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The Engineering Career Path Remains Viable p. 14

Tribology Industry Sets Sights on Sustainability p. 24

November/December 2023

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75 Years of Innovation:

A Look Back at Hydraulics and Pneumatics Ingenuity
p. 18

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SARA JENSEN
Technical Editor
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What do the Next 75 Years Have in Store for Hydraulic and Pneumatic Systems?

Over the past 75 years, the fluid power industry has continued to evolve. While the principles of hydraulics and pneumatics themselves have not changed during this span of time, shifting customer requirements and technological advancements have brought new components and systems to market.

With these technology developments have come new capabilities, application uses and more. And *Power & Motion* has been there to cover it all.

As noted several times this year, 2023 is *Power & Motion*'s 75th anniversary, and throughout the publication's history—and multiple name changes—there has been a strong focus on the hydraulic and pneumatic technologies helping to put the world in motion.

This remains the case today, even as electrification and other market trends bring new design needs and technologies into the motion control space.

In honor of *Power & Motion*'s 75th anniversary, our team has been looking through some of the archives to get a sense of where the industry has come from. But what about the future? What might the next 75 years have in store for hydraulic and pneumatic systems?

Obviously electrification and automation are having a large impact, as well as greater integration of sensors for performance monitoring and maintenance needs. A desire for more compact designs and increased power density are also driving fluid power designs.

Starting on p. 18, you'll find insights from members of the fluid power industry on how they've seen hydraulic and pneumatic technologies evolve and where these technologies are headed.

You can also head online to p*owermotiontech.com/magazine/51708* for additional insights—as well as historical imagery depicting hydraulic and pneumatic technologies throughout the years—which were contributed by a number of companies within the fluid power industry. P&M

Bosch Rexroth Opens Hydraulics Training Center

The training center will provide classroom and hands-on learning opportunities to help train current and future hydraulics engineers.

by Sara Jensen

Bosch Rexroth has opened a new Hydraulics Training Center to help support the technical education needs in the fluid power industry. The state-of-the-art facility will help provide skills development for those just entering the industry as well as seasoned professionals.

"As a leading manufacturer of hydraulic products, it is very important for us to have a state-of-the-art training facility, allowing us to support the future of fluid power," said Phil West, training center manager, Bosch Rexroth, in an interview with *Power & Motion*.

There is a need for more training in the hydraulics and pneumatics industry to ensure those working in it have the required skills, which Bosch Rexroth hopes to help overcome with its new training center. "With the reduction in the number of big industrial companies offering engineering apprenticeships and their own in-house training, there is a need to fill the gap," said West.

Bosch Rexroth held a ribbon-cutting ceremony to officially open its 4,000 sq. ft. Hydraulics Training Center on September 20, 2023. Bosch Rexroth

Skills Development for Hydraulics Engineers

The training center is equipped with three advanced training stations to provide practical, hands-on training. Classrooms and conference rooms in the training center provide learning space as well.

Also included in the hydraulics training center are standard industrial components for trainees to work with which adhere to internationally standardized programming languages with open interfaces, ensuring trainees are prepared to work with technology available in the market.

Creation of the training center enables Bosch Rexroth to offer its hydraulics expertise for a wide range of industries. In addition, West said "We have a unique advantage of having our training center embedded within our manufacturing campus and have a supply of extremely qualified hydraulic engineers at our disposal."

This will help provide access to current technologies and hydraulics engineering knowledge to help enhance the educational experience.

Bosch Rexroth plans to offer training courses covering a range of subjects—including hydraulics, electric drives, control technology and more. "Digitization and automation are very much part of the operation of today's hydraulic systems. Therefore, it is essential that design engineers, commissioning engineers and maintenance engineers have an understanding of more than just the fluid running through pipes," said West.

By covering an array of applicable subjects through its training courses, the company aims to provide the wide breadth of knowledge necessary for working in the hydraulics industry today as well as in the future, given the fast pace at which technology is changing due to increasing digitization and automation, as West pointed to as well as electrification and other trends.

"We have structured our courses to cover all aspects of hydraulic learning and will be hosting students new to the industry with our Basic Hydraulics Training Course," said West. "We also offer courses for experienced engineers with a program of advanced classes tailored to specific customer requirements."

Bosch Rexroth plans to hold courses throughout the year at the new hydraulics training center, offering multiple learning opportunities for the engineering community.

The first set of courses set to begin in January 2024 include:

- Basic Hydraulics.
- Proportional Hydraulics.
- Hydraulic Setup, Commissioning and Maintenance.
- Design Considerations for Industrial Hydraulics. P&M

Positive Outlook for Fluid Power

As more electric options come into play and an economic slowdown is expected, positive sentiments remain for the hydraulics and pneumatics industry.

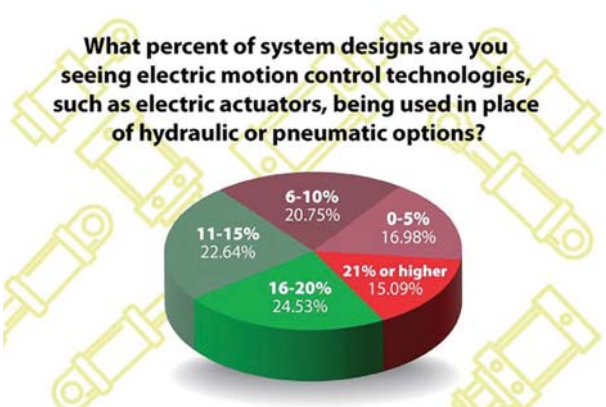
by Sara Jensen

After a few years of strong growth, the consensus is that the global economy is headed for a slowdown in 2024. However, a positive outlook remains for the fluid power and electronic motion control sectors as efforts to electrify vehicles and machines continue as well as infrastructure and reshoring projects—all of which will help drive demand for motion control components.

Technological advancements taking place in hydraulics and pneumatics will benefit the market as well. Improved efficiency, more compact designs and increased power density are just some of the areas of focus which will help meet customer and market needs going forward.

Even as electronic alternatives start to make inroads in more applications, there are still many instances where hydraulic or pneumatic solutions are the preferred option. Both types of motion control technologies will see continued growth in the coming years as each offers unique benefits which suit the various applications they serve.

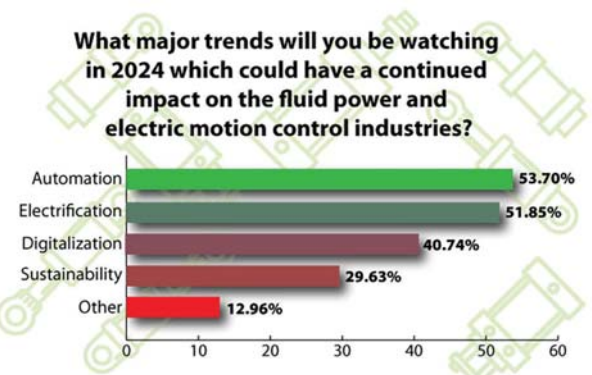
The greater integration of electronic and fluid power technologies will benefit the market as well by bringing new performance capabilities to help meet the evolving needs of customers—including those developing electric and autonomous vehicles.



To get a better sense of current and future market trends, *Power & Motion* surveyed its audience as well as spoke to several members of the industry to gain their insights on the state of fluid power and electronic motion control.

Demand for Hydraulics will Remain Strong

The majority of respondents, 77%, anticipate positive market conditions in 2024 for hydraulic components and systems. Many noted the technological advancements taking place in the industry as a reason for its expected positivity, as well as the move to electrification and automation—both of which will still require hydraulic components.



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One respondent even said the rush to electrify everything is actually increasing demand for traditional products. Another noted the continued electrification of hydraulics and enhanced power versus weight ratios will positively affect hydraulics growth.

Continued demand in the oil and gas markets and the need for hydraulics in the construction equipment being used for infrastructure projects and building of new manufacturing facilities will benefit the market as well.

Ken Baker, CEO of Baily International, said the company is predicting a soft landing for the hydraulics market in 2024 as the economy slows down. Availability of components was a large market driver over the past 2-3 years but that is starting to normalize, which will play into the expected market slowdown.

"We're more optimistic than some people in the industry in general, but we are seeing it slow down. And I think that's going to be the key to watch," said Baker. "We're trying to keep a careful eye on our inventory, because you can get ahead and inventory too much, but you don't want to be caught short when you see the rebound coming."

Despite Electronics Making Inroads

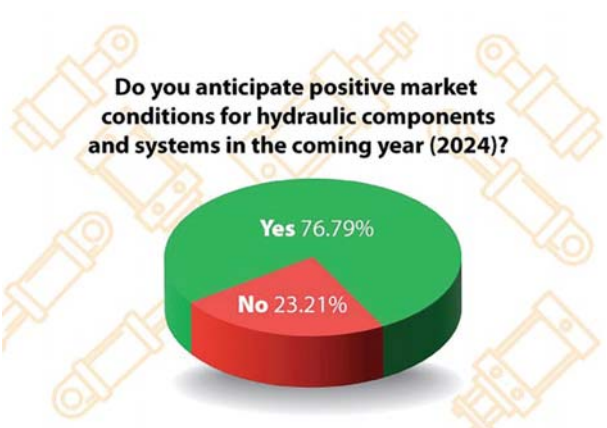
For the 23% of respondents who do not believe there will be positive market conditions in 2024, several noted the market slowdown as a reason, as well as competition from electronic options.

Jeff Herrin, senior vice president of Research, Development and Engineering at Danfoss Power Solutions, said borrowing costs could have an impact on the hydraulics industry in 2024. "Interest rates are unusually high, which could delay machine purchases due to financing costs. While temporary, this affects not just OEMs, but many others in the supply chain."

He also noted single- and multi-family housing construction is slowing down and there is significant fluctuations in grain and commodity prices—both of which could impact the construction and agricultural equipment markets, the largest customer segments for hydraulics.

As such, Herrin said Danfoss is predicting a down cycle for mobile machinery but in other customer segments limited growth. He agreed with Baker that the good news in the market is the supply chain disruptions are largely gone "and we're getting back to the market fundamentals of borrowing costs and supply and demand. This is the first time in 3 years we can say that."

On the technology side of things, it is clear the integration of electronics and continued trend toward electrification are having an impact on the hydraulics industry. According to



Matteo Arduini, president of Hydraulics EMEA (Europe, Middle East and Africa) and Rick Martich, president of Hydraulics, Americas and SVP, global Operations and Systems Sales at Helios Technologies, one of the most significant developments in the industry is the rise of electrohydraulics.

