotics' electromechanical cylinder, seen here at the company's facility in Somerville, Mass., provides an efficient alternative to hydraulic versions. © Copyright 2022 by Liftwave, Inc. dba RISE™ Robotics. All Rights Reserved. US Patent 11255416 Patent Pending: WO2019/014259

with the U.S. Air Force (USAF). Through these, its electromechanical cylinder will be integrated into various machines to help modernize their designs by making them more productive.

Acosta said that while RISE™ Robotics' technology can benefit electrification and efficiency, the precise control and other features of the RISE™ Cylinder can help to provide faster operations and reduce maintenance which are all beneficial for the military.

> "The new partnership with Danfoss is an example of how we are both innovative and both working to find ways to meet the demand for electrification from customers."
>
> —Arron Acosta

One of RISE™ Robotics' projects with the USAF is to develop a prototype of a munitions handling unit for global strike command. The goal is to enable faster loading and reduce downtime.

"[USAF] had identified a problem long before RISE™ came along, where these munitions handling units' load times are longer than they should be because the hydraulics are unable to precisely control the motion," explained Acosta. "Their hydraulics are only doing an eighth of an inch precision, so operators are constantly overshooting and undershooting."

There is a lot of repositioning operators need to do, which prohibits their productivity. Issues with sag and drift often occur as well due to the eventual wear of the hydraulic components noted Acosta. This can cause uncommanded motions to occur, requiring operators to continually reposition the unit.

Integrating the RISE™ Cylinder into the munitions handling unit will enable operators to get quickly and precisely to a position and stay there, said Acosta. "That is our one of our major initiatives, to demonstrate the value of the fastest, most precise actuation technology [the RISE™ Cylinder]."

RISE™ Robotics is also working with the Air Force Research Lab on the development of an ultralight forklift. For this project, Acosta said the company will develop a dual-purpose forklift which is actually more akin to an articulated wheel loader utilized on a construction site.

The USAF uses this machine to load and unload cargo from planes; it is transported to various locations on these planes as well. Creation of a lighter weight machine will make it easier to transport and reduce the amount of load carried on planes.

RISE™ Robotics will integrate its electromechanical cylinder and associated technology to help reduce the weight

of the forklift. Doing so eliminates the need for a pump box and other hydraulics components which can be heavy and add pounds to machinery. It also allows a reconfiguration of some of the physical framing and component infrastructure which has the potential to enable further weight reductions or other design benefits. "We are going to be doing work on figuring out, 'what does the loader the future look like?' And we are really focusing on making ultra-light loaders," said Acosta.

One of the challenges to be figured out is how light the machine can be made as it will still need to be able to lift heavy loads. "There is only so light you can go because you need counterbalance," he said. "So we are going to take it down [a few pounds] and really see how far we can go."

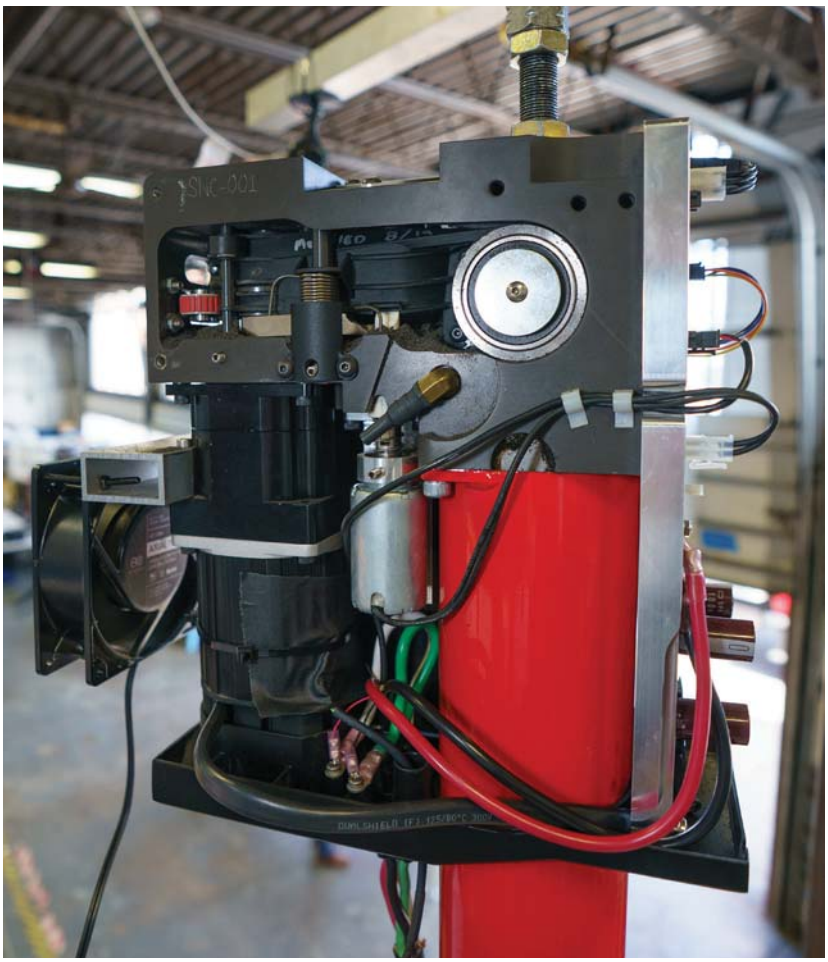
Technology Scale Up for Heavy Machinery Electrification

In May 2022, RISE™ Robotics announced it would begin collaborating with Danfoss Power Solutions on electrification of off-highway equipment using the RISE™ Cylinder. "Danfoss is thrilled to collaborate with us to explore what we have achieved and how it can benefit them and their customers," said Acosta.

For RISE™ Robotics, the partnership with Danfoss provides the ability to scale its technology and bring it to various machines and regions around the world. While it could slowly work at building up its manufacturing capacity, Acosta said that can be time consuming and capital intensive. "At the end of the day, when we succeed that means the existing industry would shrink," he said. "And that just seems like a slow and destructive technique.

"The new partnership with Danfoss is an example of how we are both innovative and both working to find ways to meet the demand for electrification from customers," he continued.

Working together will actually help accelerate development of necessary technologies and the creation of near-term low-carbon solutions, said Acosta. This is because both companies will be able to bring together their expertise and industry knowledge which makes it easier to ensure the right technologies are developed for given applications.



Testing of the RISE™ Cylinder at the company's facility in Somerville, Mass.

Acosta said RISE™ Robotics will bring to the partnership its engineering services and the IP for its technology, and will work together with Danfoss' innovation team which has experience in a variety of technologies and applications that it will bring to the partnership.

Much of the work being done between the two companies is still in the early stages, but in general Acosta said there is a broad vision to bring electrification to a range of heavy-duty equipment. For the time being, the companies are focusing on one specific example and will expand its efforts from there.

"When we succeed with that example, because of its size, performance and demanding attributes, it will become a case study or a bookend on multiple parts of the business," said Acosta. Essentially, between the Anthony Liftgates partnership and Danfoss collaboration the industry will be able to see the broad range of applications in which the RISE™ Cylinder can be applied. "Other customers will be able to see if they can interpolate [possible uses] between those [applications]. They will be able to see the beginnings of a full catalog [of solutions]," he concluded. **P&M**

A Technical Comparison: Pneumatic Cylinders and Electric Rod Actuators

A look at the performance criteria of electric and pneumatic sources of automated linear motion.

by Ryan Klemetson

When it comes to designing applications that need linear motion, engineers are often drawn into the debate about which is better for automation: pneumatic cylinders or electric linear actuators.

