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January/February 2022

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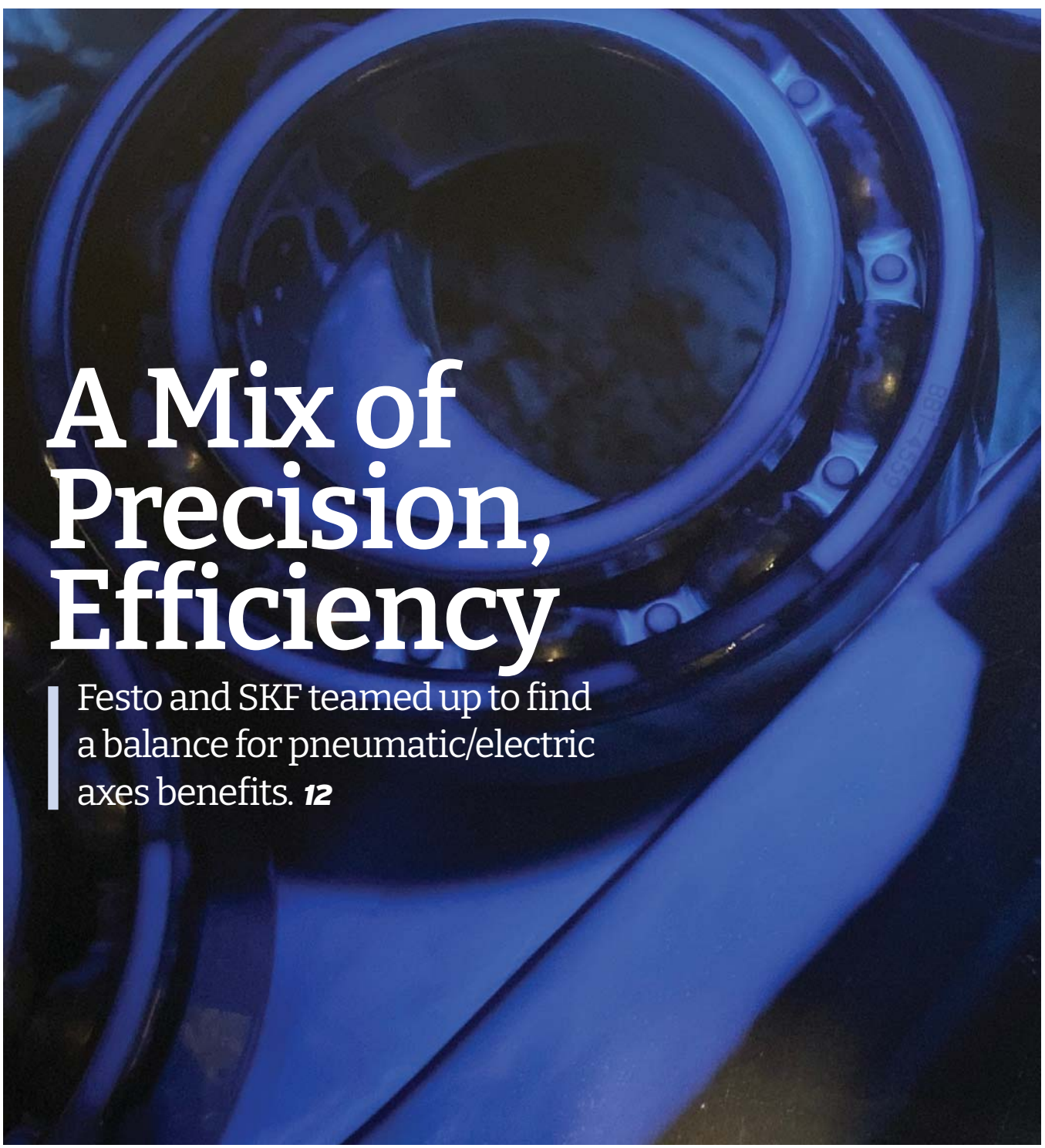

A Mix of Precision, Efficiency

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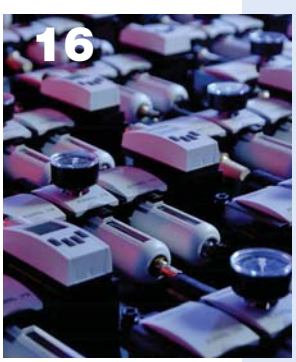

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POWER&MOTION

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BOB VAVRA
Senior Content Director
bvavra@endeavorb2b.com

The Return on "Human" Investment

One of the best parts of this job is getting to share great stories about how technology is applied. There's a lot of focus on what product innovations will do in the future, and that's important. Equally valuable is what those innovations are doing today to improve efficiency and productivity.

Under the headline "A Mix of Precision, Efficiency" is the story about how Festo and SKF worked on a joint venture to integrate electric actuation into an anti-corrosion spray for SKF's roller bearings line. It's one thing to talk about those concepts in abstract terms; it's quite another to see them applied to real-world challenges.

One of the expected benefits of the application was energy savings, but to achieve that at the loss of efficiency or quality doesn't provide value. As the article discusses, the key to any technology change is whether you gain more than you lose, and how long it might take to achieve that gain.

"Return on Investment" is one of the trickiest equations in all of manufacturing, because everyone views ROI from a different perspective. For the CFO, six months to ROI might be too long; for the operations manager, it might not be enough time to fully implement the change. In the real world, the words "Return" and "Investment" may as well be opposites. Return is almost always seen in the shortest time possible, whereas Investment is seen as a long-term commitment.

Yet both are vital. We need investments to improve our returns, and we need to loop those revenues back into further improvements. As it was in the case at SKF, the investment was seen through the lens of trying to improve one area of operation. The reality is that it improved other areas as the benefits were better understood and the operations team got a better sense of how to optimize the technology.

Continuous improvement doesn't happen on a spreadsheet; neither is it a "feeling" about how something will perform. There's enough data today to measure how technology is performing in our systems, and enough on-the-ground experience to turn that data into knowledge, and then into improvements that can be rolled out elsewhere in a plant.

As this case study demonstrates, the technology is only the first step to success. This project succeeded because engineers asked how things could improve and worked in tandem to turn technology into solutions. That investment in human capital is also hard to calculate, but the return almost always pays huge dividends.

And those are the best stories to tell.

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Power & Motion Names Six Leaders to **Editorial Advisory Board**

by Bob Vavra

***Power & Motion* has named** six industry leaders to its first Editorial Advisory Board. The board's role will be to help guide the present and future content direction of Power & Motion and to help identify trends and innovations that will shape the future of the fluid power and motion control industries.

"The role of an Editorial Advisory Board is one of essential guidance for our editors to ensure their coverage remains valid, current and beneficial to our audience," said Group Content Director Michelle Kopier. "Working with key figures in the industry helps us keep a pulse on what lays ahead for the modern fluid power and motion control industry."

The six members of the board are the first members of what we expect will be a larger group of industry experts from all segments of the industry. We continue to accept nominations for Editorial Advisory Board members, and those nominations can be sent to bvavra@endeavorb2b.com for consideration.

This first group reflects the changes in this industry that led us to expand our coverage of fluid power in 2022 under the *Power & Motion* brand. We are pleased that each of these individuals have agreed to help guide the industry by partnering with *Power & Motion*.