"The market is moving away from defining and specifying hydraulics and electronics in isolation," said Arduini and Martich in an interview with *Power & Motion*. "Instead, there is a push for these elements to be integrated into intelligent systems that offer enhanced efficiency and functionality."

Baker said Bailey International sees a continued electrification of hydraulic circuits but doesn't foresee a replacement of hydraulics by electrical products because of the physics involved. "But we do see more sensors, more controls, more electrohydraulic valves, and more monitoring of the system. And we're seeing that move from the high tier ones down in the middle market."

Energy efficiency is a key area of development as well according to Herrin, both on a component and system level. "At Danfoss, it's been our experience that the bigger efficiency lever is at the systems level because we can optimize machine operation, and therefore power consumption, through software and electronics," he said.

Tim Bankhead, application engineering manager, North America at HydraForce/Rexroth, a Bosch Company, said energy savings is a perennial concern for the company and its development efforts.

"The best minds in fluid power are finding ways to create more compact, powerful, energy-saving and sustainable solutions to address the application of hydraulics regardless of the power technology driving those machines," he said.

Technology Advancements to Benefit Pneumatics

Those in the pneumatics sector also anticipate positive conditions in 2024, though just 67% of survey respondents indicated as such. Some of the reasons respondents said they see continued positivity in the market include the lower energy costs associated with pneumatics as well as the faster motion and response possible with these systems.

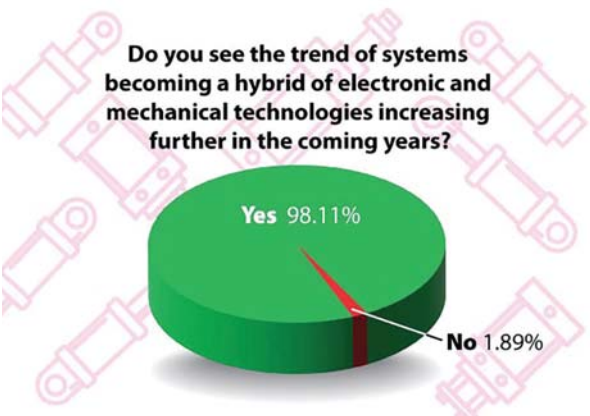
It was also noted that the continued integration of pneumatics with robotics will benefit market growth as well as additional pressures in the manufacturing industry to be efficient which pneumatic systems can help achieve.

For the 33% who do not see positive conditions for the pneumatics market in 2024, reasons included the anticipated economic slowdown as well as decreased demand for these components and electrical options replacing pneumatics in some instances.

Similar to the hydraulics market, there are several economic factors which could negatively affect the pneumatics sector such as commodity prices and high interest rates said Melissa Childers, business development manager, Motion Systems Group, Pneumatics Division at Parker Hannifin. However, she said she expects the pneumatics market to strengthen in performance in 2024.

"We are seeing growth from the previous year in our system solutions for our door systems for the bus and coach market as well as our CTIS [central tire inflation system] technology," she said.

Rex Bateman, director of engineering at SMC Corp., said ongoing labor strikes and the continuation of a soft market could present economic headwinds for the pneumatics industry in 2024. The semiconductor industry, which utilizes pneumatic systems, is currently experiencing a significant slowdown, he said, and it may be late 2024 before it starts to recover.



But overall, he sees the pneumatics market continuing to grow as the need for automation rises as pneumatic components can play an important role in these systems. In addition, there are opportunities for the use of pneumatics in alternative energy and sustainability solutions.

Several advancements in pneumatic system designs have increased their capabilities. Bateman said SMC has improved its pneumatic actuator designs to increase controllability in positioning, speed, acceleration and deceleration which could offer advantages over electric solutions.

Frank Langro, director - product market management, Pneumatic Automation at Festo North America, said improvements in force control is one of the development areas that will impact pneumatic systems going forward. One way in which Festo has addressed this is using piezo electric technology instead of the more commonly used solenoid pilot valve.

"Piezo technology enables precise control in processes such as wafer polishing and battery winding. Improvements to these processes reduce waste and are vital as the demand for semiconductors and rechargeable Li-ion (lithium-ion) continues to rise," he said.

In addition, Langro said piezo pilot valves use up to 95% less energy than solenoid valves which helps meet the growing industry trend toward increased energy efficiency.

Electronics Bringing New Capabilities, Alternative Technologies to Market

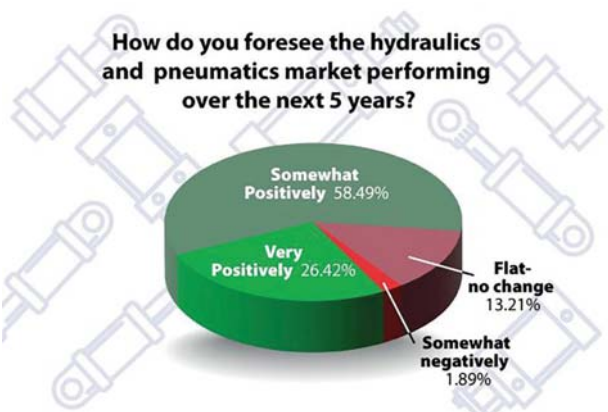
Integration of electronics within fluid power systems is increasing. Forty-four percent of respondents to *Power & Motion*'s survey said that 21% or more of their hydraulic and pneumatic system designs now incorporate electronics of some sort such as sensors. This was followed by another 44% who were split between 16-20% and 6-10% of their systems incorporating electronics.

Each of the industry members we spoke to also said they see this trend increasing. In the case of sensors, their use can aid with enabling more precise movements of hydraulic and pneumatic components as well as gathering of performance data to help improve maintenance. Festo's Langro said that today the information coming from many devices not only detects failures but also helps to predict them, minimizing downtime and thus costs for end use customers.

Baker said the rising use of sensors is helping meet customers' desire for highly accurate systems, especially for safety and service purposes. Position sensors are the type Baily International sees the largest requests for; this is not surprising given the rising development and use of machine control systems and automation—knowing the position of a machine or one of its parts helps to ensure safe and optimal movements.

Bankhead of Hydraforce/Rexroth said there is a trend toward integration of digital electronic technologies such as hydraulic controls with onboard electronics and integrated sensing. "The integration of sensors is a critical path to adding value to the market with digitally connected hydraulics," he said.

Herrin said the discussion of electronic control systems taking the place of mechanical controls has been taking place for years. "I can remember when electronically actuated hydraulics made up 5 or 7% of the market. Now we're well above 50%," he said. "The use of electronic controls is a long-term trend that will continue. A key reason is that OEMs want to differentiate and customize their solutions, and that is almost always done with software today. Hydraulic components have to be electronically actuated to work with these custom solutions."



Childers noted the move toward Industry 4.0 as a driver for the greater integration of electronics as well. In addition to integrating sensors, portals and communication networks enable collection and monitoring of collected data to ensure productivity of a system or machine. She said Parker offers a solution with built-in diagnostics capabilities which helps to

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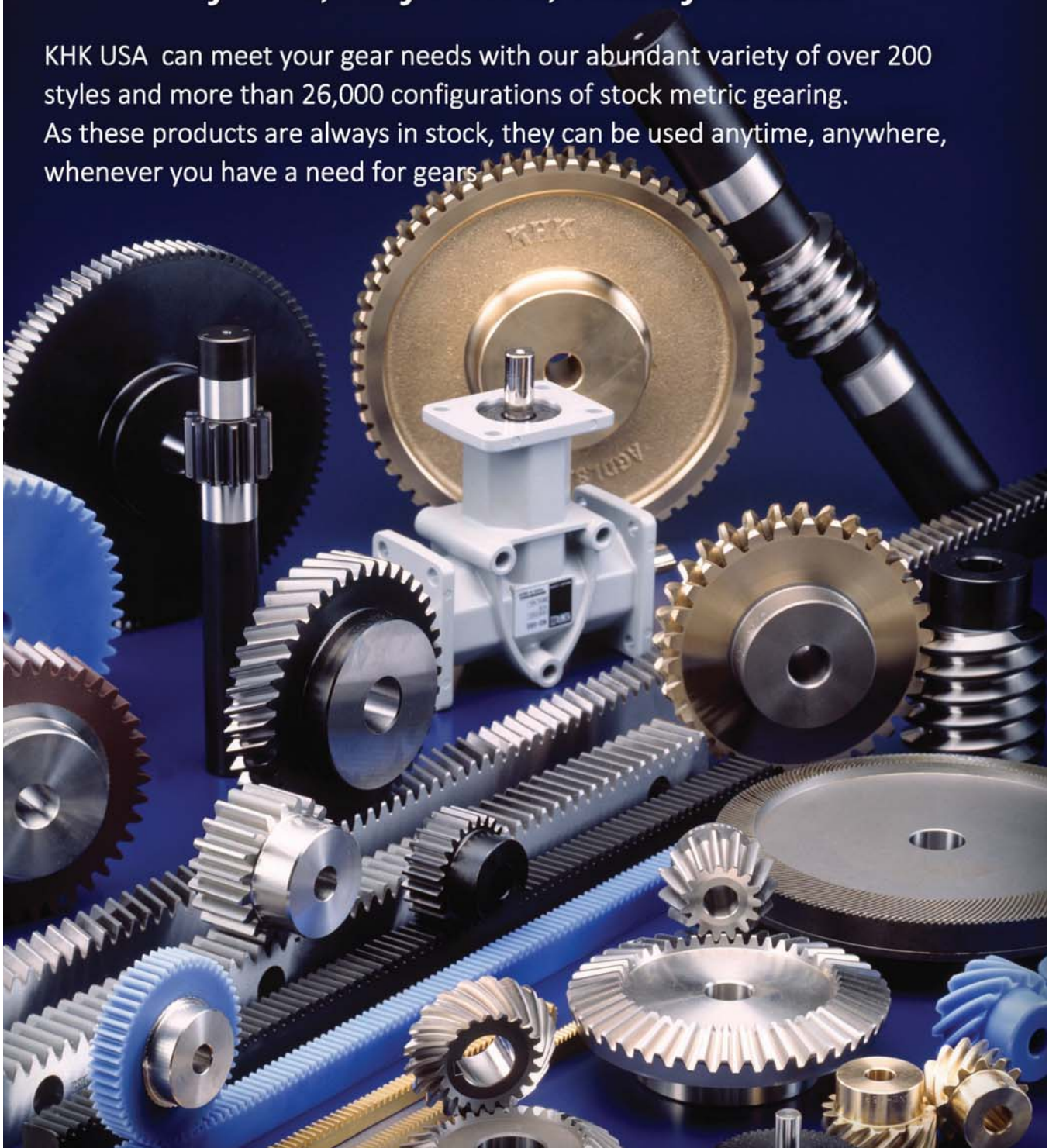

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detect short circuits in valves and monitor valve cycles, aiding with maintenance of the pneumatics system.