Pneumatic cylinders have long been used as an economical source of linear motion across a broad spectrum of manufacturing processes. They are durable and simple to install, and they provide a low-cost method of providing what's needed for linear motion and forces. But electric rod actuators have become an economical alternative for linear motion. They can provide control and reliability advantages while meeting an application's requirements.

Here's a technical comparison of the performance of the two when it comes to critical criteria such as motion control; force; velocity, acceleration and deceleration; system components and footprint; reliability, life and maintenance; data collection; efficiency and utility costs; and shock and side loads. It should help design teams choose the best approach.

Motion Control

Pneumatic cylinders easily accomplish basic end-to-end positioning. Mid-stroke positioning, however, requires adding hardware to hit that third position, which results in positional performance that is not very accurate or repeatable. Servo-pneumatics can address these positioning issues, but they complicate the design and add costs which make their cost structure similar to that of electric actuators.

In addition to positional accuracy and flexibility deficiencies of pneumatic cylinders, speed control can also be a challenge and requires fine-tuning. In pneumatics, speed control is monitored through flow controls. Operators must manually dial in an application's speed, which can be difficult to meet. Once the speed setting is adjusted, the valve regulates the pressure output required from the cylinder. Again, operators must fine-tune the cylinder to get the desired force.

Finally, a pneumatic cylinder's repeatability of position, speed and force can be diminished by worn seals, leaks, pressure drops and spikes in the compressed air, as well as other maintenance factors. These factors often make it difficult for pneumatic cylinders to provide repeatable performance in demanding industrial environments.

Electric actuators are often chosen by

Victor Kodunov/Dreamstime

designers to get control over multiple positions, accuracy, repeatability, output force, acceleration, deceleration and velocity at any time during the motion.

Electric actuators, coupled with a servo drive and motor, offer infinite control over position, as well as positional accuracy and repeatability far beyond that of pneumatic systems. Additionally, multi-axis servo controllers are readily available off-the-shelf for most modern control systems and can be easily used with several linear and rotary axes to run even the most complex motion profiles. This motion control and flexibility can be programmed into PLCs, HMIs and other controllers.

With these added capabilities, machine start-up and change-over times are fast and repeatable. This lets OEMs easily boost performance and that translates into more productive processes.

Force

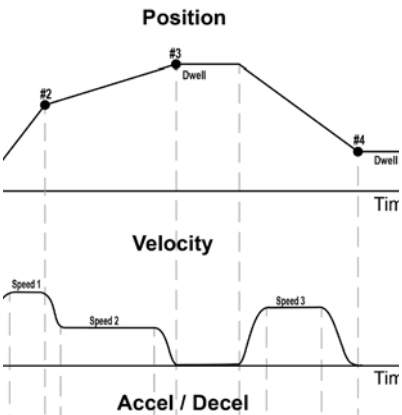
Pneumatic cylinders typically operate at pressures from 80-100 psi or 5.5-7 Bar. They follow the Force = Pressure × Area fluid power principle, so the forces they can generate are easy to calculate.

However, pneumatic cylinders are typically not used at their full output force and are often oversized to improve control and ensure system operation. With pneumatic cylinders, system rigidity can be viewed as low due to the compressibility of air. This can lead to slight system delays and process variability due to the time lag needed for pressure to build.

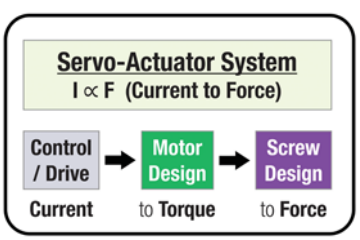
Electric actuators can precisely control the power going to the servo motor that drives the mechanical components to create both linear movement and force. Force is generated almost instantaneously and is essentially "on demand."

The servo controller's closed-loop control enables precise, repeatable speeds and forces. This ensures processes are consistent cycle after cycle while preventing damage to the product or system.

When selecting electric actuators, designers should match the motor's rpm and torque to the actuator's screw lead and gearing. Although this step may appear to complicate the process, many companies that make actuator and servo components provide easy-to-use sizing software that takes all these variables into consideration.



Motion profiles graphed at different velocities with varying accel/decel rates, all under full and precise control.



Electric actuators precisely regulate current through the servo motor to achieve accurate and repeatable force.
All images courtesy of Tolomatic

Velocity, Acceleration and Deceleration

Pneumatic cylinders can generate high velocities if compressed air volume and pressure are readily available. With sufficient volume and flow, pneumatic cylinders operate at high cycle rates in basic end-to-end positioning applications without the need for detailed sizing or application engineering.

A common challenge of pneumatic systems is that the velocity of commanded motion is difficult to accurately and repeatedly control. Engineers designing pneumatic systems that will operate at high linear speeds, or with high acceleration and deceleration rates, must typically consider shock absorbers or design for the shocks and impacts that may be present. If they don't, the resulting shocks and impacts can shorten the service life of air cylinders and associated components.

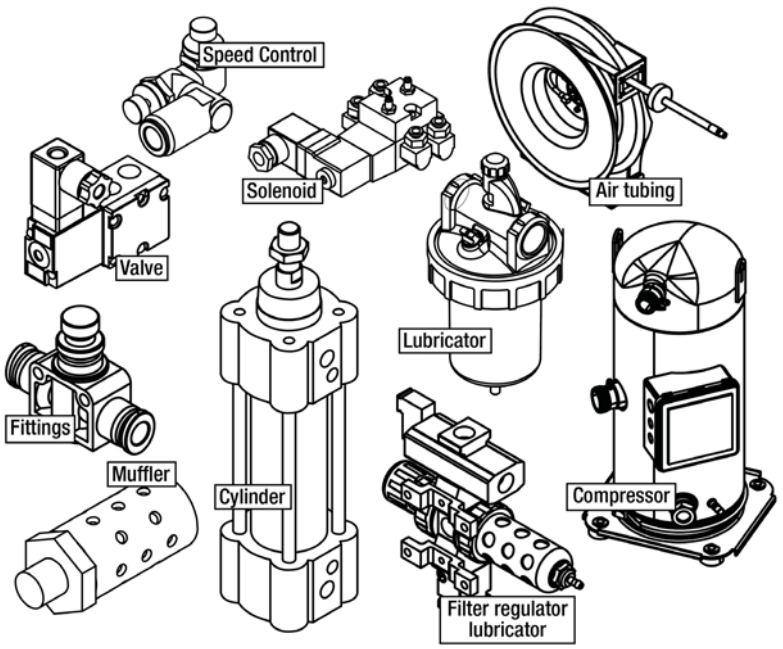
Electric actuators can precisely control velocity and the acceleration/deceleration profiles throughout the motion profile. They can also be easily changed from one speed to another without stopping or over-running position. Velocity control improves overall performance, minimizes move times, and increases cycle rates and overall productivity. And the smooth motion eliminates the potential for shocks and impacts, which improves the machine's overall reliability and reduces risk of downtime.

Providing high speeds and forces simultaneously requires a more involved sizing process. Designers will need to assess various screw leads, gearing and servo motors that have the range of rpm and torque capabilities to meet their requirements. The combined limitations of these may restrict the actuator's maximum velocity or thrust capabilities. In some cases, pneumatic cylinder systems offer higher overall linear velocities. However, overall cycle time can often be reduced when using electric actuators operating at similar, but lower, velocities. This is achieved by moving only the minimum amount of distance necessary instead of running end to end as is required when using air cylinders.