Here are the members of the *Power & Motion* Editorial Advisory Board.

Joe Alfieri

Group Vice President
Moog Construction

■ In January 2021, Moog Inc. asked Joe Alfieri to lead Moog's new startup for the construction industry named Moog Construction. He currently serves as group vice president and general manager of Moog Construction, which is the Moog Inc. business unit focused on accelerating electrification, automation and connectivity by enabling the world's safest, most sustainable and most productive machines.

Joe joined Moog in 2008 as a project engineer in Moog's Space & Defense Group. After working as a project engineer at Moog, Joe took on new roles in the Moog Space and Defense Group including as a sales engineer, program manager and Commercial Space business manager. Joe then took an assignment in Moog's Corporate Group as a program director focused on compliance and legal initiatives.

Joe next moved to Moog's Aircraft Group and served as program director of the F-35 Joint Strike Fighter program. In January 2019, Moog promoted Joe to general manager of the Aircraft Group's Commercial Aircraft Business Sector with sales of approximately $500 million; in 2020, Moog promoted Joe to group vice president.

Joe earned his MBA from the University at Buffalo, and he received both his master's degree in computer science and a bachelor's degree in computer engineering from the Rochester Institute of Technology.

Scott Baxter

Business Development Manager
PEKO Precision Products

■ Scott Baxter has spent over 13 years as business development manager and content writer at PEKO Precision Products in Rochester, N.Y. He has a passion for manufacturing which shines through his business relationships and writing.

Scott's bachelor's degrees in both manufacturing engineering and economics grant him a unique perspective on the machinery manufacturing industry. He also loves helping machinery and equipment project stakeholders bring their products to market.

Paul Carlson

President and CEO
Tolomatic

■ Paul Carlson is an accomplished executive with more than 30 years of leadership experience. Paul's career has spanned multiple industries including industrial automation, alternative energy, food & beverage and electronics.

Paul has worked with both public and privately held organizations in functional capacities that include executive management, operations, engineering and sales. Paul has spent considerable time in China and Mexico opening multiple manufacturing facilities in addition to several U.S.-based assignments.

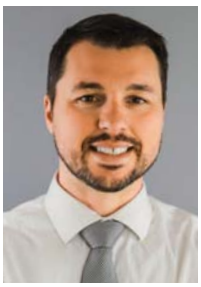
Paul's employment history includes Emerson, Control Products, Inc., Coca-Cola, IMI Cornelius, Trane and Earth Energy Systems.

Michael Terzo

CEO and Founder
Terzo Power Systems

■ Michael Terzo is an engineer with more than 20 years of engineering and manufacturing experience. Dedicated to the advancement of innovative and cost-effective solutions, Terzo Power Systems, LLC in El Dorado, Calif. specializes in bringing ultra-efficient electro-hydraulic technology to the fluid power industry for mobile, commercial and industrial


Joe Alfieri


Scott Baxter


Paul Carlson


Michael Terzo


Valeria Tirelli


Thomas Wanke

His work includes seven years of development and the 2014 launch of Hydrapulse technology and Terzo Power Systems. He has developed more than 100 products for industrial clients as a recognized expert in manufacturing and hydraulic systems.

Valeria Tirelli

President & CEO
Aidro Hydraulics & 3D Printing (Desktop Metal company)

■ Valeria Tirelli is president and CEO of Aidro Hydraulics & 3D Printing, an Italian company that excels in introducing additive manufacturing alongside conventional manufacturing of valves and hydraulic components. After studying business administration and working as financial controller, Valeria joined the company founded 40 years ago by her father. In the headquarters located in the northern Italian province of Varese, Valeria decided to innovate the company creating a dedicated department of metal additive manufacturing with the traditional fluid power production.

Valeria is promoting the adoption of additive manufacturing in various industry, participating also in international groups for the definition of guidelines and standard. She is invited to many events concerning additive manufacturing both in Italy and Europe.

Thomas Wanke

CFPHS, CFPE
Director of the Fluid Power Industrial Consortium Industry Relations at Milwaukee School of Engineering

■ Tom Wanke has more than 50 years of experience in the fluid power industry, 48 of which have been at MSOE. Tom was recently inducted into the International Fluid Power Society's (IFPS) Hall of Fame. Prior to his current position, Tom was the director of MSOE's Fluid Power Institute for 37 years. He has a bachelor's degree in mechanical engineering technology and a master's degree in engineering, both with the fluid power specialty option from MSOE. Tom is an IFPS Certified Fluid Power Hydraulic Specialist and Certified Fluid Power Engineer.

He has worked on projects in the following areas: component and system design; development and evaluation; field troubleshooting and failure analysis; and fluids, filtration and contamination control.

Tom has developed & presented numerous fluid power courses, workshops and seminars covering a wide variety of topics in fluid power. P&M

NFPA Plans for a Lively Conference

From a discussion of the future of fluid power and electrification to a review of supply chain challenges and their impact on all aspects of manufacturing, the 2022 National Fluid Power association's Annual Conference promises a look into the future of the industry and its impact on association members.

The event is scheduled for Feb. 22-24 at the Arizona Biltmore in Phoenix and was still scheduled as a live event as of press time. The keynote and general sessions also are scheduled to be available as virtual events as well as at the event location. Full details for the event's status can be found at www.nfpa.com and will be included in newsletters at www.powermotiontech.com leading up to the event.

Among the speakers scheduled for the NFPA annual Conference (all times are PST):

Tuesday, Feb. 22:
4:30 p.m.–Dan Miller will discuss "Executive Wellness": a discussion of dieting to achieve vibrant longevity without disease or disorder.

Wednesday, Feb. 23:
8 a.m.–Opening Comments and General Meeting.
8:45 a.m.–Theodore Krause will talk about "Electrification via Fuel Cells and the Future of Off-Highway and Fluid Power."
10:45 a.m.–Michael Wade, professor of Innovation and Strategy at IMD and the Cisco Chair in Digital Business Transformation, will present on "Charting a Vision for a Digital Strategy that Supports your Business Strategy."
1 p.m.–Best-selling author David Burkus will present on "Leading High Performance Teams from Anywhere."

Thursday, Feb. 24:
8 a.m.–Opening Comments and NFPA Foundation Update.
8:30 a.m.–Stan Ridgley, associate professor of management at Drexel University, will present on "Everything They Never Told You About Strategy, But You Absolutely Need to Know"
10:30 a.m.–Rosemary Coates, executive director of the Reshoring Institute and the President of Blue Silk Consulting, will make a presentation on "Planning for a Resilient Supply Chain, and the Latest on Reshoring."
1 p.m.– Geopolitical Strategist Peter Zeihan will present "Navigating a Disruptive World... with a Focus on Workforce, Supply Chain and the Latest in Disruption for 2022."

For more information on the event, or to register, go to www.nfpa.com and click on the Events tab.

Motion Acquires Kaman

by Bob Vavra

Motion has completed its acquisition of Kaman Distribution Group (KDG) in a $1.3 billion deal that will merge two of the country's largest industrial distributors under the Motion brand and further strengthens the company's growing supply chain influence. The deal was completed Jan. 3.