As electronics become more integrated with hydraulics and pneumatics, there will likely be more of a hybridization of these systems. The vast majority of survey respondents, 98%, said they see the trend of systems becoming a hybrid of electronic and mechanical technologies increasing further in the coming years.

Market Share for Electric Actuators Increasing

In addition to electronics being incorporated with hydraulic and pneumatic technologies, there are increasing instances of electric actuators and other technologies being used in place of fluid power options. Most survey respondents indicated they see this trend, and were fairly evenly split between how much they see electric options being used.

Twenty-four percent said they see as much as 16-20% of system designs using electric motion control technologies in place of hydraulic or pneumatic options. Just 15% said they see 21% or more of systems using electric alternatives—indicating this is a growing trend but there remains space for hydraulic and pneumatic technologies.

The power density provided by hydraulics is still required in many applications, such as heavy mobile machinery.

When asked if they see electric options ever fully displacing hydraulics or pneumatics, the majority of survey respondents said they do not see this happening. Several noted the fact that the power density of hydraulics in particular cannot be beat. Others said there will always be applications which require the use of hydraulics or pneumatics.

Automation and the positioning accuracy and repeatability possible with electric actuators for robotics were some of the reasons given by those who see the use of electric options increasing.

Andrew Zaske, vice president of sales and marketing at Tolomatic, said the increasing demands of uptime, repeatability and reduced maintenance are among the reasons people are moving toward use of electric actuators. He also said the company is seeing growing interest in using electric actuators in place of hydraulics in new areas.

Tom Diedrichs, product manager, actuators at Ewellix, sees this trend occurring as well. "There is a general push for hydraulic replacement in all types of applications that see value in the benefits that electromechanical actuators [aka electric actuators] bring," he said.

Another benefit he points to is safety—with electric actuators there is no chance of hydraulic fluid leaking and causing harm to humans or the environment. In addition, because there are no fluids working under high pressures, safety issues are mitigated when maintaining systems.

When determining whether to use a fluid power or electric motion control solution, it is important to evaluate the application and performance requirements as well as component and systems costs and productivity gains said Bateman.

As Moog Inc. stated to *Power & Motion*, "In today's world, it is critical to understand that power and motion control is a shared space between fluid power and electric technologies.

For example, Moog Construction collaborates with OEMs on their power, motion, and sustainability efforts by looking at the crossroads of hydraulics and electric power technologies. In the case of a tractor loader backhoe or excavator, a manufacturer might want to have a vehicle's wheels or tracks powered by an electric motor while the machine's working hydraulics would employ hydraulic actuators powered by an electric motor and battery system. "Determining what's best for an application will, in Moog's opinion, continue to guide technology selection and innovation with hydraulic, hybrid, and fully electric power and motion control solutions."

Overall, a positive sentiment remains for the fluid power industry even as electric options are becoming more common. Most survey respondents, 58%, foresee the hydraulics and pneumatics market performing somewhat positively over the next 5 years, and 26% see it performing very positively. **P&M**

Visit our State of the Industry hub at powermotiontech.com/magazine/51708 for the full Q&As with the industry experts featured in this piece as well as video interviews and additional industry insights.

Engineering Remains Viable
and Important Career Path

by Sara Jensen

The engineering community remains positive about the continued need for engineers as technologies evolve and the career opportunities possible.

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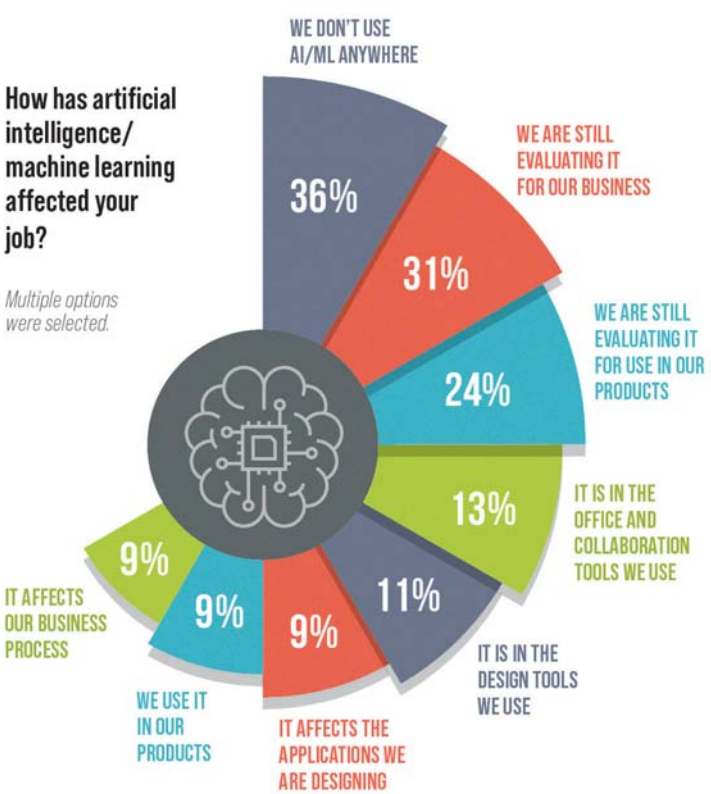
A key finding from *Power & Motion*'s 2023 Salary & Career Survey is not a surprising one—careers in engineering are important to the continued advancement of society yet filling open roles remains difficult.

The majority of survey respondents, just over 68%, said they believe there is an engineering shortage while 63.6% said their organizations are having difficulty finding qualified candidates for open engineering roles. And this is not unique to the fluid power industry. Surveys conducted by affiliate brands to *Power & Motion* in the electronics and mechanical engineering space had similar results.

Engineering, like many industries, is reaching a point where there is a wave of people retiring and fewer people entering the field. The fluid power sector in particular has noted challenges with attracting new talent as it is not necessarily an area of the engineering field many consider going into.

Efforts are being made by various industry associations and other organizations to educate younger generations about the opportunities in engineering, and fluid power specifically. These efforts may be starting to show as once again in 2023, a large portion of survey respondents—about 28%—noted being in the engineering field under 10 years.

The general consensus from this year's survey is that a career in engineering can be a rewarding one but more efforts may be required to overcome the shortage of those entering the industry.



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Conditions Currently Positive for Engineers

Overall, there appears to be a sense of satisfaction among those working in fluid power engineering roles. The majority of respondents expressed feeling satisfied to extremely satisfied in their current roles, with just 15% indicating they are not satisfied. This was further demonstrated by the fact that just over 90% of survey respondents said they have the same job as they did in 2022.

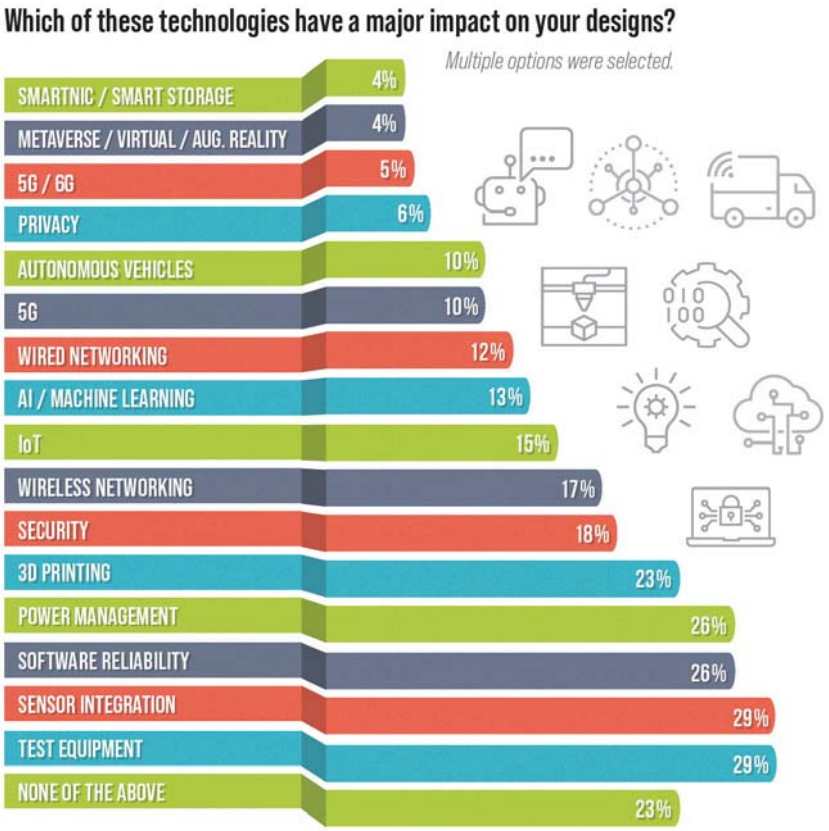
Aspects which influenced this job satisfaction had a lot to do with the design work involved as well

as company culture. About 77% said the challenges which accompany the design of new products were important or very important to their job satisfaction while another 70% noted the opportunity to design products that can benefit society being important to their job satisfaction.

Researching potential design solutions and the pressures associated with solving design problems were also highly rated as important factors.

Compensation was also an important satisfaction factor for many; most respondents, 61%, feel they are being adequately compensated at their current company with 35% saying they believe their employer is competitive with others in the industry in this regard.

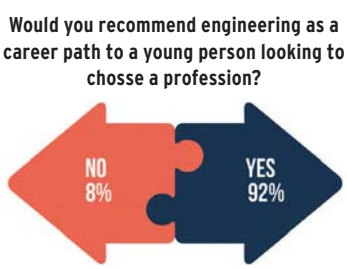
However, 27% see their employers as somewhat less competitive regarding compensation compared to other engineering companies. Over half of respondents, 53%, believe an 11-25% pay increase would better align their compensation with the work they do while 28% said just a 1-10% increase would help in this matter.