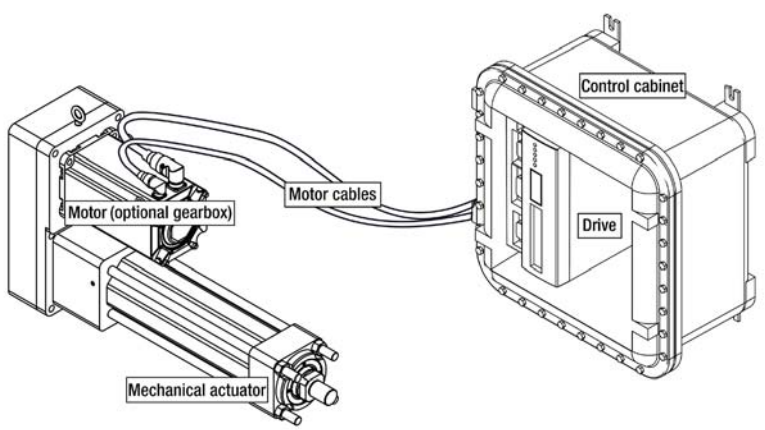
System Components and Footprint

Pneumatic cylinders require a cylinder, compressor or compressed air supply, valves, filters, regulators, tubing and fittings, as well as ancillary components. This results in an increased component count compared to electric actuators.

The compressor or compressed air supply takes up additional floor space at the machine, or requires a compressor room, which consumes significant plant space. When factoring the compressor into the overall footprint, pneumatics have a larger



Pneumatic systems consist of several components and accessories.



Electric actuator systems have relatively few components.

total footprint in the plant than electric actuators.

Most compressed air supplies also need overhead air hoses and air drop lines to bring compressed air to the workstation. These long hoses mean there's more air to compress, an increase in potential leaks and a decrease in overall efficiency.

Electric actuators are physically larger than pneumatic cylinders and are rarely if ever a drop-in replacement, so they need more space. However, electric actuators have fewer components: a mechanical actuator; a motor (servo or other); an optional gearbox; cables; and a drive/amplifier, which is usually housed in a control cabinet.

Electric actuators, due to having powertrain components (power screws, bearings, etc.) inside the assembly, are longer than pneumatic cylinders. But this additional length is more than compensated for by the actuator's smaller overall footprint.

Reliability, Service Life and Maintenance

Pneumatic cylinders can provide rugged performance and have a long service life if properly maintained. One key element necessary for long service life is durable rod and piston seals. They must maintain proper engagement with their sealing surfaces to contain the pressure required for the given motion and force.

As the cylinder cycles back and forth, seal wear is inevitable. Any leaks decrease the cylinder's efficiency, force, speed and responsiveness.

Predicting when seals may fail and when to carry out timely maintenance can be almost impossible. As seals wear, operators must manually adjust air flow rates and pressures on individual devices to ensure proper machine operation and process repeatability.

Many factories have preventative maintenance and replacement schedules for pneumatic cylinders to avoid unexpected downtime. The schedules must include time to test and tune systems on startup. Although periodic maintenance for pneumatic cylinders increases machine and process reliability, it also adds time, labor and costs for replacement parts, and someone must manage the maintenance schedule.

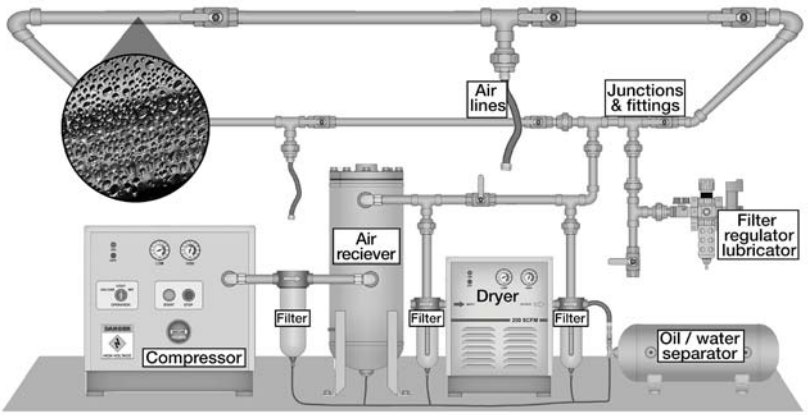
A final factor in cylinder reliability and service life is taking care of the air supply so that the compressed air is clean and free of moisture. Condensation in air lines can prematurely fail pneumatic components through corrosion and create an environmental risk through bacterial growth that might contaminate the manufacturing process.

Electric actuators can be sized for the application's life requirements. Their main torque and force transmission elements—the screw assembly (ball or roller screw) and bearings—have dynamic load ratings (DLRs) that estimate the actuator's service life. Designers can use the industry standard L10 life estimates to size and select components to help ensure equipment meets the life requirements. Some of these components may be greased for life. For those requiring maintenance, there are easy, in-the-field greasing methods to extend their service life in demanding applications.

A secondary wear element on electric rod-style actuators is the rod seal. It keeps water, dust and other contaminants from getting inside the actuator and damaging torque transmission components. Unlike

seals on pneumatic cylinders, those in electric actuators do not have the precise sealing requirements needed to contain high pressures. Even if the seal fails, electric actuators will still function. Rod seals on most electric actuators can be easily and inexpensively replaced.

Misuse is the primary reason electric actuators fail. The most common forms of misuse are exceeding the actuator's performance specifications for extended periods of time and damage during commissioning or installation due to inadequate attention to controls parameters.



Pneumatic/compressed air systems can be extensive and require lots of maintenance and servicing.

Data Collection

Pneumatic cylinders can have proximity sensors with IO Link or an Ethernet valve bank to supply performance data. But without expensive linear transducers and other sensors to provide absolute-positioning feedback, the information reported back to the controls system is often inadequate to tightly monitor and control a process in real time.

Electric actuators commonly use servo drives that are available with off-the-shelf features that let operators monitor and send performance data to data acquisition systems. Current supplied to the motor can be easily used to track force and repeatability. The feedback device on the motor is used to accurately track position, velocity and acceleration/deceleration during the entire motion cycle at any point in time. With this data for every cycle, engineers can closely monitor actuator operation and then improve machine performance, reliability and controls.

Efficiency and Electricity Costs

Pneumatic cylinders, the support components and the compressed air supplies typically operate at 10-20% efficiencies. Many factors affect this efficiency, including the number of components, leaks and air quality. As efficiency changes, so can accuracy and repeatability. Additionally, pneumatic systems must always be pressurized to guarantee specified motion and force. When the system is active, compressors must run even though many of the cylinders may not be working—an inefficient use of power.

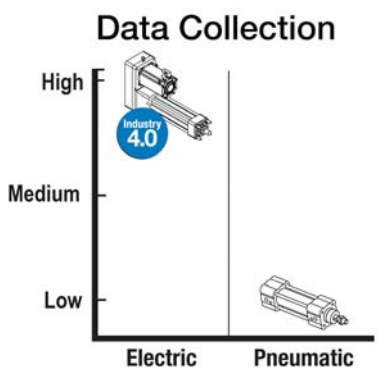
This inefficiency is exacerbated if there are leaks. The compressor continues working, providing air p ressure and volume flow while air continuously leaks. Even several small leaks can mean a significant loss of air. The increased demand on the compressor adds to electricity costs. And in large plants with complex compressed air subsystems, it can often be difficult to locate and fix all the leaks in a system.