Motion is the fifth-rated distributor in the most recent *Source Today* Top 50 Industrial Distributors listing, and Kaman is ranked 20th on that list.

"It's a very exciting time; this transformative move will be highly beneficial to everyone involved, especially for customers of our combined entities," said Motion President Randy Breaux. "Our customer service will be the best it's ever been with deepened and expanded capabilities. In addition, KDG shares many of our same cultural beliefs, principles and ambitions, including our commitment to providing superior service and value to our customers. We look forward to welcoming the highly talented KDG associates to the Motion team."

"Our Motion team, led by Randy Breaux, is eager to bring together the world-class talent and industrial expertise of these two organizations to build an even stronger business," said Paul Donahue, chairman and CEO of General Parts Company, of which Motion is a wholly-owned subsidiary.

Bloomfield, Conn.-based Kaman Distribution Group provides equipment and solutions for the power transmission, automation and fluid power industry. The company has more than 1,700 employees and a customer base of more than 50,000. A press release stated Kaman will generate $1.1 billion in revenue in 2022.

"Motion is a nationally recognized brand and a market leader in industrial distribution," said Kaman President and CEO Ben Mondics in a press release. "We are very pleased to combine our two great businesses and leverage our collective resources and expertise to accelerate profitable growth. We appreciate the exceptional efforts of our employees who make our company so great, and we are confident Motion is the natural partner for continued long-term success."

Agile Production System

by Rehana Begg

Automotive manufacturers have their marching orders—find a way to drive the future of electric vehicles.

It's a tall order that requires an overhaul of the automotive production system. But it is one that Schaeffler's Automotive Technologies Division is strategically preparing for.

The German manufacturer of rolling element bearings for automotive, aerospace and industrial is leading a group of 17 partners—including scientists from the Karlsruhe Institute of Technology (KIT)—in a three-year project that will develop an agile and digitalized production system with a modular product concept for innovative electric cars.

Bringing academia and industry together, the consortium will develop a solution to the question of how electric motors can be manufactured flexibly and economically. The AgiloDrive2 research project will focus on ways to make electric motor production more flexible, sustainable and affordable on the basis of data-based production technologies, agile process chains and intelligent control architectures, noted Shaeffler's press release.

The findings of the AgileDrive2 project will be translated into scalable electric motor production at a state-of-the-art plant currently under construction at Schaeffler's Automotive Technologies Division in Bühl, Germany.

Agile Production

The AgileDrive2 project was preceded by AgileDrive, an 18-month pilot funded by the Baden-Württemberg Ministry of Economics, Labor and Tourism and in collaboration with the Karlsruhe Institute for Technology (KIT). The initial phase used digital twins (virtual simulations of the real-time digital counterpart) to develop modular structures for electric motors and their production. Two demonstrators were fabricated as proof of concept for the implementation of a novel agile production system.

Electric motors come in many configurations and their topology may depend on the type of electrified powertrain or technical specifications, such as winding type, installation space, torque, continuous output and operating behavior. Schaeffler has the ability to offer electric motors that extend across all degrees of electrification for hybrid modules, hybrid transmissions and all-electric axle drives with a wide output range extending from 20 to over 300 kW.

"We are responding to the variety of versions and inconstancy in quantities with an agile production method, which we intend to develop and validate mutually in the AgiloDrive2 project," explained Thomas Pfund, president of the E-Motors Business Unit at Schaeffler, in a press note.

The goal is to develop a versatile production system following a product/production co-design principle that will promote a close cooperation between

product system and production system development. "Instead of rigid production lines, we will be looking to highly flexible, digitalized and efficient technology modules, which are easily scalable, permit flexible configurations and interlinking and can be established on a software basis," said Pfund.

Plug & Produce

The research team will focus on developing a modular machine structure, which permits the reuse of production equipment in an efficient and sustainable way. Digital twins will permit efficient production planning and accelerated commissioning, while AI solutions further increase product quality, and digital qualification methods facilitate and expedite employee instruction.

Schaeffler noted that the culmination of standardized machine connections, hardware and software interfaces and cross-manufacturer communication standards should assist in accommodating the rising complexity and permit the rapid integration of systems in accordance with the "plug and produce" approach.

Stator with hairpin winding from the pilot phase of the AgiloDrive research project at KIT. ***Markus Breig, KIT***

Not only will these agile approaches facilitate the operation of production systems at demand-based operating points, but they will also enable cost-reducing economies of scale through data-based process adaptation across different product series and technologies, explained Professor Jürgen Fleischer, head of the wbk Institute of Production Science at KIT and scientific project manager at AgiloDrive2.

Sustainable Mobility

The AgiloDrive2 project—consisting of the wbk Institute of Production Science, the Institute of Electrical Engineering (ETI), and the Institute of Product Engineering (IPEK) of KIT, as well as industrial partners—is funded by the German Federal Ministry for Economic Affairs and Energy (BMWi) with $18.57 million (€16.4 million) at a total project volume of $38.3 million (€33.7 million) over the next three years.

The project is expected to bolster international competitiveness of the German automotive industry by integrating electric mobility at both technical and economic levels, as well as to propel the industry toward sustainable energy and mobility.

A MIX OF Precision, Efficiency

Festo and SKF teamed up to find a balance for pneumatic/electric axes benefits.

Two years ago, Festo sales engineer Jim Ross and his colleague, electric automation business development specialist Nabil Salman, walked into Bo Askew's office at the SKF USA in Flowery Branch, Ga. They told Askew that Festo would soon introduce a new low-cost family of electric axes. That immediately caught Askew's attention.

Askew, the facility supervisor and machine reliability champion at the Flowery Branch roller bearing manufacturing plant, was looking for cost-effective electric options to replace pneumatic motion in order to lower energy consumption at the plant. Askew subsequently discovered that energy savings was only one of many advantages of these new all-in-one electric axes.

Ross and Salman explained that the new Simplified Motion Series (SMS) family of two position axes that would soon be available were priced similarly to pneumatic cylinders. He said that these all-in-one machine-mountable units saved cost and space by eliminating the need for having an external drive located in a control panel. Programing position, speed, torque and cushioning were simple and accomplished via the unit's onboard interface, not on a computer.

Within the SMS family of actuators, there were ball screw, slide and rotary style units that covered most simple two-position motion applications. (Recently three position capability has been added to every axis in the family through IO-Link.) SMS axes offer easy integration with a PLC via digital I/O or IO-Link.

Askew ordered two units for testing,

Housings inside the machine slide forward between guide rails, with each housing eventually reaching the center point directly under the preservative spray nozzle. ***Festo***

the 150- and 200-mm models of the EPCS ball screw cylinder. In the SMS family, the EPCS is the model most closely related to pneumatic cylinders. The EPCS has a rod that extends and retracts via ball screw rather than compressed air. Six weeks after the new units were purchased, the EPCS cylinders, among the first to be delivered, arrived along with M12 electrical connection cable and I/O hardware.

Askew knew just where he wanted to test the 150-mm unit—the roller bearing preservation machine where he could replace a 150-mm pneumatic cylinder with a 150-mm electric cylinder and have an apples-to-apples comparison of performance.