Most respondents, just over 80%, see their total compensation in 2023 increasing compared to the previous year with many indicating an increase between 1 and 6%. About 23% of respondents expect an increase of over 6%. These compensation expectations are more positive than those from 2022's survey results—71% of respondents at that time expected a compensation increase with just 5% expecting one over 6%.

A larger majority in 2022, 23%, expected their total compensation to stay the same as the previous year while in 2023, just 16% of respondents felt this would be the case.

Given performance of the company or the individual, at 63% and 43% respectively, were noted as reasons survey respondents might receive a bonus or other payment above their base salary, it is possible to infer that the total compensation increases expected in 2023 are due to positive market conditions or employers making efforts to retain employees—or a combination of both.



Although most respondents are satisfied with their current jobs, 59% said they would follow up if they learned or were approached about an interesting job opportunity. Another 20% said they are actively seeking a new position while an almost similar amount, 22%, said they could not imagine changing jobs in the foreseeable future.

Job Challenges and Technological Influences

Today, there are a range of industry trends and technological advancements influencing product development—bringing about new design opportunities and challenges for engineers.

Almost 29% of survey respondents said sensor integration is one of the technologies having a major impact on designs. This is not surprising given the increasing use of sensors in hydraulic and pneumatic systems to collect performance data as well as improve control capabilities.

Power management and software reliability were also noted as having a strong influence on designs. Increased emphasis on improving efficiency, due in part to the growth of electrification, and connectivity between systems and machines are likely drivers for this trend.

Also high on the list of technological impacts is 3D printing, with 23% indicating it having a major influence. There are several benefits which can be achieved with 3D printing including the ability to produce more complex geometries as well as lighter weight components. In addition, there is the opportunity to use fewer materials and reduce the amount of machining required to produce a part, benefiting sustainability initiatives.

Use of artificial intelligence (AI) and machine learning (ML) is increasing in many industries, though only 13% of respondents said it is impacting their designs. Thirty-six percent of respondents said they are not using AI or ML in any aspect of their job while 31% said they are still evaluating these technologies for their business and another 24% said they are being evaluated for use in products. Just under 10% said AI and ML are impacting their business or products.

As far as what engineers think of AI and ML, there was an equal response rate at 35% that these technologies have a positive affect on tools and processes as well as not being ready for use in fluid power and needing regulation. Another 33% see these solutions providing a competitive advantage.

Similar sentiments were expressed in the surveys conducted by *Power & Motion*'s affiliate brands, indicating the use of AI and ML in engineering is still in the early stages.

What are the professional issues that keep you up at night? *Multiple options were selected.*

A number of respondents, 30%, said staying current with new and emerging technologies is a top professional issue keeping them up at night and over 60% of survey respondents said they are being given more tasks outside their main area of expertise.

Increasing development in the areas of electrification, automation, and connectivity, among others, mean electrical and mechanical systems are coming together more than ever, requiring many engineers to expand their knowledge base to ensure optimized performance of the components and systems they are designing.

Most respondents noted product quality issues as the professional issue which keeps them up at night, with just over 43% indicating as such. This was followed closely by 37% noting product reliability issues as a major area of concern. Also high on the list were component availability issues and delivery schedules, indications that supply chains are still a work in progress for many.

Long-Term Potential for a Career in Engineering

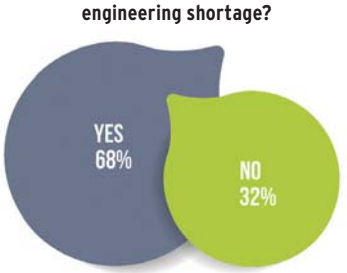
Though a career in engineering has its challenges—as any job does—the majority of respondents, 70%, said they believe it to be as promising a career path today as it was five years ago. The satisfaction levels and salary potential noted by survey respondents are good indicators of this sentiment.

In addition, many said the fact that roles are starting to open as a wave of engineers begin retiring will offer advancement opportunities for the next generation. Others specified the fact that ongoing technological advancements will require engineers of all types to develop new solutions.

As one respondent put it, "The world is changing faster than ever and will only accelerate. We need engineers to create effective products with these new technologies."

Another respondent said, "The increase in the rate-of-change of technology is increasing the technology to learn and apply, as well as making it difficult for existing engineers to keep up. This increases the opportunity by making more positions in more new niches, as well as the opportunities that open due to attrition."

Do you believe there is an engineering shortage?



Numerous respondents also noted the lack of people entering the field and the difficulty of finding those with the skills required. Sixty-five percent of respondents said mechanical design was the specialty for which they were

having the most difficulty finding qualified candidates. This was followed closely by 51% noting systems engineering as a challenging area to find skilled candidates.

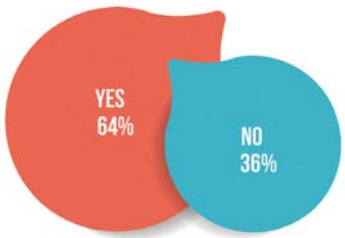
Power, digital, and software were also high on the list of engineering specialties for which it is difficult to find candidates.

When it comes to filling open engineering roles, there was almost an even split between those who said their companies are looking to increase the number of engineering jobs at their company, 44%, and those who said their company plans to maintain their current level of engineers, 46%. Just 10% said their companies plan to scale back engineering staff.

Thirty-four percent said they see an increase in hiring at their companies though just under 20% said hiring for new positions have been put on hold with some indicating freezes have been placed on hiring other than for replacement of existing positions. Another 13% said budget cuts are being made to their company's engineering department but there were also 33% which said they see no effect to hiring and budgeting taking place—indicating there is a bit of a mixed outlook in the fluid power engineering industry.

The anticipated market slowdown in 2024 could be a reason for this; growth for fluid power and its customer markets is anticipated to be slow or even flat before ramping up in 2025, so some companies may be holding off on hiring but they will also want to prepare for the growth expected in the remainder of the decade.

Are you being given more tasks outside of your main expertise?



Besides hiring more talent, ensuring engineers who already work at a company want to stay there is just as vital. Most respondents, 67%, believe their companies are just as focused on employe retention this year as they were in 2022. For those companies looking to do so, the ability to work in team situations, company culture and value, and recognition from others were all highly rated factors for job satisfaction beyond the design work and compensation levels possible—and therefore aspects companies could keep in mind when looking for ways to retain as well as attract engineering talent.

While many see engineering as a good career path, 43% said they have considered leaving the profession at some point with 50% indicating their desire to try something different as the reason. Other highly rated reasons include doing something less stressful, having more free time and making more money.

Almost 20% indicated they were ready to retire, further signifying the generational shift that is starting to take place in the industry.

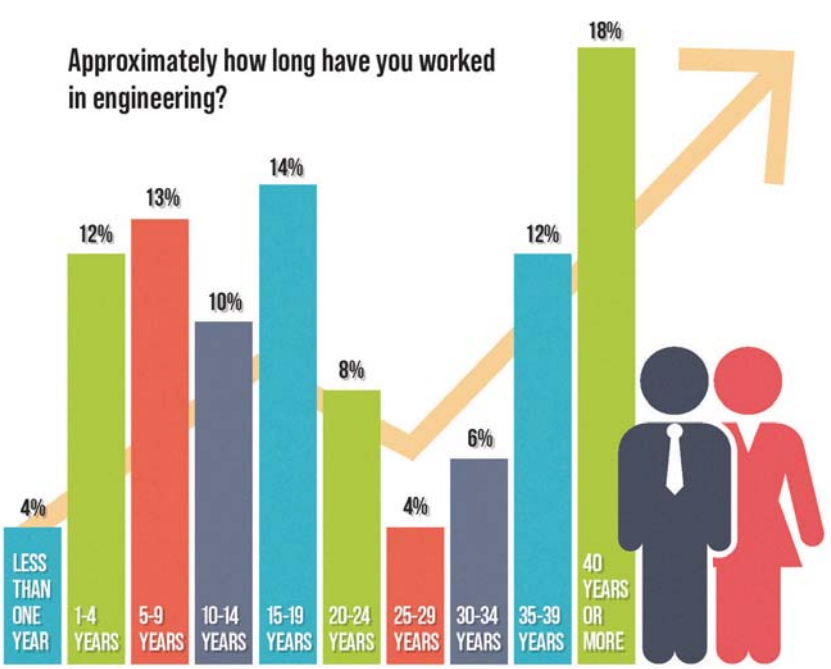
Just 5% said they consider leaving because of the poor job outlook for engineers which helps further support the mostly positive sentiments expressed by respondents throughout this year's survey.

The overwhelming majority of respondents, 92%, said they would recommend engineering as a career path to a young person who is looking to choose a profession. Respondents cited future opportunities, salary potential, an ever-increasing need for engineers, the challenging but satisfying work involved, and the variety of work possible as reasons they would recommend engineering as a career.

One respondent noted that because burnout—which 33% said is a reason they considered leaving the profession—is becoming better understood and handled, "engineering is a very engaging and necessary profession. Engineers can create massive positive change and are consistently challenged to think critically and learn more, which is very rewarding."

Another respondent said, "Engineering has the tools to let you fly, climb or think out of box."

With these and other positive sentiments expressed by respondents, it's clear there remains a bright future ahead for engineering. P&M



How 75 Years of Innovation Have Shaped Hydraulics and Pneumatics

Members of the fluid power industry provide their insight on the technological innovations which have occurred in hydraulics and pneumatics, as well as those yet to come.

by Sara Jensen

Since the first uses of hydraulics and pneumatics, these technologies have continued to evolve to meet new application and industry needs as well as make use of various technological advancements. And over the past 75 years, *Power & Motion*—originally called *Applied Hydraulics*—has covered the fluid power industry's ongoing efforts to improve performance and capabilities and address customer requirements.

When the first issue of *Applied Hydraulics* was published in February 1948, the editor's letter said the use of hydraulic mechanisms for actuation and control had grown tremendously and further growth potential was evident. In its September 1958 issue, the publication announced its name change to *Applied Hydraulics & Pneumatics* to better reflect its coverage of how fluid (whether air or oil) is used to transmit energy. As stated in that issue's editor's note, the renamed publication recognizes the wide use of compressed air and oil, and while applications may be different, the basic design problems solved by hydraulics and pneumatics are similar and thus able to provide learning opportunities for those working with either technology.