Electric actuators typically operate in the 75-80% efficiency range. Thanks to the mechanical construction and torque-transmission components, this efficiency remains consistent over time.

Electric actuators only demand current to the motor when force is needed. This means that when electric actuators are at rest, they require little to no current to hold position (unless force is required), which lowers electrical use and costs.

While pneumatic systems always need energy to maintain system readiness and responsiveness, electric actuators provide motion on demand and are highly efficient when operation is required. The use of holding brakes can further increase efficiency by holding large loads in place while power to the actuator is switched off.

With increased regulation requiring many manufacturing companies to limit or cap their use of electricity which, in turn, limits compressed air use, electric actuators are often put in place to lower electricity use and meet green and energy efficiency goals.



Electric actuators can use Ethernet connectivity for Industry 4.0 and Internet of Things (IoT) designs.

Shock and Side Loads

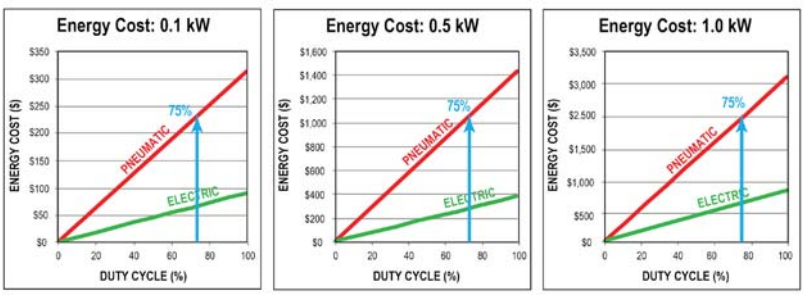
Pneumatic cylinders often use an integral air cushion that lets them withstand shock loads. Shock loads in line with the cylinder's rod are typically absorbed by the piston reacting against the compressed air in the cylinder.

Side loads due to misalignments or forces from a moment arm put stresses on both pneumatic cylinders and electric actuators. In pneumatic cylinders, they can cause premature wear or seal failure. This leads to poor velocity and force performance, an increase in leaks and premature cylinder failures. To protect against side loads, pneumatic cylinders should be aligned with the intended axis of motion.

Electric actuators, with their screw assemblies and bearings, lack any

Calculating the Power Costs of an Application

1. POWER-OUT (kW) = Velocity (m/sec) x Force (N) ÷ 1,000 (converted to kN)
2. POWER-IN (kW) = Power-Out (kW) ÷ Efficiency (%)
3. COST OF APPLICATION $ = (Power-In) x (Hours/year) x (Electricity Cost)



ASSUMPTIONS: Electric Efficiency 79%; Pneumatic Efficiency 22%; Cost kW/hr $0.08

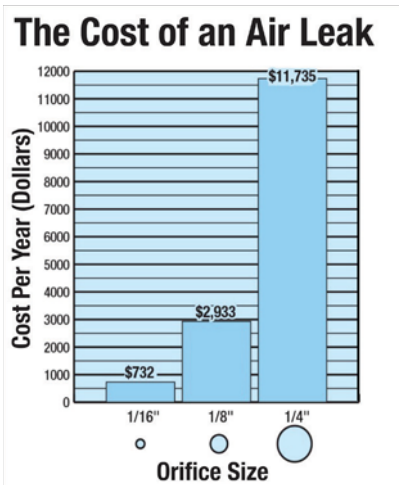
Here is a graphic method of estimating the power used and estimated electric utility costs for an electric actuator. Blue arrows depict cylinder operation at 75% duty cycle.

	Electric Cylinder		Hydraulic Cylinder	Pneumatic Cylinder
Specification	Roller Screw	Ball Screw		
Motion Profile Control & Flexibility	Easy and most capable	Easy and most capable	Limited or complex servo-hydraulics	Limited or complex servo-pneumatics
Positional Accuracy & Repeatability	Best accuracy and repeatability	Best accuracy and repeatability	Limited with complex servo-hydraulics	Limited with complex servo-pneumatics
Max Force	Very high	High	Highest	Medium
Max Speed	High	High	Very High	Very High
Actuator Life / L10	Very high / calculated	Medium / calculated	Medium / NA	Medium / NA
Maintenance	Minimal	Minimal	High	High
System Efficiency	~75%	~80%	~40 to 55%	~10 to 25%
Energy Consumption	Low	Lowest	High	Very high
Shock Loads	High	Low	Very high	Very high
Operational Temperature Tolerance	Very tolerant & efficient	Very tolerant & efficient	Seal failure, sluggish operation	Seal failure, sluggish operation

This chart describes the relative performance of electric, hydraulic and pneumatic cylinders.

inherent protection against shocks and side loads so they can shorten the actuator's life. In some cases, it helps to oversize the actuator to better withstand anticipated shocks. Using a roller screw also adds protection against shock loads because it provides more contact points (rollers as the load transfer element from the nut to the screw) to resist the loads. Another layer of protection can be provided by adding shock absorbers, depending on the size of shock and load.

Electric rod style actuators also don't handle side loads well. They put lateral forces on the actuator's front rod seal as well as the screw and nut. Increased loading on the rod seal often puts more wear on it which lets contaminants into the actuator and causes premature screw and bearing failures. Additionally, side loading on the screw and nut can shorten their life.



Air leaks in a facility's compressed air subsystem can be costly. This chart shows the estimated annual costs of different-sized leaks in a compressed air network. They are calculated using the industrial electricity rate of $0.07 per kWh and assume consistent operation and an efficient compressor.

Summary

Pneumatic cylinders have a reputation as economical automation components. It is significantly less expensive to install them than an electric actuator/servo if there is already a source of compressed air. But pneumatic cylinders have some drawbacks compared to electric actuators. For example, they are generally limited to two-position motion profiles; they have more components; they have shorter and unpredictable lives; they need to be manually adjusted; and they consume more electricity.

Electric actuators let designers reliably control position, velocity, acceleration/deceleration and force. In addition to this flexibility, electric actuators can be correctly sized for the life of the application. Electric actuators can also use closed loop control which simplifies the task of collecting data and improving process control. They are virtually maintenance-free and highly efficient and don't need compressed air, which lowers costs. They also often have lower total cost of ownership versus alternative pneumatic cylinders despite their higher initial purchase price. **P&M**

Ryan Klemetson is a business development manager at Tolomatic Inc.

All images courtesy of Ohio Fabricators Co.

A Checklist for Sizing

HYDRAULIC FILTERS

Here are a dozen questions designers and operators should consider before choosing a new or replacement filter for a hydraulic system.

by Don Krause

To get the best performance out of a hydraulic system, it is essential that it have proper filtration. Choosing the right type of filter and sizing it properly could be the difference between a smooth running, long lasting hydraulic subsystem and one that performs poorly and is often down for maintenance.

But selecting the proper filter is not a simple task for designers or operators who must replace old or damaged filters. Even if a maintenance team is replacing a damaged filter with one just like it, the team should ensure it is the right filter for getting the job done efficiently and effectively.

To get the right filter, engineers and designers need to know and understand hydraulics and the application, including its performance requirements.

Here are a dozen questions designers and operators should

consider before that will help designers get to know the application and choose just the right filter.