The TOG 110 Preservation Machine

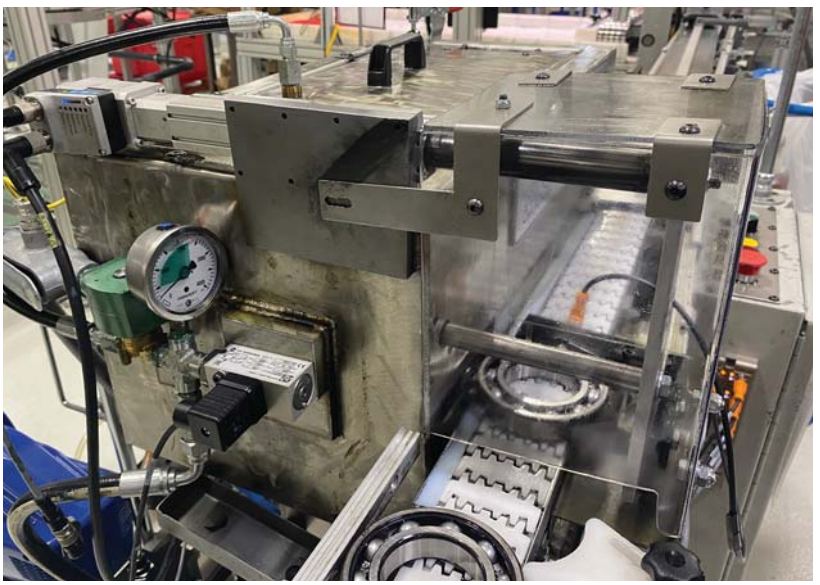
Once SKF roller bearings are pressed into housings during manufacture, housings are sprayed with an anti-corrosive preservative. This is a simple operation that can be performed manually using a spray bottle. While visiting a SKF plant in Italy, Askew was intrigued by an automated anti-corrosion spay machine at that plant. He was attracted to its simplicity, speed and, most importantly, that it freed a team member from spraying duties to focus on more challenging tasks.

Flowery Branch then manufactured its own preservation machine based on a design by Askew. The TOG 110 Preservation Machine sprays anti-corrosion preservative on 100- and 110-mm roller bearings. This is a fully automated spraying machine. The machine does, however, require manual changeover of the home position on the 150-mm pneumatic cylinder to accommodate a new run of different-diameter housings.

In single file, housings travel down a conveyor to the TOG 110 entry point where housings are pulled by tooling one at a time into the machine via the retracting rod of the 150-mm pneumatic cylinder. The new bearing housing pushes the next in line ahead by one housing diameter deeper into the machine. Housings inside the machine slide forward between guide rails, with each housing eventually reaching the center point directly under the preservative spray nozzle. As one new housing is pulled into the machine, a sprayed housing at the end of the line is pushed out onto an exit conveyor.

Very little force is needed to move the bearings through the machine as the low-friction plastic flooring is coated by a layer of preservative residue from the spraying process. The TOG 110 with pneumatic cylinder has a 900 unit-per-hour cycle rate and is operated 24/7.

For the TOG 110 to function properly, every entering housing must be pulled into the machine and left at the same location every cycle. If the position when the housing enters the machine is off, the line of housings inside the machine begin to diverge backward or forward from the center point under the sprayer.



A roller bearing is about to be pulled into the TOG 110. The Festo EPCS 150-mm electric cylinder is mounted top of the machine. Cycle rate increased from 900 to 1,500 housing per hour with the addition of this electric cylinder. ***Festo***

Divergence from placement at the center point has two consequences. An out-of-position bearing may have only a small part of its surface sprayed and need to be reworked. Or housings leaving the TOG 110 may be pushed tightly against the exit-guiderail and jam the line of housings within the machine. Jams are safety hazards as there is still force being exerted on housings from the pneumatic cylinder trying to retract.

To correct the fault, air had to be exhausted, and the cylinder rod attached to the tooling manually readjusted. Over a period of months adjustments from changeovers and incorrect positioning wear nuts and rod grooves down, which affects precision adjustment. Excessive wear warrants replacing the cylinders on average twice per year.

Test-Driving an Electric Axis

With the TOG 110 Preservation Machine misalignment problem in mind, Askew had an ideal test case for the Festo EPCS electric cylinder. Festo Electric Automation Specialist Salman began the process by providing remote training on the EPCS. The manufacturing team mounted the unit directly on top of the TOG 110 and connected the rod to the tooling. The similarity of the rod in both electric and pneumatic cylinders provided for a simple conversion.

With some trial-and-error, the EPCS was soon in operation. The team programmed the torque, speed, and the end and home positions—home being the exact location to pull a housing into the machine. PLC I/O programming was identical to that for a digital pneumatic valve, which made this step simple. The cylinder's IO-Link capability provides diagnostic feedback.

Both torque and speed were set at a minimum level for optimum control and positioning when the rod retracts, pulling housings into the machine. For the return trip—the extension of the rod out to the pickup point for the next housing—there was no housing to control, so the speed was set high to increase cycle rate. A cycle rate of 1,500 per hour was achieved for the electric cylinder, an increase of 600 cycles per hour over the pneumatic cylinder's 900.

Most importantly, every bearing entering the TOG 110 was precisely positioned so housings under the spray nozzle were

These SMS axes from Festo provide an economical and easy-to-use solution for electric motion. ***Festo***

centered for an in-specification dose of anti-corrosion fluid, and housings exited at the proper point, eliminating jams. When work needs to be done on the interior of the TOG 110, safety systems stop the machine. The electric cylinder does not produce stored energy in stop mode, which is a safety improvement.

Changeover is simply a matter of setting a new home position via the unit's onboard interface. Since no physical adjustments need to be made, the electric cylinder undergoes less wear. After one year's 24/7 service, the cylinder has not needed to be replaced; pneumatic cylinders would have been. Askew plans on installing SMS units on the plant's grinding and honing machines as well as on the 200-mm preservation machine.

"After the EPCS was operating for nearly a year, I wrote Jim and Nabil to tell them how successful our joint test project of the electric cylinder had been," Askew said. "I believe it is important to share successes and in doing so continue to motivate vendors and customers to explore new solutions that improve production."

Electric Motion Bridges the Gap Between Pneumatics and Servo Motion

Festo represents an engineering breakthrough that combines the simplicity of pneumatics with the benefits of electric automation. SMS takes proven ball screw axes, toothed belt axes, mini slides, electric cylinders, piston rod and rotary actuators and integrates them with an onboard servo drive. Users commission two-position functionality via onboard push buttons with no additional software needed.

When controlled with IO-Link, which is a standard feature of SMS axes, positioning along the axis length is infinitely variable. When used like this, SMS axes offer a cost-effective alternative to more expensive and complex traditional servo motion. They are low cost when compared to traditional servo motion solutions and setup is simple, as pneumatics opens the door to applications that have previously been cost-prohibited to electrics—including conveyor material handling and applying electric motion in mobile applications.

Via IO-Link, technicians can remotely adjust movement parameters, including infinitely variable positions and speed. They can also copy and back up functions for parameter transfer and read functions of essential process parameters.