A room full of testing stations at The Lee Company in the 1960s aided product development for the fluid power industry.
THE LEE COMPANY

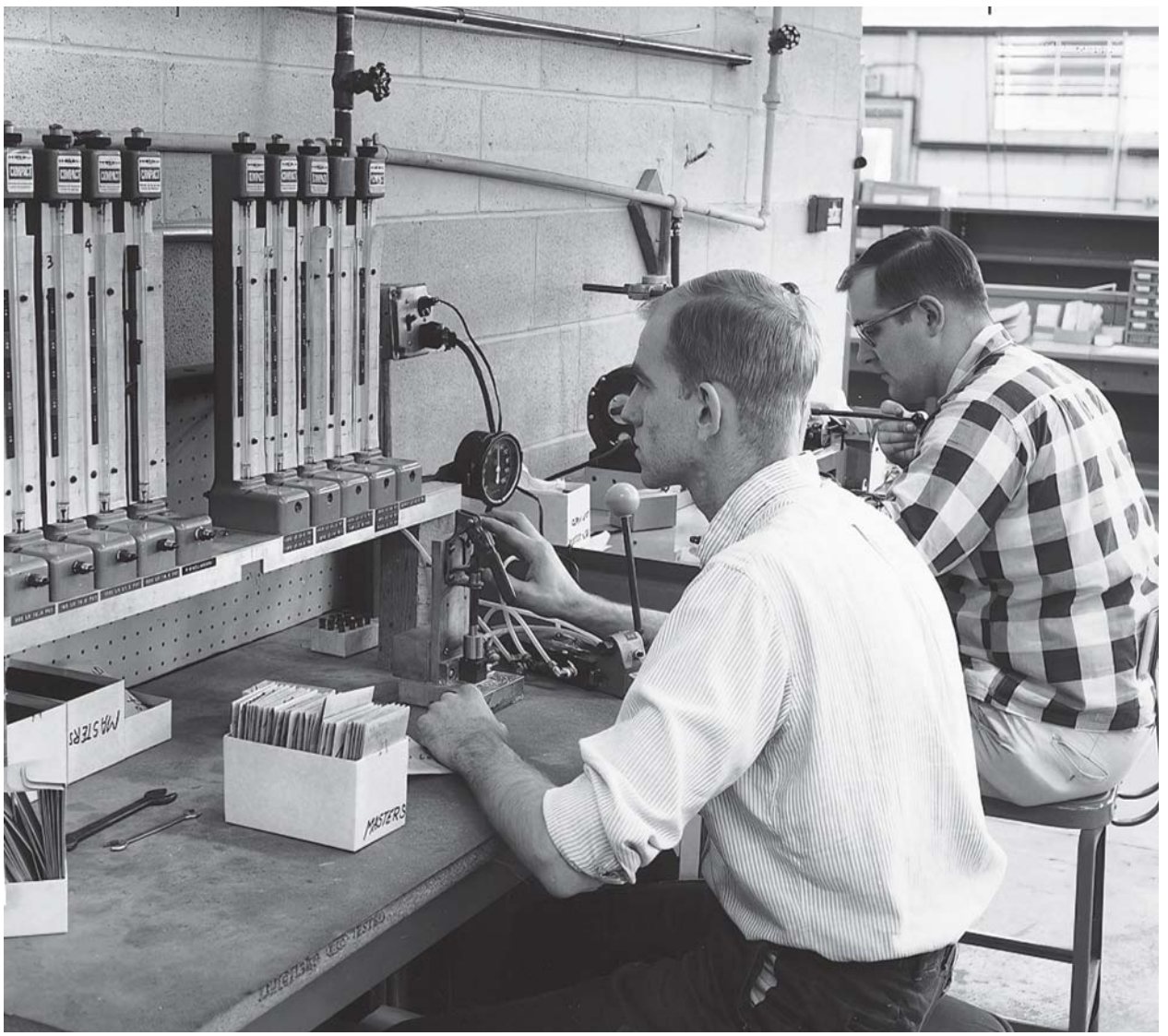
Fast-forward to today, and now hydraulics and pneumatics can be found in any number of markets and applications. The fluid power industry is also undergoing another evolution as integration of electronics with—and in some instances in place of—hydraulics and pneumatics increases to achieve greater levels of efficiency, precision and data collection.

To get a better understanding of the many innovations which have taken place in hydraulics and pneumatics over the past 75 years, as well as thoughts on where these technologies may be headed in the next decades, *Power & Motion* spoke with several members of the fluid power industry for their perspective on this ever-evolving sector.

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

***Power & Motion:* What have been the biggest technological changes in the hydraulics and pneumatics industry over the past 75 years?**

Tony Welter, president, Hydrostatics division, Danfoss Power Solutions: From my perspective, the biggest change in the hydraulics industry has been the incredible increase in efficiency, both in terms of components and systems. A number of factors have led to improved component efficiency. The first is simply advancement in the science of hydraulics. Today, we better understand how hydraulic oil flows through components, where the losses occur and how the components interact. Finite element analysis, computational fluid dynamics and other tools have enabled us to improve the designs, performance and robustness of hydraulic components. Similar advancements in manufacturing technology, like precision machining and finishing and complex cored castings, have enabled the production of more compact and efficient components.



A testing station at The Lee Company in the 1960s where engineers worked to ensure the company's products would perform as desired in customers' fluid power systems. THE LEE COMPANY

On the systems side, we've advanced from inefficient fixed displacement systems to variable displacement, load sensing systems with advanced controls. These on-demand systems have saved huge amounts of energy.

Dave Geiger, engineering manager, new business capture at Moog Inc.: The ability to offer electronic closed-loop control has been the biggest technological advance[ment] in my opinion. Mind you, we were able to do it mechanically. But now virtually everything is running the way of electronic control.

Frank Langro, director – product market management, Pneumatic Actuation at Festo North America: The monumental technological change has been the miniaturization of sensors and their integration into pneumatic devices, including cylinders. While sensors bring information about the state of the machine, miniaturized sensors are being integrated into pneumatic devices and capturing information about the device. Real-time data can then be used to modify the behavior of the device. The device, in effect, becomes smart and is able to react to surrounding conditions. This is a long way from the days of "bang-bang" pneumatics.

Neal Gigliotti, manager, applications engineering at Bosch Rexroth: There have been many key changes over the past 75 years, including the invention of dynamic closed loop proportional control valves, digital hydraulic axis and pump controllers, solid state PLC technology, Fieldbus (ethernet) communications to components, variable speed servo motor controlled hydraulic pumps, and the invention of computers

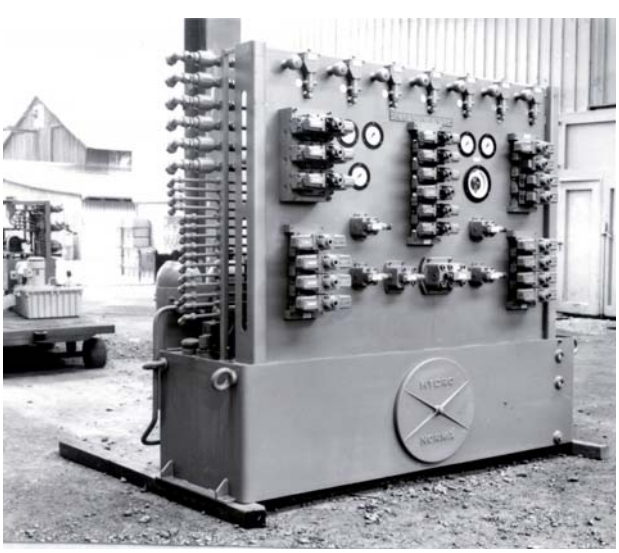
and subsequent development of computer-based hydraulic and control system simulation.

Gregg Shanley, technical marketing manager, automotive and industrial and Steve Plumley, manager of inside sales Operations at The Lee Company: Over the past 75 years, the hydraulics and pneumatics industry has helped usher in historic change that continues to propel significant innovation across multiple technological applications in the aerospace, automotive, industrial and medical fields, among others. According to our engineers at The Lee Company, we can distill these advancements into two distinct categories: an increase in the overall reliability of pneumatic or hydraulic systems and a general trend towards the miniaturization of these systems.

Due to the critical nature of the functions that hydraulic and pneumatic systems serve, safety is paramount and there is no room for error. Consumers have and will continue to demand reliable, innovative solutions to their problems without compromising on function, form or safety. Systems have gone from being large and unwieldy to small and reliable, making them more complex, but easier to use, safer, and more cost-efficient for the average consumer.

The changes and advancements in the industry are endless. Take for instance the anti-lock braking system (ABS). Fifty years ago, a driver manually pumped or slammed their vehicle brakes during an emergency stop, placing wear-and-tear on internal hydraulic systems to create enough force to stop the vehicle. That same driver is now likely driving a car with ABS that proactively does this work for them, helping to modulate their brake usage and maneuver through potentially dangerous conditions by detecting and monitoring the rotational speed of each wheel. Hydraulic systems are now being used in prosthetic joints, helping patients to regain a more natural mobility feel and a sense of normalcy in their day-to-day lives. Systems can now be stacked into modular "packs" capable of performing multiple functions in a self-contained hydraulic unit. In the case of a backhoe loader, for example, these stacked mini systems can be adapted to provide functionality to perform new movement processes such as digging and lifting within the same system.

The Lee Company has continued to modernize its operations over the years to help meet the ever evolving needs of the fluid power industry.
THE LEE COMPANY



A 1,000 L tank capacity hydraulic power unit with heavy front panel design from 1972 developed by Bosch Rexroth.
BOSCH REXROTH

Each example above marks an exciting innovation that helped in some way to change how we interact with the world over the past 75 years. We are proud to play a part in continuing to help solve unique hydraulic and pneumatic challenges.

***P&M*: During your career in the fluid power industry, what have been some of the more exciting advancements or interesting technologies you've seen enter the market?**

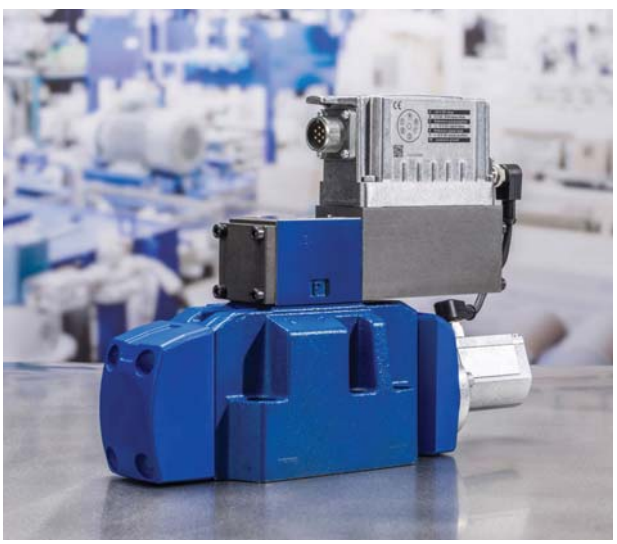
Tony Welter, Danfoss: The steady growth of electrohydraulic (EH) components and systems has been one of the more interesting advancements I've watched throughout my career. The integration of hydraulics with electronics and software has made these components smart and enabled them to do things we couldn't do with

mechanical or hydraulic pilot controls. Software control makes our products more configurable. We have much more flexibility than we do with hardware configuration, which simplifies machine development and commissioning. To get a machine to do what we want it to do, we no longer have to change hardware, such as a spool. We can tweak a software parameter in a matter of minutes.