What is the pump's flow rate? Knowing the pump's flow rate for the fluid will determine the filter media's surface area. Table 1 on p. 22 shows an approximate filter size (in square inch of filter media) and the acceptable flow rates.

What is the pipe size? Flow rate and pipe size go hand in hand. The filter must be properly sized to keep the pressure drop compatible with the fluid passing through it. A pump putting out 50 gpm, for example, will create less pressure drop when going through a 3-in. npt (American National Standard Taper Pipe Thread) pipe than through a 1-in. npt pipe. The pipe size will help focus filter selection. A general reference chart on p. 22 (Table 2) relates pipe size to flow rate.

Typically flow velocities in hydraulic subsystems should be high enough to ensure the subsystems run smoothly and efficiently. In pump suction lines, flows should be travelling roughly 2-4 ft per second (fps); in pressure lines, 10-25 fps is the range for fluid velocities; and for return lines, the figure is 5-10 fps.

What is the working system pressure? The answer to this question will let designers choose a filter that will withstand that anticipated pressure. If the filter can't and it collapses, it will likely lose its integrity, break down, damage the entire hydraulic subsystem and lead to a possible breakdown. To make matters worse, when a filter collapses, fragments of epoxy or filter media are injected into the flow stream and can damage downstream equipment.

What is the fluid? Is it standard hydraulic fluid? Is it a petroleum-based product compatible with the equipment? These answers will let designers and operators know if the fluid is compatible with all system components as well as filters. If it is not, be prepared for serious system damage or destruction.

This pump motor was destroyed by contamination.

To get the right filter, engineers and designers need to know and understand hydraulics and the application, including its performance requirements.

For example, if phosphate ester is the process fluid, polyester, nylon and stainless steel filter media are fine, but polypropylene is unacceptable. Standard hydraulic oils are compatible with filter media such as cellulose, polyester, polypropylene, stainless steel and most other types of media. The point is to ensure that the process fluid, filter media and seal material are all compatible. If there are any compatibility issues in any area, there will be leaks and major contamination problems.

What is the fluid's viscosity? Standard hydraulic fluid has a viscosity of 150-200 SUS (Saybolt Universal Seconds, the time [in seconds] for 60 ml of oil to flow through a standard orifice at a given temperature). Any fluid with a higher viscosity is thicker than standard hydraulic fluid. Fluids with higher viscosities create higher pressure drops as they flow through the system, especially during cold weather start-ups. Designers and operators should be aware that allowable initial pressure drops vary widely from component to component and so they should know system requirements for pressure and ensure they will be met.

What type of pump is being used? Is it a piston, gear, vane or other type of pump? This is important to know when installing a new or replacement suction strainer. Suction strainers keep contaminants out of the pump, the most important component in a hydraulic subsystem. Different types of pumps sometimes require more protection. Chart 1 on p. 22 provides general guidelines for adequately protecting hydraulic pumps.

What mesh or micron should be used? To completely size a filter, knowing the filtration level is critical to efficiency. Suction lines should be no finer than 200 mesh (74 micron). Having filtration that

Piston Pump
Low pressure: 250-500 psi - use 100 mesh (149 micron)
High pressure: 1,000-2,000 psi - use 200 mesh (74 micron)
Gear Pump
Low pressure: 250-500 psi - use 30 mesh (595 micron)
High pressure: 1,000-3,000 psi - use 100 mesh (149 micron)
Vane Pump
Low pressure: 250-500 psi - use 60 mesh (238 micron)
High pressure: 1,000-5,000 psi - use 100 (149 micron)

Chart 1: This chart is a general guide to adequate protection for a pump.

is too fine on the suction side can cause pump cavitation. (See Table 1 for guidelines on filter mesh.)

Typically, the pressure line has the finest filtration in the system because it is the most critical. So, the pressure line filter mesh could be in the sub-micron area, depending on the application. The return line should be anywhere from 5-74 microns, again depending on the application. This is an area that should be looked at closely because applications, requirements and operational scenarios vary so much.

What type of filter is required? If it is a suction strainer, is it in-tank or in-line?

FLOW RATE (GPM)	FILTER MEDIA (SQ. IN.)
3	33-38
5	55-65
10	110-118
20	150-165
30	250-270
50	300-330
75	355-405
100	455-500
150	640-690
200	965-1050
400	1740-1800

Table 1: All figures are approximation based on 149 microns at a standard operating temperature of 100°F. This allows for flexibility when using other levels of filtration and lets the table serve as a guideline.

FLOW RATE (GPM)	PIPE SIZE (NPT)
2	1/4" - 1/2"
3	3/8" - 3/4"
5	3/4" - 1 1/4"
10	3/4" - 1 1/4"
20	1" - 1 1/4"
30	1 1/2" - 2"
50	1 1/2" - 2"
75	2 1/2" - 3"
100	2 1/2" - 3"
200	3" - 4"
400	4" - 6"

Table 2: Common sense dictates that the higher the flow rate, the larger the pipe should be. Here are general approximations that relate flow rate to pipe size.

Is it a replacement filter for an existing housing or does it also have a cartridge that must be replaced? Is the filter media wire cloth, cellulose or synthetic? If it's a synthetic material, has it been performing properly?

Will the system operate continuously, intermittently or infrequently? If a system operates continuously, possibly working three shifts per day, the filter chosen must be able to endure the rigors of that operational pace. If the filter will be used in a subsystem that operates only once in a while, a less costly filter may do the job. The worst possible occurrence is machine breakdown because the filter installed couldn't withstand the operation.

What is the system operating temperature? A hydraulic subsystem's standard operating temperature is usually around 100°F. If the temperature runs hotter than that, the system should be kept cool. Too hot a system destroys seals, causes leaks and breaks down the fluid. Either a cooler should be installed or high-temperature seals made of Buna, Teflon or Viton should be used.

Is the system mounted inside or outside? Moisture is the second most damaging contaminant in any hydraulic subsystem. With outdoor hydraulic subsystems, exposure to rain, snow and humidity gives water a good chance of getting inside them. To prevent this, adding hygroscopic breathers can keep water out. Even in some indoor systems, depending on the local weather, moisture can cause problems. It may be necessary to use stainless steel filters with housings to prevent corrosion. If unsure if the metal in the filter is stainless or plated steel, find out what the other components are made of as that may help determine which materials should be used.

What about the air that gets into the reservoir? The tank breather is an area of hydraulic subsystems which seems to be neglected and not serviced as often as it should. As reservoir fluid levels rise and fall, atmospheric air enters and is expelled. The air carries both particles and moisture which contaminate the fluid held in the reservoir. To keep out these contaminants, a hygroscopic breather may be warranted.

Sizing this component is just as critical as any other filter. Air intake is measured in standard cubic feet per minute (scfm or just cfm). A general rule of thumb for sizing a tank breather is to divide the pump rating by 7.5 to get the cfm. For example, if the system is running at 100 gpm, then divide that by 7.5 to get 13.3 cfm. Most small breathers are rated for up to 35 cfm and are available with 3-5 micron filtration. Remember, it is permissible to oversize the air filter.

The answers to these questions will help designers and operators choose the best filter for a specific hydraulic subsystem. To protect the entire subsystem, all lines—suction, pressure, return and tank breather—must be adequately and appropriately filtered to keep it running smoothly and efficiently. P&M

Don Krause is general manager of business development at Ohio Fabricators Co. in Coshocton, Ohio.