SMS actuators are applied in positioning, indexing, clamping, feeding and cut-to-length tasks where electric automation adds proficiencies and value. Ordering, inventory and replacement are streamlined as all of the components are integrated into a single unit with a unique part number. Units in the series include ELGS-BS ball screw, ELGS-TB toothed belt axis, EGSS mini slide, EPCS electric cylinder (The cylinder used by SKF), EPCE compact electric cylinder, ERMS rotary drive and ELGE toothed belt axis.

Both Digital I/O (DIO) and IO-Link control come standard with each unit. With DIO control, there are two positions available—home and a configurable endpoint. As stated above, IO-Link offers flexible positioning along the axis, like a traditional electromechanical axis.

PLC set up for DIO control is identical to programing a digital pneumatic valve with two digital outputs and two digital inputs. One digital output extends the axis and the other retracts it. And the digital inputs indicate when the axis has reached the extended position or the retracted position, just like proximity switches would function on a pneumatic actuator.

This similarity to a pneumatic valve simplifies PLC programing, reduces the number of I/O typically required for servo-controlled motion, and speeds up installation of single and multiple units. Integrated position feedback eliminates the need for proximity sensors.

Since the electronic components and modules are onboard the integrated drive, these actuators are machine-mountable. There is no external servo drive to mount in the control panel, which means minimal control panel overhead associated with these electric drives. **P&M**

Article contributed by Festo.
Bo Askew, Facility Supervisor and Machine Reliably Champion, has worked for 27 years contributing to the success of SKF Flowery Branch production systems.

Jim Ross joined Festo in 2014 as a sales engineer. He has held roles in national accounts and key account management. Jim enjoys collaborating with customers on new designs and solutions using Festo's products. He holds a double major BSBA in Marketing and Logistics from John Carroll University, and an MBA from Benedictine University.

Nabil Salman joined Festo in 2017 as an electric automation business development specialist. In his past, he's held roles in control engineering and project management. He enjoys promoting and growing Festo's electric automation line to a multitude of industries. Salman holds a Bachelor of Science degree in Electrical Engineering from Mercer University

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1. The AVENTICS AF2 Flow Sensor supplies compressed air to the pneumatic system and measures the overall airflow of the system.

MACHINE LEARNING

Models Predict Compressed Air Anomalies

AI condition monitoring and prediction can locate leaks before they happen, optimizing energy use in industrial pneumatic systems.

by Michael Britzger, Nils Beckmann

The energy supply in a company is not only essential for successful industrial production, but also represents a significant cost factor in manufacturing. For this reason, manufacturing companies, as well as developers of components for energy supply, are more frequently concerned with optimizing their production and products.

Across discrete and hybrid industries, the production of compressed air is responsible for as much as 30% of overall energy costs and therefore represents one main cost for energy supply within these industrial environments. Moreover, a significant portion of this cost is unnecessary, since nearly a third to a fourth of industrial compressed air consumption is waste caused by leaks. Thus, leaks in compressed air supply have been identified as a significant cost driver in industrial production.

However, the growing complexity of industrial pneumatic systems induces a more

At a Glance:

- Compressed air makes up as much as 30% of all energy costs in a plant and almost one-third of all generated compressed air is estimated to be wasted.
- Using machine learning and artificial intelligence can identify and predict many system failures before they can occur.
- One key metric is flow rate, which provides a reference for the ideal air flow.
- AI prediction models can help reduce costs and avoid unplanned shutdowns, which means a quick ROI for system costs.

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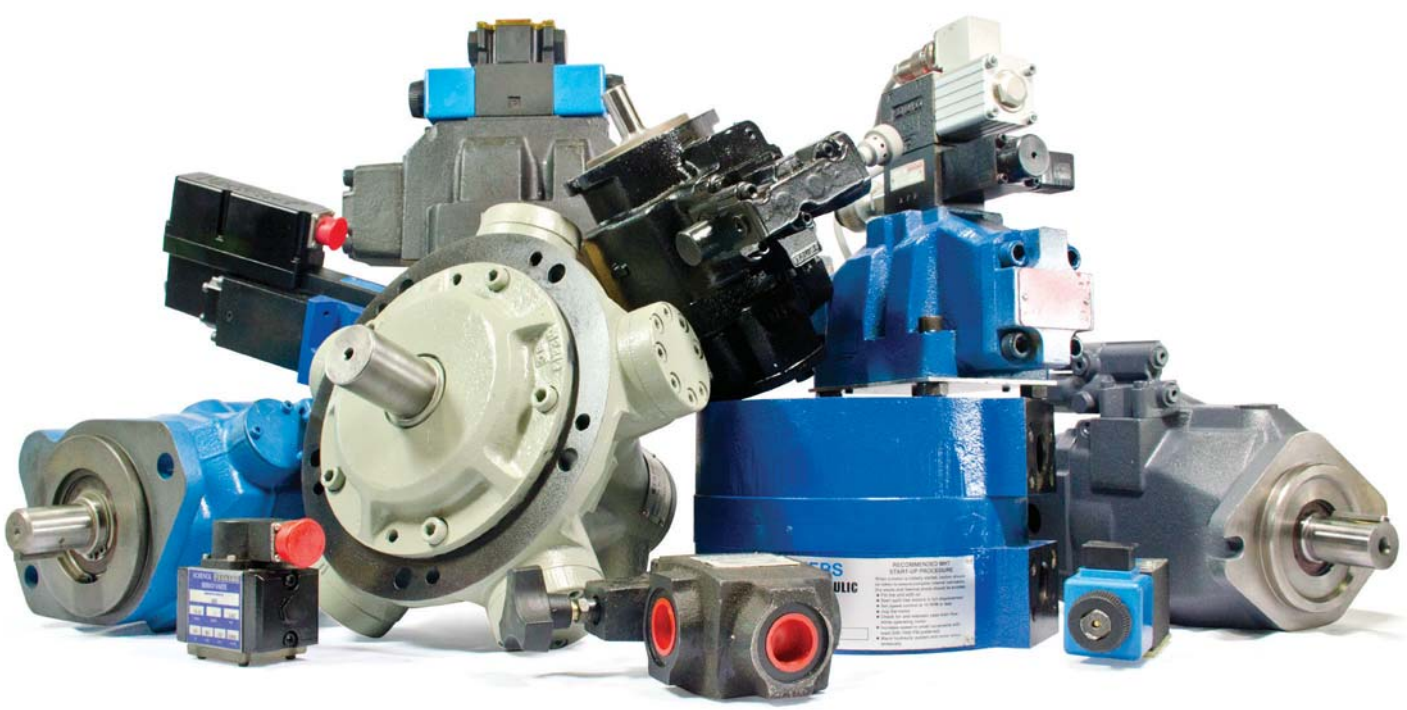