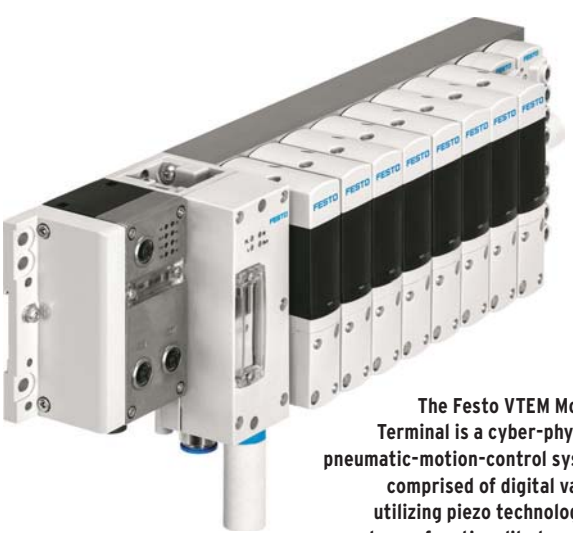
Software also enables us to add functionalities to a machine that it would take an operator years to master, significantly increasing machine productivity and safety. Now, with the integration of sensors, we're also getting a deeper understanding of what and how our components are doing, both on a parts level and a systems level. It's a really exciting time to be in the industry and see the capabilities of hydraulics continue to evolve.

Dave Geiger, Moog: For me, the most exciting advancement during my career has been the ability to design electric motion control through hydrostatic transmission. What this means, in summary, is an electric motor moving forward or reverse, and we're moving an actuator forward or reverse with a hydrostatic transmission. It's exciting because the industry is moving electric, and this is working in that direction. But, yet, we're still using hydraulics, and there's great benefit. The other option or way to perform actuation is to do it electromechanically.

Frank Langro, Festo: Two advancements that stand out were developed by Festo. The first was the integration of serial communication on the pneumatic side of a valve manifold. Typical solenoids were operated by discrete wiring inside a channel on the valve manifold or by circuit boards that had discrete traces to signal the solenoids. With the MPA valve manifold, released in 2003, Festo was the first to incorporate serial communication on the pneumatic output side of the manifold. Serial communication allowed proportional



Hydraulics have evolved to include more electronics, such as the pictured servo/proportional valve with digital on-board electronic controls from Bosch Rexroth. BOSCH REXROTH



The Festo VTEM Motion Terminal is a cyber-physical pneumatic-motion-control system comprised of digital valves utilizing piezo technology to change functionality based on various combinations of downloadable motion apps. FESTO

valves and sensor technology to be located on the valve manifold. This stimulated new installation methods. It also enabled monitoring of a manifold and enhanced control.

The second game changer was the development of piezo electric technology for pilot valve applications, a domain traditionally held by solenoid valves. Piezo elements change shape when voltage is applied. Festo has used this principle to create a pilot configuration that enables the spool valve to act as a typical directional control valve. Furthermore, piezo valves can change function via the control of the pilot.

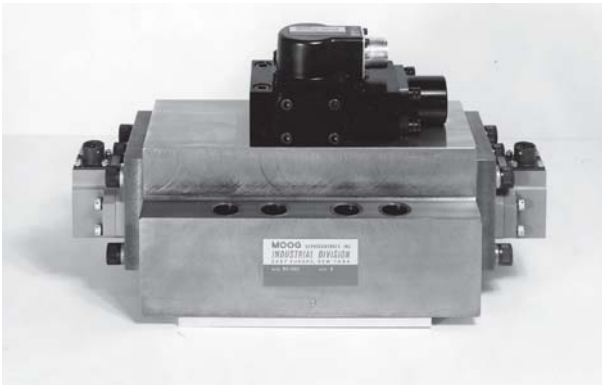
Moog was formed in 1951 with the invention of the company's servo valve, an electrically operated valve capable of controlling hydraulic fluid for motion control applications where precision is critical.
MOOG INC.

The same physical hardware can act as a 4/2, 4/3, 3/2 and 2/2 valve. The main valve can also perform pressure and flow control. This exciting

Festo invented the pneumatic valve terminal in 1989, bringing to market a solution that reduced piping and wiring on machines and simplified the pneumatics of complex systems.
FESTO

development opens up a variety of motion possibilities for a pneumatic cylinder. For example, soft stops can be achieved through the valve without utilizing external shock absorbers.

James Lane, manager, LETO engineering operations at Bosch Rexroth: Closed loop axis control. The ability to control so much power with such a high level of precision has really opened up the possible applications of hydraulics.



The Moog servo valve was developed in the early 1950s and helped revolutionize the aerospace industry by facilitating the transition from manual, mechanical control to precise hydraulic control through electronic signals. MOOG INC.

Gregg Shanley and Steve Plumley, The Lee Company: There have been countless technologies developed in the fluid power industry that have helped to innovate and transform the modern world. Highlights occurring within the career span of our experts include hydraulic safety features in cars, powered exoskeletons and portable hydraulic hand tools. While these tools serve diverse applications across a variety of fields, their existence weaves together a similar theme: innovations in the fluid power industry that have resulted in less expensive, more accessible and more reliable technology.

We can see this in action within the automotive industry, where consumers have access to new safety features and enhanced functionality made possible through hydraulic and pneumatic power. Features such as stability and traction control, active vehicle suspension control and anti-lock braking systems have made cars more complicated, but safer to drive. When a car can sense the correct amount of torque to supply to each wheel when maneuvering...the average driver is better able to maintain control.

Outside of the automotive field, exciting advancements continue to be made. Powered exoskeletons can be used in various applications as extensions of the human body to reduce fatigue or amplify strength or range of motion in order to complete tasks. As the fluid power industry continues to develop new advancements across the technology stack, these exciting tools will no doubt continue to provide increasingly enhanced functionality under a comprehensive umbrella of safety. **P&M**

Read an extended version of this article at powermotiontech.com/21276891.

Sustainability Emerging as Key Trend for Tribology Industry

The 2023 STLE emerging trends report points to sustainability gaining ground as a key driver for development efforts in the field of tribology.

by Sara Jensen

Technology developments in the field of tribology are being driven by six key industry trends.

As sustainability becomes a larger focus around the world, several industries are seeing the impacts including the tribology industry—a field which studies friction, wear, and lubrication by looking at how interacting surfaces behave in relative motion.

The Society of Tribologists and Lubrication Engineers (STLE) has released its *2023 Report on Emerging Issues and Trends in Tribology and Lubrication Engineering* which outlines the top trends and issues facing the industry. While supply chain challenges remain at the top of the list, sustainability is emerging as a key trend affecting everyone in the tribology and lubrication fields said Dr. Neil Canter, FSTLE, CMFS Chemical Solutions, during STLE's webinar outlining highlights of the 2023 report.

Canter and STLE's Advance Innovation Team prepared the report which is updated once every three years with input from industry experts to get their perspective on the key factors impacting development efforts. The 2023 report outlines the six trends currently top of mind for those working in the field of tribology.

"The findings from this report indicate that individuals who are tribologists or are considering a career in tribology will have major opportunities to use their skills to make a difference in meeting challenges that will promote the growth of sustainable practices," said Canter.

1. Supply Chains

Like many industries, tribology has been impacted by the supply chain issues which began during the COVID-19 pandemic. The availability of the raw materials necessary to create lubricants and other fluids remains a challenge, making it difficult for manufacturers to produce and supply product to customers.

In some applications, there are several components which go into the fluid formulation and if even one of them is hard to get it can cause major issues for manufacturers.

Canter said there has been some alleviation in this area, but other factors such as weather events are creating issues. These are hindering logistics, and thus deliveries, and in some cases even shutting down production of oil refineries or other businesses which feed into the supply chain.

He said the availability of raw materials, weather and other factors will likely continue to plague the supply chain in the future.

Though sustainability is a trend of note on its own, it will play a part in supply chains and the other trends impacting tribology as well. Most notably for supply chains are the efforts being made to create lubricants from more sustainable sources and extending the lifespan of materials. Instead of just disposing of a fluid once it is past its useful life, some in the field are looking at how raw materials and finished products could be reused over and over again.

This circular economy reduces the amount of raw materials necessary to produce lubricants and keeps them out of landfills, all of which benefit the environment and sustainability initiatives. And it can help supply chains by creating a means of more easily producing and delivering products.

2. Sustainability

Sustainability has become increasingly important in recent years due to the global population's growing concern about the environment. Although a succinct definition of what sustainability entails is difficult, currently it is mostly concerned around the need to minimize rising global temperatures.

Studies have shown the important role tribology can play in reducing emissions, an important part of the sustainability equation. Canter pointed to one of the initial reports noting this fact, *Tribology Opportunities for Enhancing America's Energy Efficiency* from the U.S. Dept. of Energy (DOE), which was prepared by tribology researchers. The report noted the considerable energy savings which could be achieved using existing and new tribology approaches, leading to emissions reductions.

Per the DOE report, more than 22 quads of energy (1 quad = 1×10^{15} BTU = 1.055×10^{18} Joules) could be saved each year in the U.S. through tribology developments. If even a fraction of this were to be achieved, it would go a long way toward helping reduce the amount of carbon dioxide (CO_2) produced each year in the U.S. as well as global efforts to prevent the earth from warming to 1.5 C by 2030—the point at which the majority of the scientific community has agreed will be catastrophic for the earth and its inhabitants.

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New lubricant formulas are under development to help overcome the limited availability of raw materials as well as the need to meet sustainability initiatives.