MAINTENANCE Needs a Seat at the Table

SCHAEFFLER Americas' Frank Mignano discusses the state of condition monitoring and its future applications.

by Bob Vavra

As part of the *Power & Motion* Insights video series (*powermotiontech.com/21243022*), senior content director Bob Vavra discussed the present and the future of condition monitoring in the age of Industry 4.0 with Frank Mignano, condition monitoring manager for SCHAEFFLER Americas. They discussed how best to determine critical fluid power assets, how sensor and battery technology have evolved, and how modern systems capture and display data using machine learning and artificial intelligence. The interview has been edited for length and clarity.

Bob Vavra: From your perspective, why is condition monitoring so important?

Frank Mignano: I've been dealing with condition monitoring products, sales and application of portable continuous vibration systems for the past 30 years and for about all 30 of those years, there's absolutely no reason a piece of rotating equipment should fail without notice. Every vendor has a version of that typically, and that allows us to see what's going on with the bearings. We block out the low frequency things; we focus in on the condition of the bearings, gears and even lubrication. And there's simply no reason why a piece of rotating equipment should fail.

If you do a criticality study of a plant, you become the maintenance manager. You're responsible for now 5,000 assets. You go through a criticality study, and you define the criticality of the assets because the more critical it is, the more kinds of things you're going to do to it. And typically out of that, 10-20% will be critical. You want to have some sort of online monitoring because that's costly. Everything goes through that bottle filling machine or that extruder gearbox. And so that makes it critical.

But 60-80% of the assets would be the balance of plant. These are your process motors, pumps, fans, compressors. When

you look at how to maintain balanced plant assets, the goal is to collect vibration once a month. That has provided tremendous value over the years, with great ROI (return on investment) on those systems. They're still prevalent today, obviously.

But what Industry 4.0 does is, we amplify that. We have a much closer look as to what's going on with that asset. Instead of getting one set of readings a month, we're getting six sets every single day. Over a month, we'll have a trend of 180 points. We now have a very, very good idea of the condition of that asset right up to date, right now, on your phone.

BV: You can monitor everything, but should you? How often do you do the six times a day versus one time a week versus one time a month? How do you do that deeper analysis into your system?

FM: Again, one of the things that I notice quite a bit these days is when you go out to visit facilities, there's not a lot of people there. I mean, it used to be a department with three or four or five guys, and it's one guy now wearing five hats, and he barely has time to have a sandwich in the middle of the day. So that's one avenue that we address with these types of systems.

Data collects itself now and automatically analyzes itself, so this is a tremendous tool for industry. It doesn't matter if you're making potato chips, French fries, beer, cement, paper, whatever it is, there are process machines that need to be maintained because we all know that breakdown maintenance is the worst way to maintain your assets. It's the most costly [method]. You have to fly parts in, you have to keep people late. And [the assets] always fail at 2 a.m. on Friday night. It's just a rule of thumb. That's what happens.

BV: Run to failure; I've never seen that as a particularly good maintenance strategy. It's just a disaster. It increases cost and exacerbates safety problems. But there are machines on your floor that you can run to failure.

GOLDEN SIKORKA | GETTY IMAGES

"It doesn't matter if you're making potato chips, French fries, beer, cement, paper, whatever it is, there are process machines that need to be maintained because we all know that breakdown maintenance is the worst way to maintain your assets."

So how do you section those off and what kinds of machines do you see are most likely to run to failure?

FM: To continue what I was saying before, 10-20% [of equipment] would be critical, 60-80% would be the balance of plant and then another 10-20% would be run to failure because they have no effect on production. It's a 10-hp motor; it's not even worth the time to even stop and look at it. Run to failure is absolutely a good maintenance strategy for the right asset.

That's why doing a criticality study is really important. It's not only rotating equipment—you do it on instrumentation, you do it on tanks and vessels and piping. It takes all the opinions out of it. You say, "we have a failure that costs us over $50,000," well, that's critical. A refinery might be $250,000. Somebody making potato chips, it might be $10,000. So, you build a program for that site and, that's what falls out of it. Run to failure is absolutely an acceptable strategy for those pieces of equipment that really are not having an effect on production and not very costly to replace.

BV: And you want to be able to take a look at the cost of having those replacement parts on site rather than carry that motor in your stockroom just waiting for something bad to happen.

FM: Exactly. That's another opportunity to implement these types of technologies.

GOLDEN SIKORKA | GETTY IMAGES

> That's why doing a criticality study is really important. It's not only rotating equipment—you do it on instrumentation, you do it on tanks and vessels and piping. It takes all the opinions out of it.

Spares optimization—that is a huge opportunity to save money for a lot of sites. I know there's a lot of good work that's been done. A lot of our distribution partners can go out and work with end-users because a lot of times they have a big giant motor that has no place in the plant anymore because they've changed the process somehow. There's no reason to keep this motor; sell it, write it off, get rid of it. You're paying money to have these things in stock.

By implementing Industry 4.0-type technologies, you're going to have the health of that asset right away on your phone; any changes, you're going to know about it. And then we work with our distribution partners to ensure that the replacement parts—whether it's a coupling, a shaft, a motor, pump, whatever it happens to be—are available and can get to the site by the planned outage day, and that the people who have the skill set to go do the repair are also available, typically during day shift when costs are minimized.

BV: Let's talk about some of the new technology that's out there. I know Schaeffler has OPTIME, your own wireless condition monitoring platform, but the idea of condition monitoring wireless battery-powered systems: What does that give the plant operations team, the maintenance team today, that they haven't been able to have before?

FM: Constant, consistent coverage of the healthy asset. With the portable system, it's manpower dependent and, unfortunately with COVID, people are out for a week or two weeks. It's a critical time. You lose that monthly collection: It slips to six weeks, eight weeks. Then you're moving into territory where these are just spot checks. There's not a condition monitoring program anymore. We're just walking around and seeing what's going on today.

Then there's hard-to-reach things—pumps, fans that are up three flights in cement mills. I don't know if you've ever walked around those, but you got to climb a lot of stairs and there's motors and fans on every deck. You just put a sensor in, you put a gateway nearby and, boom, the whole process is automated.

The other advantage of implementing these types of technologies is, it's not to replace the people that are collecting the data. Now, we have an opportunity to take those people and have them work on more important tasks, such as why are we only getting two years out of this pump? You should get five to seven to eight years out of a motor pump.

It comes down to things like root cause failure analysis and doing precision maintenance. When you look at reliability as a whole, there's so many components that all need to come together. And it's really difficult to have a good reliability program because there are so many components. You go through the strategy, you define the work that you're going to do…who's going to do it? Is it electrical, is it mechanical, is it instrumentation? You get all that lined out and you have people that can go out and do the work. You have to train those people.

BV: We're talking about breaking down silos from between design and operations, between operations and maintenance, and really from the C-suite down to the plant floor. There's always been disconnects and it's been based on the lack of information that is available to everybody, so that everybody understands everything about what's happening in the facility. And that's one of the things that we've seen with concepts like machine learning and AI. They're now giving the right

THE #1 TRADE SHOW & CONFERENCE FOR **FLUID POWER, POWER TRANSMISSION, AND MOTION CONTROL**

CO-LOCATED WITH CONEXPO-CON/AGG
(two shows, one price)

The **International Fluid Power Exposition (IFPE)** is the place where engineers meet to:

- **Spark new ideas** with in-depth technical conversations with other engineers.
- **Discover solutions** current suppliers can offer to your unique challenges.
- **Find new partners** among suppliers pushing the envelope on what fluid power can do.