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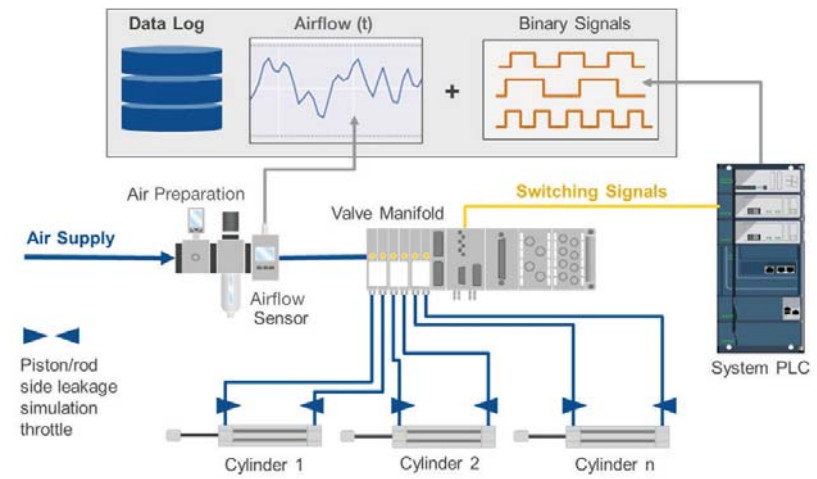
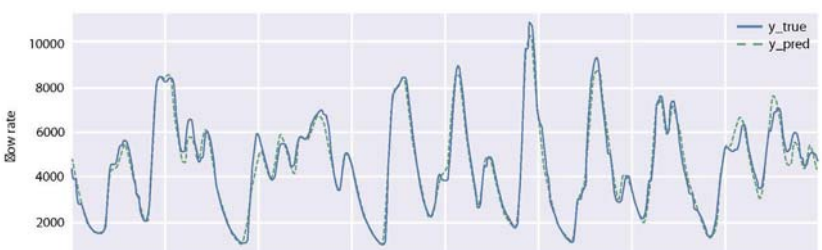


2. The diagram above demonstrates a typical application of a pneumatic system, in which an air flow sensor measures compressed air and stores the data in a database, then a PLC receives signals from the database to switch the corresponding valves on or off.



3. This trained prediction model saw an overall airflow prediction accuracy of the mean absolute percentage error of below 7%.

complex failure identification by means of the concrete subsegment or component at which the loss of compressed air occurs. So not only early detection but also the most accurate possible location of such leaks can reduce maintenance costs and reduce unplanned downtime, and by this ensure and improve the overall equipment efficiency of the industrial system.

Early detection and identification of leaks will generally reduce the amount of energy consumed, reduce CO2 footprint and maintenance costs and avoid unplanned downtime by improving overall equipment efficiency.

The digital enhancement of industrial productions has led to a state where these environments are equipped with a variety of sensors and data aggregation points that allow for performance monitoring and root cause analytics. Currently this journey of digital transformation is being brought to a higher level, where the generation and aggregation of data not only allows for descriptive and diagnostic analytics, but the prediction of events and failures due to the application of smart algorithms. The introduction of supervised and unsupervised machine learning algorithms in particular has become an important field of application within industrial environments.

IIoT engineers at Emerson have developed a machine learning-driven model that predicts the behavior of a pneumatics system. Thus, when minor deviations from the expected behavior occur, the model can detect the corresponding anomalies, such as leaks, and pinpoint their location within the system. By predicting the presence and location of such anomalies, machine learning models have the potential to prevent leaks altogether, significantly improving overall system efficiency.

The Promise of Predictive Machine Learning

Those familiar with digital transformation may be aware of the benefits that real-time monitoring and measurement provide, but predictive machine learning models may be new. While both models help plants reduce costs and optimize processes, their results are of different degrees. Real-time monitoring informs users of an incident and enables them to react just after it happens. It minimizes the effects of an issue.

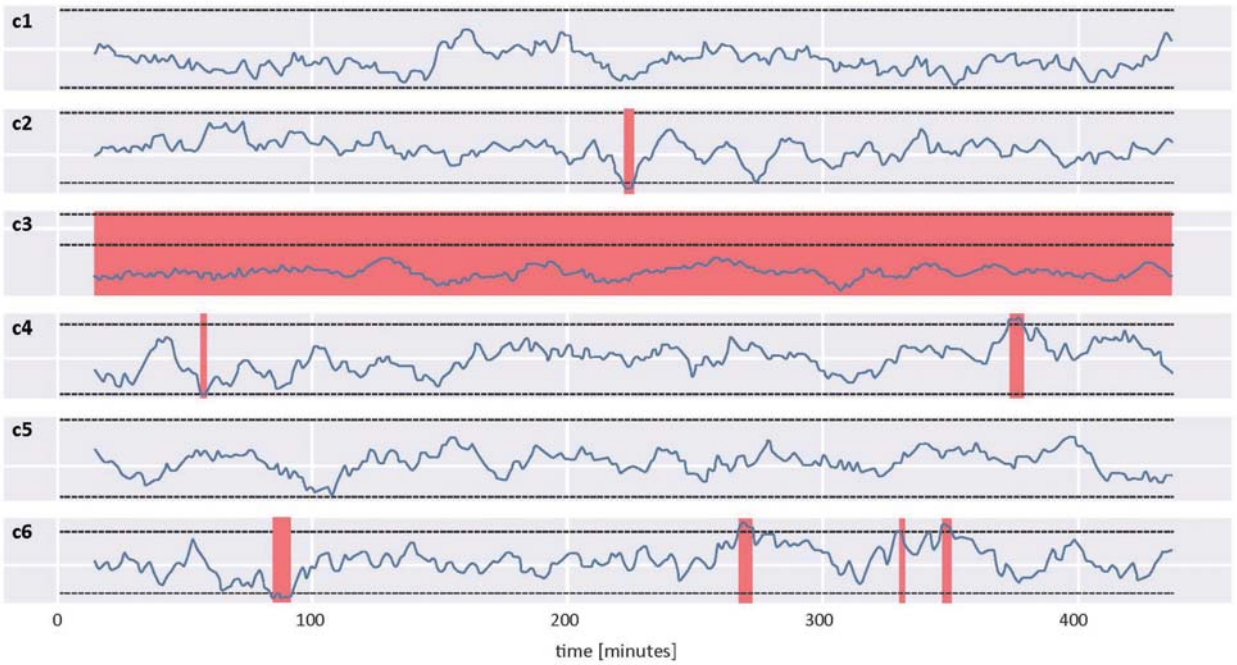
Prediction models, on the other hand, can prevent issues altogether by providing information about what is going to happen, based on the historical training data and the model. Instead of being notified shortly after the fact, end-users receive information about an issue that will or may occur very soon. This empowers users to optimize their operations and move from reactive to proactive operational processes.

While monitoring solutions offer real-time insights, it's fair to say that machine learning model predictions are future-time insights. We've seen from countless books and movies that knowing what will happen before it does happen is incredibly valuable. A plant that can precisely control operations informed by predictive machine learning models has the potential to achieve perpetual uptime, avoid quality issues and possibly prevent injuries.

In the ideally connected world, smart systems report failures before they happen and take the necessary corresponding actions. Imagine the process: The system predicts a leak and its location, then orders the component forecasted to fail and schedules maintenance in a regular time slot, all before a lot of air is lost. No unplanned downtime, no unnecessary energy consumption. Predictive machine learning models can make significantly optimized operations like this a reality.