The creation of a circular economy for the production of lubrication noted above is just one of the ways in which the industry can do its part to help with emissions reduction efforts. By reusing products, or producing them from different types of materials such as recycled plastic, there is also the potential to reduce emissions typically created during the manufacturing process as well as material sourcing.

To be more sustainable, many companies and other industry entities are looking at different scope values to better understand the total carbon footprint associated with sourcing, manufacturing and delivering their products. As outlined by Canter during the webinar:

- Scope 1—direct emissions such as those generated at a manufacturing plant.
- Scope 2—indirect emissions often associated with an operation's power source, such as electricity and how that is generated by the local utility (coal, wind or other).
- Scope 3—indirect emissions produced by upstream and downstream business partners such as the suppliers of the raw materials for lubricant production.

In general, it is viewed that moving toward increased use of renewable energy/sources for fuel, electricity, raw materials and more will benefit global emissions reduction goals.

3. Electrification

Canter said the electrification trend involves more than just the transition to battery-electric vehicles. While a part of the equation, it really has to do with using alternative power sources—including fuel cells, solar and wind—to generate energy.

Tribology and sustainability will need to come together to help bring more productivity and safety to the manufacturing industry.

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Development and market availability of battery-electric vehicles has of course grown in recent years due to technology advancements and a greater desire for such vehicles. Almost every transport industry, from passenger cars to trucks and buses to construction equipment, is going electric, bringing with it new considerations for design teams including those on the tribological side of things.

A whole new approach to lubricants will likely be needed for electric vehicles said Canter for both thermal management and lubrication. Lower viscosity fluids for heat transfer will be required, but it will also be necessary to keep electrical properties in mind because the fluid cannot be too insulating or too conductive otherwise performance issues could occur. Other factors he said will be important to consider include:

- extreme pressure protection,
- oxidation and sludge control,
- compatibility of additives due to high amounts of copper in electric vehicles, and
- balancing of additives for efficiency, durability, noise, vibration and harshness.

Because of these aspects, new technologies and formulas may be required. In addition, Canter noted new materials for seals, resins, coatings and plastics are being utilized which create further factors to be taken into consideration when developing lubricants for electric vehicles.

With the electrification trend will come greater demand for electricity. This is not only due to the need to charge electric vehicles but also the greater implementation of digitalization in various fields such as manufacturing and even in tribology. Increased use of the internet, data transmission centers and more is leading to further growth in electricity consumption.

From a tribology standpoint, Canter said this brings a greater need for heat transfer fluids. He explained that many data centers, for example, use tremendous amounts of electricity which generate large amounts of heat. Development of heat transfer fluids for these applications, as well as electric vehicles, will help to prevent heat buildup which could cause performance issues.

4. Manufacturing

Automation and the implementation of Industry 4.0 technologies—as well as the start of Industry 5.0—are key drivers in the manufacturing sector which could have implications on the tribology industry. Related to these are the concepts of machine learning (ML) and artificial intelligence (AI) which can be applied to tribology and thus are reviewed in the STLE report said Canter.

He noted the report also looks at additive manufacturing (AM), also referred to as 3D printing, which is also growing in use in the manufacturing sector for production of prototypes, spare parts and more. Canter said there are still a lot of aspects that need to be worked out regarding the use of AM, but there are also many benefits the manufacturing industry sees to its

use once many of the hurdles are overcome, including the fact it is considered to be more sustainable as there is less material used and often less machining required.

Also important to tribologists are the changes in bearing designs that are likely to occur for the manufacturing sector. Canter said bearings are going to need to become smaller and more efficient to help improve the performance and energy use of the machines into which they are integrated.

According to Canter, one of the key aspects for this sector going forward will be determining how to integrate tribology and sustainability into manufacturing. He said bringing them together as part of a plant reliability program can help to improve the productivity and safety of a manufacturing operation.

Sustainability will become a more active part of manufacturing through improvements in production efficiency, energy savings and reduced emissions. This will also be seen through increased use of synthetic lubricants which are proving to provide better performance and longer run times in addition to environmental benefits. Water-based lubricants could be an option in the future as well but are not yet available.

5. Medical/Health

Tribology is becoming particularly beneficial in the health and medical fields said Canter. It can come into play with contact lenses, orthopedics, implants and various other applications in this field.

By better understanding how implants interact with adjacent body parts or natural tissues within the body work with one another, there can be greater efforts made to improve lubrication to reduce friction, as an example, and thus improve comfort for patients.

Canter noted that getting down to the cell level and understanding how body cells deal with friction could lead to the development of synthetic, water-based lubricants for use in the body to help alleviate friction issues which can occur with implants.

6. Government Regulations

The STLE report reviews both global and regional government regulations impacting tribology, many of which are related to emissions reduction and other sustainability efforts—further demonstrating how impactful a trend sustainability has become. Several regulations noted aim to increase use of diesel alternatives and push various industries toward zero emissions in an effort to reduce the warming of the planet.

Regulations highlighted in the report include MARPOL which aims to reduce emissions from the marine sector, and on-road vehicle regulations such as Euro 7, China 6b and Phase 3 GHG regulation in the U.S. Each of these are designed to reduce the amount of emissions produced by newly built cars, trucks and buses with eventual goals of completely eliminating emissions in future regulations.

Also covered are those regulations addressing use of raw materials, including some which are used for greases and other fluids. Lithium salt, for instance, is currently under scrutiny by the European authorities as a potential toxic substance for the environment. This material is an important element of lithium-ion batteries as well as greases; a regulation mitigating its use could pose challenging to manufacturers.

Canter said the grease industry has already begun looking at how to shift away from use of this material due in part to the battery industry's demand for it which has constricted supply availability.

Biocides, chlorinated paraffin and per- and polyfluoroalkyl compounds (PFAS) are other materials used in the lubrication industry which are being regulated as well, or could be in the near future.

So how will the findings of the STLE report truly impact those in the field of tribology? Canter concluded the webinar by saying the industry should look at where the lubricant end users are as sustainability is emerging as a key driver for them to improve productivity, reduce emissions, and reduce waste. Lubricants can help with these efforts; there are many technologies that will need to be replaced in the coming years to achieve various customer and sustainability goals. P&M

Compressed Air:

Smart Point-of-Use Systems Bring Energy and Cost Savings

The addition of digitalization to point-of-use air management units enable energy and cost savings to be achieved in pneumatic systems.

by Alan McCay

Over time, there have been technological advances in preparing air for use before it enters machines for operation. Advancement was slow until we learned more about how to implement digitalization.

For a basic air system, the compressor room has a compressor, an air dryer to remove water or moisture from the air, and mainline filtration to remove particulates and compressor oils. When leaving the compressor room, the air piping will be plumbed to the point of use, including machines such as case packers or case erectors. Those are just two of many machine types that use pneumatic automation for numerous functions.

For many machines, at the point of use, a filter regulator and lubricator unit (FRL) is installed. The FRL is usually connected in a compact package and further regulates the air pressure and removes contaminants before the air is finally used in the machine. In the case of lubricators, few applications will require these and may be left off the system.

Pneumatic control is a natural place to look for energy savings and sustainability opportunities. Detecting or predicting component failure in a pneumatic system is also possible if the right data is analyzed.

Since all of the air at the machine point of use flows through the FRL, it is the ideal place to add flow, temperature and pressure sensors for predictive maintenance analysis and energy savings opportunities. Pneumatic component manufacturers have realized this and developed products with remarkable success in energy reduction and overall cost savings for end-users' facilities. Many of these products are designed to be an integral part of an FRL or may be used as a stand-alone unit.

How Digitalization Can Benefit

Smart point-of-use air management systems contain high-level features that can help a facility reduce costs. Energy consumption can be reduced by leveraging the unit's digitized data, and predictive maintenance capability.

The addition of digitalization has allowed onboard sensors to gather data, which is then sent to a hub installed on the unit. This data utilizes OPC Unified Architecture (UA) to communicate flow, temperature and pressure measurements used to establish baseline conditions for machines and other air consumers. This data is valuable for sustainability and predictive maintenance.

Figure 1: **The electropneumatic regulator on the left side of the point-of-use air management system contributes to the unit's control of air pressure to a machine, saving costs due to air leakage.** SMC

Achieving Energy Cost Reductions

The primary areas to decrease energy and associated costs are air leak reduction and lessening internal leakage of system components such as cylinders and valves. The idea is to reduce pressure or completely shut off the air supply during machine idle times. Manufacturers install flow, pressure and temperature sensors, pressure regulators and shut-off valves at the machine point of use to measure and ultimately control airflow and pressure to a machine—saving costs (Figure 1).

With the digitized data collected, these sensors detect user-defined idle times during a machine cycle and automatically reduce the pressure controlled by an electropneumatic air regulator. During long-term idle times, a two-way valve is used to completely isolate airflow to a machine.

As machines are idle at maximum pressure during non-production or minor stoppages, the inherent amount of leakage due to line or connector loss or internal component leakage can be high. Parameters can be set in the point-of-use air management system to detect idle time and programmed to

reduce air pressure for a period of time called *standby mode*. Reducing the air pressure decreases the potential for leakage and wasted air during these idle times, therefore reducing the CO_2 emissions related to lessened compressor load.

The unit enters *isolation mode* during prolonged inactivity, triggering the two-way valve and ultimately stopping airflow altogether. These long-term idle times can be programmed for weekends and seasonal, planned or unplanned downtime. These periods can also be relatively short, like when a machine stops for only a few minutes.

Note that during standby mode, pressure is reduced but not completely shut off. Therefore, air will remain in the system. When returning from standby mode into normal operation, ramping back up to pressure takes less time than it would in complete isolation mode, with the air pressure entirely exhausted from the system.

Condition-Based Predictive Maintenance

The pressure, flow and temperature sensors can also set a baseline within the onboard data hub. During normal operation over time, a digital fingerprint is established, and the data can determine and flag anomalies to reveal potential problems before a system component fails.

For example, it can detect excessive air consumption during a period of machine cycling. This could indicate a potential air leak due to worn seals in a cylinder, and the early detection would allow for cylinder replacement during scheduled downtime—which would be another cost saving.

Scalable Architecture

In some cases, manufacturers have installed wireless technology that enables smart air management systems to communicate with each other (Figure 2). For example, one base unit will communicate with 10 remote units installed on other machines. All information is taken from these remote units, funneled to the base unit, and reported upstream into the network. The factory network can then connect to a gateway and then the cloud. This allows for only one data hub connected to the factory network. Units can also be hardwired through a fieldbus network instead of using the wireless method if desired.