CONNECT WITH TOP MANUFACTURERS

Including **Bosch Rexroth**, **Danfoss Power Solutions**, **Parker Hannifin**, **Poclain**, **IFM Efector**, **Hawe Hydraulik**, **Husco**, and 375+ more!

Join your peers from these OEMs:

- Caterpillar Inc
- Volvo Construction Equipment
- Liebherr
- CASE Construction Equipment
- Komatsu
- John Deere Construction
- Doosan Bobcat
- KOBELCO Construction Machinery USA
- LBX Company

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

KEN ROSENBECKER SALES MANAGER NORTH AMERICA | WIPRO INFRASTRUCTURE ENGINEERING

IFPE ONLY HAPPENS ONCE EVERY THREE YEARS!

SAVE 20% OFF REGISTRATION

Register now at **IFPE.com** and type **AD20** in the Promo Code box

INTERNATIONAL FLUID POWER EXPO

MARCH 14-18, 2023

LAS VEGAS, NV, USA

information to the right person in the right context so that they're individually able to understand all the things they need to understand without having to worry about things that don't really directly affect them.

FM: You know, that's the beauty of these technologies. If I could put my Schaeffler shirt on here, with the OPTIME system, one of the unique things that we do is we provide actionable information. So, we're not just providing a bunch of trends and time waveforms for the end-user to try and figure out what's going on. Schaeffler has been developing and deploying condition monitoring for a long time.

And of course, we're backed by a gigantic global bearing company. We've been making bearings for over 100 years, so we know a lot about rotating equipment and that knowledge has been put into the algorithms of OPTIME. We'll take all this data and we'll come back and say we think there's a lubrication issue or we see bearing damage on this machine.

GOLDEN SIKORKA | GETTY IMAGES

There's a finite set of things that can happen out there. And once you know how to define those and the problems to look for, you put that into the algorithms and then these systems become a lot smarter. They're available every day and up to date. Then you have actionable information.

Precision maintenance is a fantastic way to improve the skill set so that when they

> Precision maintenance is a fantastic way to improve the skill set so that when they align something, we know that it's aligned properly. We've just given that asset a better chance to live a long life.

align something, we know that it's aligned properly. We've just given that asset a better chance to live a long life.

BV: What's the next thing that you see coming down the line, or are we just getting to trying to get better and better at this? Or is there something else that you see as the next generation of all this?

FM: That's a good question. Some places only run Monday to Thursday. So, designing the sensors to adapt to specific applications—I think we'll see that as we move forward; sensors that can determine that the machines are running, let's collect data now rather than just on a schedule.

One of the things we've already added to our platform is a smart lubricator. There are a lot of single-point lubricators out in industry. One of the things that we're coming out with is a base unit for that which will automate that process as well. In addition to the condition monitoring of that asset, we'll be able to tell what the status of that lubricator is. Is it full? Is it empty? Does it need to be changed? Is it clogged? What's the temperature near that lubricator?

Then we're going to go out from there as we listen to the voice of the customer. What needs are next? Do we want to integrate oil analysis systems? There are permanently installed analysis systems. Do we want to take that data and import that, put a chip on that, make it part of the family, make it part of the platform?

So, the sky's the limit. It's going to be based on what the customer need is, and then we're going to go ahead and validate that and develop and add to the portfolio. **P&M**

1.

2.

1. Solenoid Valves Offer Many Configurations

The NITRA ISO 5599/1 pneumatic solenoid valve components are completely interchangeable with any brand of ISO 5599/1 equipment. The ISO 5599 size one and size two components include solenoid valve bodies in 5-way, 2-position configurations with single or double solenoids and 5-way, 3-position, double solenoid valves with a center-pressure, center-closed or center-exhaust configuration. Standalone bases and manifold components with a side or bottom orientation and NPT or G-thread ports are also offered. Solenoid coils are available in 12V DC, 24V DC, 24V AC, 110V AC and 220V AC; accessories include manifold blanking plates, inlets, blind ends and seal kits.
AutomationDirect
powermotiontech.com/21249165

2. Braided Hose Extends Service Life, Manages Environment

The Aeroquip two-wire braided hose offers higher reliability and extended service life, reducing maintenance time, costs and waste. The EC881 hose offers a 35% higher pressure rating, 26% higher operating temperature, eight times more abrasion resistance, 67% greater flexibility and five times more impulse life than the standard EN 857 type 2SC hose. With its higher pressure capabilities, EC881 hose can replace heavy, rigid four-wire spiral hose in certain applications, providing a direct cost savings of up to 30% as well as several design benefits. Braided hose is much more flexible than spiral hose, which may enable OEMs to reroute and reduce hose assembly lengths, contributing to further cost savings.
Danfoss Power Solutions
powermotiontech.com/21249166

3. Isolation Valve Useful In Harsher Environments

The NIV Series Media Isolation Valve is a solenoid-operated device that uses a flexible diaphragm to isolate the actuation mechanism from the fluid path. Media isolation valves are commonly used for a wide variety of applications, including those that require precise, repeatable dispensing of media for analytical instrumentation. All wetted areas of the valve are either PEEK or PTFE, making this series ideal for use with corrosive media. A unique feature of the NIV Series is the one-piece valve stem that functions as a sealing membrane while also supporting and centralizing the poppet in the seating area. This multi-functional poppet/diaphragm/stem results in a simplified design with fewer parts (only two for the 2-Way and three for the 3-Way), longer life and zero dead volume. Choose from four orifice sizes available as 2-Way Normally-Closed, 2-Way Normally-Open or 3-Way Selector/Diverter.

Clippard

powermotiontech.com/21249167

Advertiser Index

Autonomous Mobile Robots on an Upward Trajectory

Continued technology developments and labor challenges are driving market uptake for autonomous mobile robots.

by Sara Jensen

The autonomous mobile robot (AMR) market is projected to be on a steady growth path over the coming years. Their use in manufacturing and logistics applications in particular has increased as a means of helping overcome labor challenges.

An October 2021 report from Interact Analysis projects that by the end of 2025 almost 2.1 million mobile robots will have been shipped to customers. The research firm sees strong demand for both automated guided vehicles (AGV) and AMR in the next five years, but the greater application use of AMR will see its market growth outpace that of AGV.

Both AGV and AMR are types of unmanned guided vehicles (UGV) often utilized to move material around a facility. Whereas AGVs follow a set of predetermined paths, AMR can move about freely and collaborate with humans for material handling tasks.

Research from IDTechEx released in January 2022 also forecasts strong growth for the mobile robot market, particularly in the manufacturing, delivery and logistics sectors. It foresees the market reaching a value of $83 billion in 2032, growing to $334 billion by 2042.

According to Pete Jadwinski, sales manager, America in Motion (AIM)—a company which develops custom automated solutions—the market for AGV and AMR has changed drastically over the last five years. "Labor shortage is the key driver," for the market's growth he said during a *Power & Motion* hosted webinar (*see sidebar*).

Many industries are finding it difficult to find skilled labor. Therefore, they have begun to implement solutions like AMR. Doing so enables work to be completed even if short on staff, allowing businesses to remain productive.

Use of mobile robots can also help improve safety and employee comfort by doing tasks that might otherwise be difficult or have the potential to cause harm, such as lifting of heavy objects. Workers can then be freed up to focus on other tasks, as well.