Real-Life Conditions

The nature of typical industrial applications presents several challenges for a pneumatic learning model. Modern

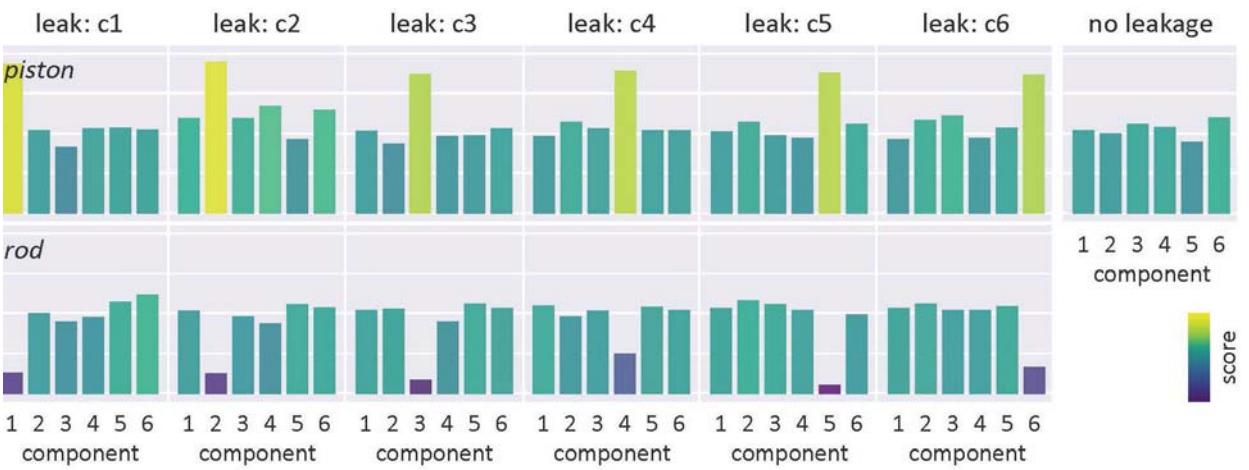


4. This graph shows that, when leakage was induced at the piston input side of cylinder 3, the score value decreased and differed from the reference score.

industrial machines and the environments where they operate can differ greatly. Temperatures and the dynamic viscosity of air itself change from plant to plant, preventing straightforward, linear models. The configuration and pneumatic architecture of each system vary from a few to several hundred components, and leaks are local events that models must assign to components.

In addition to this variation, many applications have a limited amount of training data available. Although the digital transformation of industrial equipment offers an extensive range of sensor and process data, little historical data exists because most machines have few, if any, sensors.

Luckily, the inclusion of even a few sensors provides enough reference behavior to train a machine model. It should be noted that this is basically the core mindset of digital transformation—most of the time, it's not about inventing new algorithms or technology but instead understanding the environment and application and applying existing technological "bricks" that add value. From a pneumatics perspective, the most relevant data are the central flow rate of the compressed air and the binary control



5. This is an example of a prediction model. In this instance, leakages were induced in 12 runs for each cylinder on both piston and rod side. The leakage score values differed from the reference data, showing exactly where the induced leaks were located.

signals of the pneumatic valves, which are available in the control data from the system's PLC.

What do the central flow rate and binary control signals tell a learning model about the presence or location of a leak? The flow rate itself doesn't reveal anything except the general amount of consumed air. But it does provide a reference for the ideal workflow that the model should expect. That makes it critical that the central flow rate be measured with no actual or potential leaks present. When airflow deviates from this ideal workflow, it signals a potential leak. Correlating that deviation with the binary signals of the valve manifold will then indicate exactly where the anomaly occurs.

In our application use case, this historical data is gathered by a smart sensor and a PLC. The sensor is integrated with an air preparation unit that supplies compressed air to the pneumatic system. As the compressed air moves through, the sensor measures the overall airflow of the system and stores historical data to a database. The system PLC switches the corresponding valves of a valve manifold that is connected to the piston and rod side of a series of cylinders. The binary switching signals are then stored in the same database *(Figs. 1-2)*.

In addition to historical data, a successful dynamic airflow prediction model requires validation data. To create validation data, leakage is induced via a throttle at each input supply side of every cylinder. Thus, artificial leaks are generated and the corresponding data recorded helps to validate and improve the existing algorithms before applying the solutions to an existing field application.

Forecasting Pneumatic Systems Anomalies

Models have successfully learned how to predict airflow in industrial pneumatic

systems. For instance, Emerson's machine learning model achieved a prediction accuracy of over 90%, forecasting significant anomalies and leakages, as well as indicating their location within the industrial machine. Even more, it determined a statistically significant forecast when creeping leakages affected the overall system behavior.

The system this model learned how to predict was an installed system without supervised learning or similar training data. The training data used included the overall airflow measurement without leakage, cross-correlated with the corresponding switching signals that made the system dynamics accessible. Based on the no-leakage data, the trained prediction model achieved an overall airflow prediction accuracy of the mean absolute percentage error of below 7% *(Fig. 3)*.

While the prediction model for the airflow was the first step, the more complex second step was to understand the behavior of the system using the corresponding valve switching signals to predict creeping leakage. Significant anomalies, like a broken pneumatics tube, are not very difficult to identify and locate because they usually make noise or stop the production process.

A creeping leakage occurs rather silently and isn't easily detected. These leaks can go unnoticed for long periods of time, subtly slowing cycle time, negatively impacting product quality and increasing energy costs. By identifying creeping leakage, machine learning models can help improve system efficiency in the long term.

The airflow prediction model that was generated and continuously improved served as a reference of the pneumatics system, including the empirical null distribution of each cylinder side serving as the cylinder-specific reference score. If a leak occurred, the measured score would have a value that was bigger or smaller than the reference score. Using this deviation, the faulty cylinder or valve and corresponding piston or rod side of the component could be identified.

For significance testing, leakages were manually induced for the piston and rod side of each cylinder. *Figure 4* shows that when leakage was induced at the piston input side of cylinder 3, the measured score value decreased and significantly deviated from the reference score.

The full significance of the prediction model is demonstrated in *Fig. 5*. Leakages were induced in 12 runs for each cylinder on both piston and rod side, and the score values significantly deviated from the no-leakage reference data, pointing to the exact location of the induced leaks.