Installing smart point-of-use air management systems is a great way to implement cost-saving solutions in a facility, particularly where several machines are operating, and the potential is high for internal/external leaks and component failure. In their simplest form, these units can operate without being integrated into the plant network and use only the onboard interface.

The installation cost is low, and the unit will have a quick return on investment. In their more complex form, these units integrate into the facility network and implement a data analysis method. The potential savings from this option will be even greater, resulting in an even shorter payback period. **P&M**

This article was written and contributed by Alan McCay, CFPS, Motion.

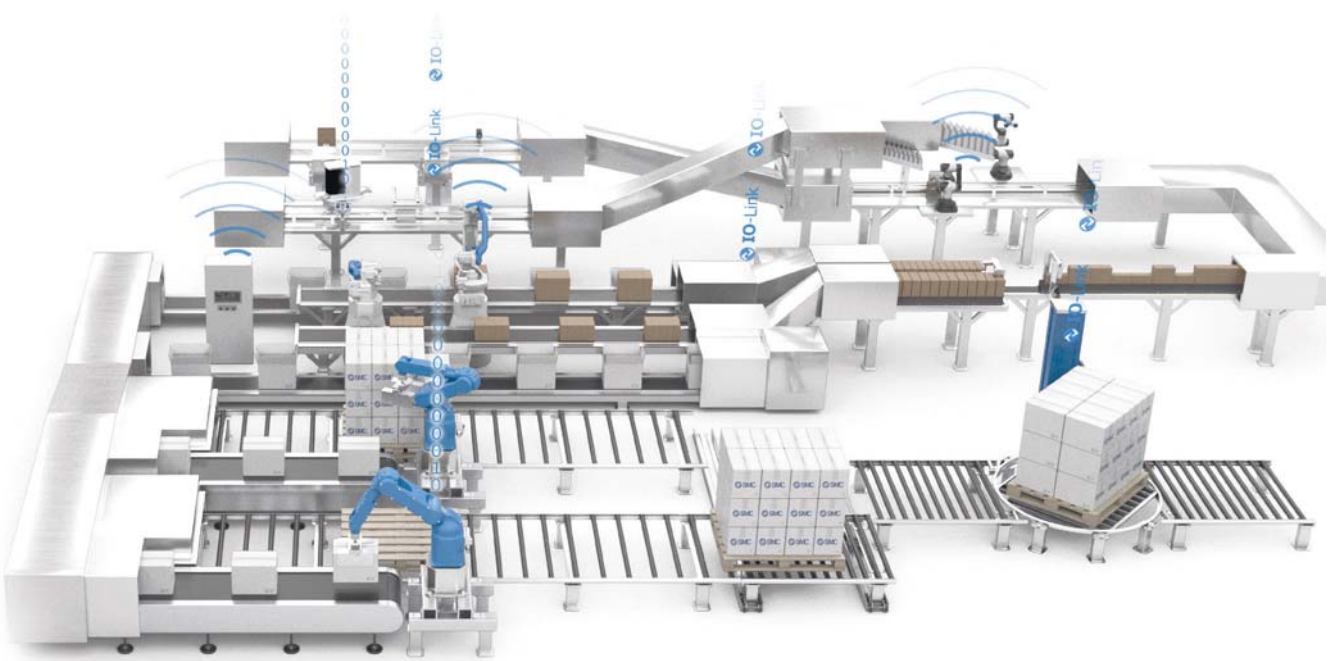

Figure 2: Wireless technology allows smart air management systems to communicate with each other, resulting in a cohesive network, giving back even more potential savings. SMC

Gefran KM Industrial Pressure Transducer

Gefran Inc. is introducing its KM industrial pressure transducer to the North American market. The transducer can be used in a range of mobile and industrial hydraulic applications.

Features of the KM pressure transducer include:

- pressure range options up to 14,500 psi (1,000 bar)
- five electrical connector styles
- stainless steel housing
- shock and vibration resistant.

powermotiontech.com/21274036

Oriental Motor EH Series 3-Finger Electric Gripper

The EH Series 3-Finger Type electric gripper from Oriental Motor USA is capable of holding complex shaped objects, such as spheres and cylinders, mimicking the dexterity of human fingertips.

Key features of the electric gripper include:

- αSTEP AZ Series motor
- ability to grip complex shapes
- maximum gripping force of 50 N
- compact and lightweight design.

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Emerson AVENTICS Series AF2 Flow Sensors

Emerson's AVENTICS Series AF2 Flow Sensors monitor air consumption in pneumatic systems, helping to reduce compressed air consumption and improve energy efficiency.

Features of the AF2 Flow Sensors include:

- flow, pressure and temperature measurement
- IIoT capabilities
- compact size for reduced space claim
- high-flow model to benefit larger systems.

powermotiontech.com/21273591

Beckhoff AA3000 Electric Cylinder Series

Beckhoff is expanding its AA3000 electric cylinder series with the AA3100 devices, which are designed to be a drop-in replacement for hydraulic or pneumatic actuators, and are ideal for linear motion applications.

Features of the AA3100 electric cylinders include:

- fully integrated mechanism for compact design
- ISO 15552 flange size to ease installation
- ability to customize to suit specific application requirements
- extra-low voltage range from 24-48V DC.

powermotiontech.com/21275743

Bucher RKVG and RKVE Ball Check Valves

Bucher Hydraulics has developed more compact versions of its RKVG and RKVE ball check valves to better fit into shrinking installation spaces. The RKVE-KB and RKVG-KB series valves are between 2 and 3 mm shorter than standard check valves.

Features of the RKVE-KB and RKVG-KB valves include:

- shortened design to fit space-constrained machine applications
- maximum operating pressure of 350 bar
- fits market-standard cavity with 118-deg. tip angle
- increased flow rates at same pressure differential to save energy.

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Q&A: Improved Hydraulic System Design Enables Efficiency Gains

Leif Bruhn of Danfoss Power Solutions discusses the technology behind the Dextreme Max system for excavators and how it can improve the efficiency of hydraulic systems.

by Sara Jensen

Creation of more efficient hydraulic systems can reduce the energy consumption of the machines into which they are integrated, leading to fewer emissions produced. This is a concept Danfoss Power Solutions is looking to prove with its Dextreme Max system for excavators.

The company has received a grant from the UK Government's Department for Energy Security & Net Zero through the Red Diesel Replacement Phase 2 (RDR2) Competition. With this grant, Danfoss will convert a 30-ton electric excavator to utilize its Dexteme Max system featuring the company's Digital Displacement hydraulic pump, the DDP1X0D.

Hydraulic system efficiency gains will be achieved with the Dextreme Max system due in part to the energy recovery capabilities possible with the DDP1X0D pump. Danfoss expects the system will help to reduce an excavator's energy consumption by as much as 50% due to the improved efficiency of the hydraulics—which can lead to efficiency improvements in other parts of the machine such as reducing the amount of battery power required.

Power & Motion spoke with Leif Bruhn, head of Digital Displacement at Danfoss Power Solutions, about the project and how the technologies involved can help to improve hydraulic system efficiency and how that benefits efforts to decarbonize construction equipment.

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

Power & Motion: Why is the company choosing to prove the Dextreme Max system with the grant from the U. Government's Department for Energy Security & Net Zero program as opposed to on of the other versions of the Dextreme system?

Leif Bruhn: Our other Dextreme systems (Swap and Flex) are past the research stage and are being commercialized to reduce diesel machines' fuel consumption. Now that the industry sees what's possible, we want to demonstrate what is possible when applying a fundamental change to system architectures to meet our customers' challenging carbon dioxide (CO_2) targets.

The support of the UK's RDR2 grant program gave us the confidence to invest in developing the additional features required for Dextreme Max in the pump, controller, and system. Dextreme Max matches the ambition of the RDR2 grant program for a first-of-a-kind demonstration, acting as a "beacon" to lead the industry toward complete decarbonization.

P&M: What enables the Digital Displacement pump to do energy recovery in the Dextreme Max system?

LB: Our DDP1X0D pump has a digital valve for each pumping cylinder. In Phase 1 of the Red Diesel Replacement program, we upgraded that valve to a new design that allows hydraulic energy recovery and transformation, and we demonstrated very high efficiencies, which will shortly be published at the 2023 International Symposium on Fluid Power and Motion Control (FPMC).

We've adopted this new design as the core of the DDP1X0D range. This means that every DDP1X0D pump will share the same design, whether fulfilling the role of a pump (in a traditional system) or the role of a pump/motor/transformer (as in our Dextreme Max system).

Just upgrading the pump is not enough to realize all the benefits; we also need to change the actuator control valves to remove throttling and route fluid back to the pump for energy recovery. So, it's a combination of a new component and a new system architecture that unlocks the full potential.

P&M: Why has the company chosen to convert an electric excavator as opposed to testing the system on a diesel-powered machine?

LB: One of the strengths of the Dextreme systems is that they can be applied regardless of the energy source: diesel, synthetic fuel, battery, or hydrogen. So, OEMs can follow a single technology roadmap to improve efficiency across their entire range. Our Dextreme Max system shows incredible economic and environmental value in large battery-electric excavators. Dramatically increasing energy efficiency in the hydraulic circuit enables OEMs to reduce their battery size/costs. P&M

Read the full interview at powermotiontech.com/21273900.

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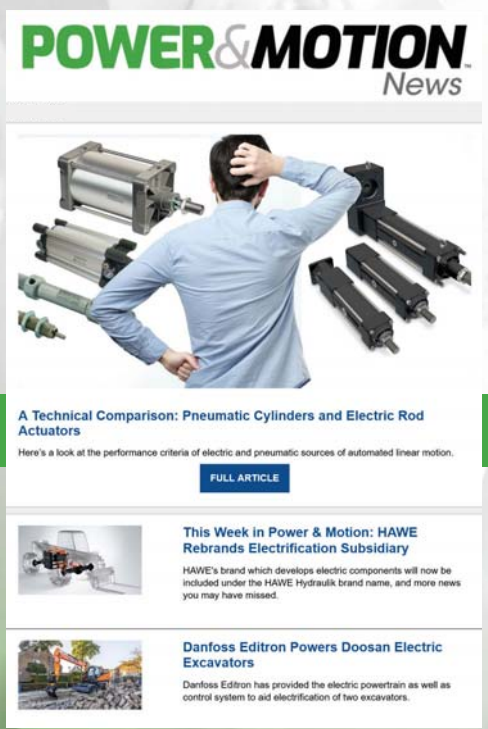

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