Ongoing advancements in the various motion control technologies utilized by AMR have enabled their increased use in recent years.

"The processing power of computers and amount of data they can handle and compute at such a high rate has made a big difference" in recent years, said Jadwinski. Related to this have been improvements in sensor technology and other components which are all working together to enhance performance of AMR.

CONTINENTAL AG

Through the many technological advancements taking place has been the ability to make the autonomous vehicles smarter, leading to a shift from AGV to AMR because of the latter's ability to understand and interact with its environment. "A big part of this is increased processing capabilities, better sensors [and] better software," said Tobias Bahnemann, CEO and co-founder, Toposens GmbH, during the *Power & Motion* webinar.

"It is a super dynamic time for the market," he added. "There are new things updated on almost a monthly basis…there is more movement than ever."

Toposens, for instance, recently introduced its ECHO ONE sensor for mobile robot collision avoidance systems. The sensor utilizes 3D ultrasonic echolocation technology to provide improved visibility of the environment around a robot and thus increase safety. Typically, 2D Lidar sensors have been utilized to prevent collisions with humans. But Bahnemann said the market has started to understand the need for detecting more than just people, necessitating the use of 3D collision avoidance systems.

Advancements in technology have also helped to bring down costs, further benefitting market uptake.

"All of these components, which have been very expensive in the past, are getting to at least a moderate cost level," said Bahnemann. "And with lower cost, the acceptance [of AMR] in the market is rising."

"The sensor- and component-level growth, combined with the number of AMRs out there, is kind of bridging the gap between an AGV and an AMR capability," concluded Jadwinski. "And the friendly and healthy competition makes all of it better. It is an exciting time to be doing what we are doing."

Read an extended version of this article at powermotiontech.com/21248406. P&M

WATCH AND LEARN MORE!

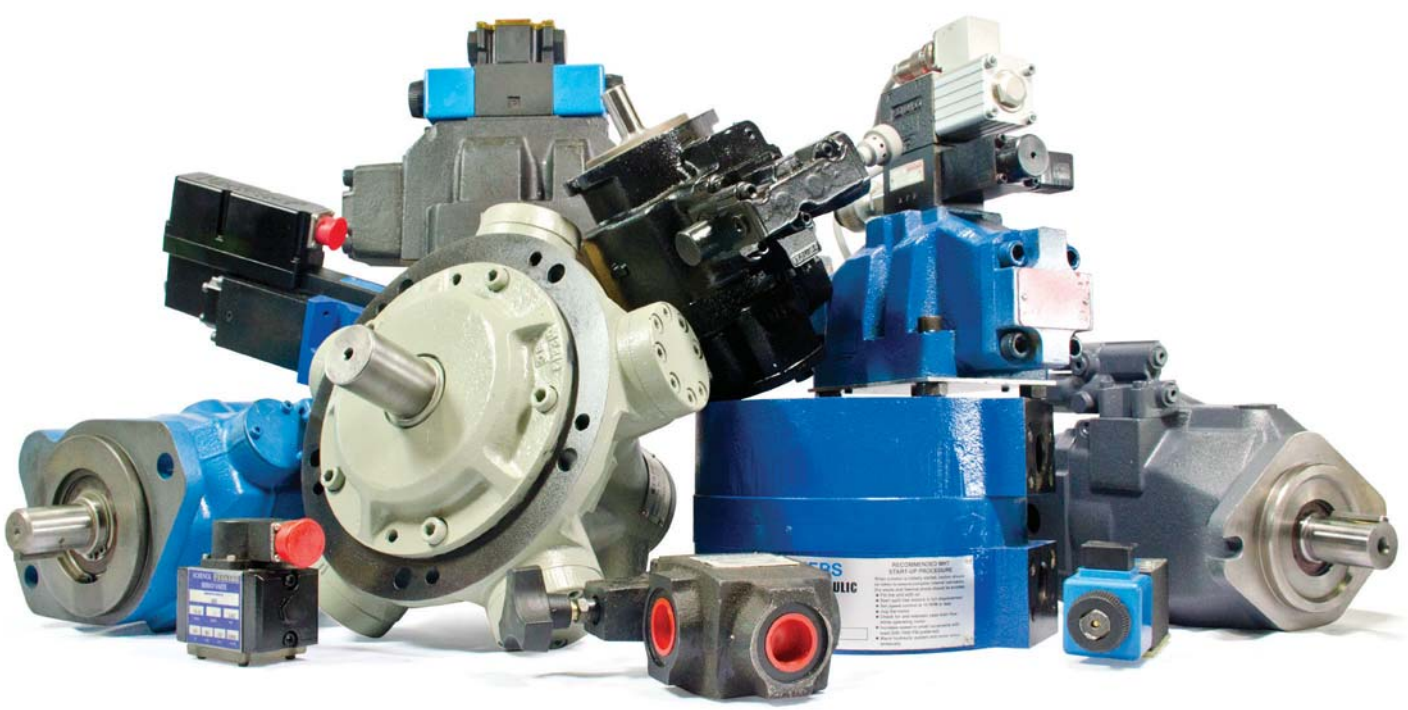
Get more insights from Pete Jadwinski, sales manager, America in Motion (AIM) and Tobias Bahnemann, CEO and co-founder, Toposens GmbH, on the technologies and trends shaping motion control for autonomous mobile robots by registering for our Sept. 19 webinar "Advancements in Motion Control Technology for Autonomous Mobile Robots" at powermotiontech.com/21247512.

LEAD TIMES OF HOURS. NOT WEEKS.

When you need to get a machine back up and going yesterday, we're here for you with our Hydraulex Reman™ line. **Remanufactured pumps, motors and valves engineered to deliver OEM level performance, that are remanufactured in the USA, and that carry an industry-best 24-month warranty.** With our unmatched on-the-shelf inventory of units and parts, and our ability to convert or build units in hours instead of days or weeks, we're sure to have the unit or part you need right now. Speed and availability redefined.

Put a Hydraulex Reman™ unit to work for you.

24 MONTH LIMITED WARRANTY ★



1-800-422-4279

sales@hydraulex.com

www.hydraulex.com

REMANUFACTURED IN THE USA

HYDRAULEX REMAN™

Altech®

IN STOCK

We have your Back ...

... DC-UPS Backup Devices

3-year Warranty

CBI

Battery Based System

12, 24, 48 V DC

UL Recognized

- Input Voltages:
  110 - 230 V; 120 - 277 V
- Temperature rating:
  +70° to -40 C° (158° to -40 F°)
- Smallest device in the industry
- Three charging levels:
  Boost, Trickle, and Recovery
- Adjustable charging current up to 35A
- Conformal coating available
- 3 year warranty

4 in 1

1 Power Supply
2 Battery Charger
3 Battery Care Module
4 Backup Module

Battery enclosures are available.

Ultra-Capacitors

No Battery Needed

12, 24, 48 V DC

UL Listed

- Environmentally safe
- Virtually maintenance free
- Input Voltages:
  12/24/48 V DC;
  110/230 V AC also available
- Temperature rating:
  +65°C to -40°C (149° to -40 F°)
- Higher energy vs. electrolytic capacitors
- Up to 10,000 Ws energy plus extension mods
- Higher power vs. batteries

Altech Corp.®

Your Source for Automation & Control Components

info@altechcorp.com | 908.806.9400

AltechCorp.com/power