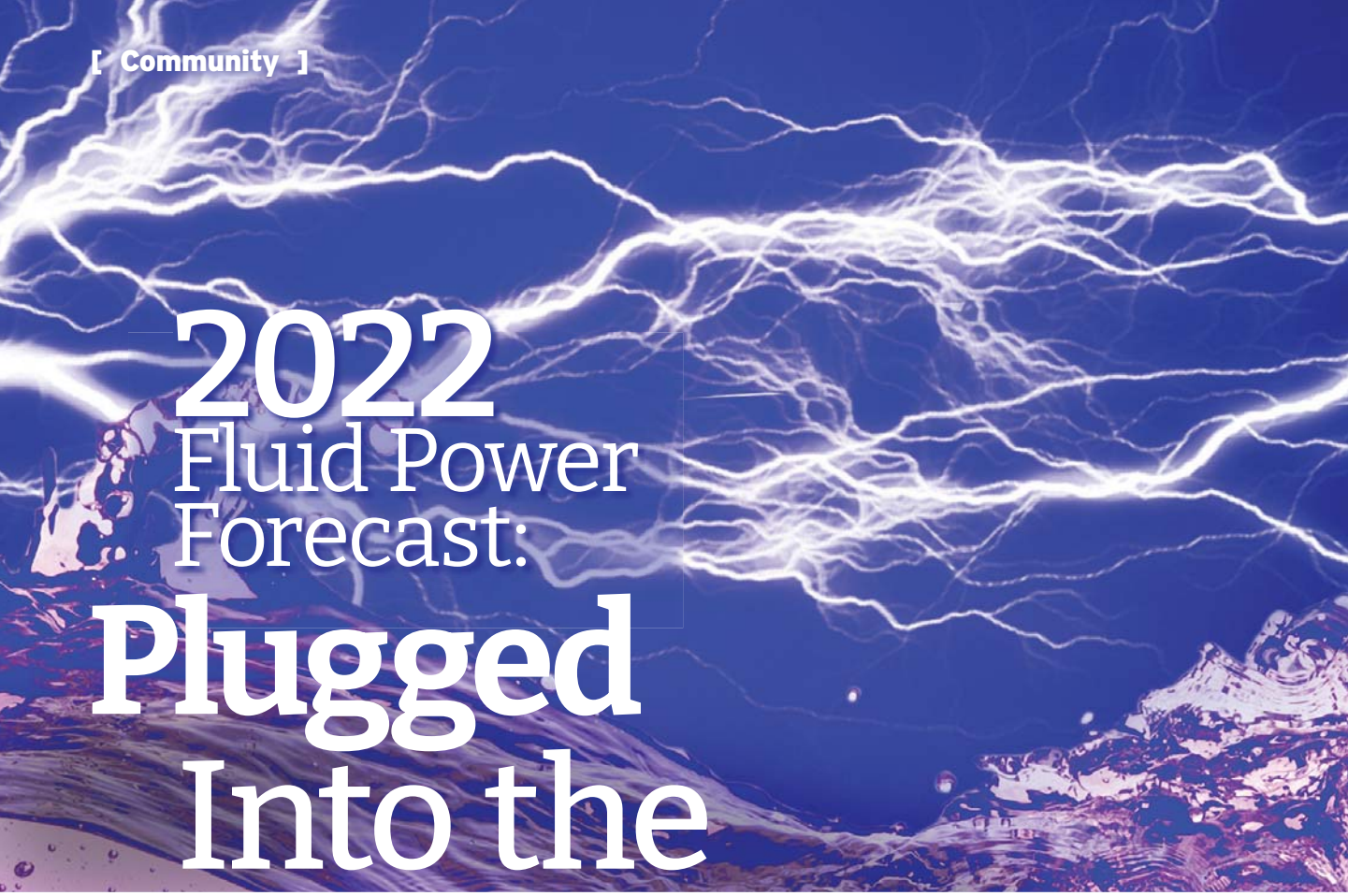
Predicting the Future, Preventing Failure

AI-based condition monitoring and prediction are future tools for optimized industrial production systems and energy use. Thanks to the innovation of leading digital transformation solution providers, these sophisticated analytics tools are becoming more and more accessible via standardized tool sets and libraries. What's more, by helping facilities reduce costs and avoid unplanned shutdowns, these solutions can quickly pay for themselves.

Machine learning models help identify anomalies in pneumatics systems before they can slow down a process or worse. These advance solutions can help facilities save energy, reducing carbon emissions and utility costs, and their condition monitoring and prediction can optimize resource use.

By integrating machine learning models, the plant of the future is proactive, not reactive. This level of digital transformation has the potential to push operations beyond improvement to optimization, providing facilities the foresight not only to see but to control their own futures. **P&M**

Dr. Michael Britzger is senior manager, IIoT Engineering & Innovation Machine Automation and Nils Beckmann is product marketing manager, IIoT Integration for Fluid Control & Pneumatics at Emerson.



2022 Fluid Power Forecast: Plugged Into the Future

Electrification puts a charge into traditional fluid power opportunities.

by Bob Vavra

The evolution of how power is generated and controlled has opened new vistas of innovation and new possibilities for the effective and efficient use of energy. Business leaders are planning for an electrified future that reduces carbon emissions—but they have to build that future with the existing technology in order to realize that goal.

At the intersection of all of this is the fluid power industry. The power factor of hydraulics and the precision of pneumatics have evolved over time to more hybrid approaches that include electrification—yet the value propositions that propelled each technology in the past remain valid for the next generation of systems. The future of off-highway construction will be impacted by a coming acceleration of electric vehicles that reduce emissions and maintenance and provide for autonomous operation.

And overlaying all of this is the proliferation of available data on system performance, fuel optimization and machine health. The use of sensors and analytics to identify what is happening in plants across the world has increased, and that data has opened new windows into ways to improve every aspect of a system.

In *Power & Motion*'s discussion with a wide range of industry leaders on these topics, the new power sources, the new control functions and an emphasis on clean fuels and environmentally sound practices won't displace the traditional fluid power technology any time soon.

In other words, two things are clear:

- Everything is changing in the fluid power industry, and
- Nothing is changing in the fluid power industry.

High on Hydraulics

Hydraulics have been the focal point for much of the industry changes. An area of particular growth has been electric off-highway vehicles for use on construction and agriculture. At the recent CES Show in Las Vegas, Doosan Bobcat unveiled an all-electric compact track loader. At the same show, John Deere unveiled its autonomous tractor, ready for large-scale production.

While all of this was going on, Danfoss Power Solutions made a major investment in hydraulics, purchasing Eaton's hydraulics business for $3.3 billion at the start of 2021. Danfoss Power Solutions President and CEO Eric Alstrom said that move will be enhanced by electrification, but that hydraulics remains a critical power source for the future.

"Hydraulics is strategic for us. It is our core, and we believe in it," Alstrom told *Power & Motion*. "Electrification is

coming, no doubt. But there are a lot of applications where energy density and power density simply favor hydraulics, and that why we remain in the favor for hydraulics for many, many years to come.

"When there is a substitution impact for effect with electrification, you'll still need implements that are hydraulic," Alstrom added. "A lot of the work functions, machines and so on still will remain hydraulic."

The National Fluid Power Association has been studying the impact of electrification on the industry—and its members. One of the key conclusions, according to NFPA president and CEO Eric Lanke, is that electrification is hardly a new concept for the industry.

"Remember that in most of the industrial applications of fluid power, the prime mover is already an electric motor. So, the interface between electric power and a hydraulic [system], or especially a pneumatic system, is pretty well understood," Lanke said. "The challenge is—and the innovation is coming—when you try to put that in a contained envelope that exists on a piece of mobile equipment.

"And this is something that we see our mobile customers really driving. They're seeking better efficiency. They're seeking lower emissions," Lanke added. "And so, we have to find new ways of making sure that hydraulics hybridizes and connects with that electric power source to continue to provide the strength and the power that you need."

"I think you're going to see the continuing trend towards electrification. I think it's pretty much a realization at this point because in certain applications, you can probably do it more efficiently and more sustainably with electric, and it might be easier to implement it," said Thomas Wanke, director of the Fluid Power Industrial Consortium, who also leads industry relations at Milwaukee School of Engineering. "But you know, there are applications where there are holes. I think it's going to be fluid power, especially where you have high power density—although every time you look at a newer breed of electromechanical actuators, they seem to be getting bigger and stronger and more powerful." Wanke also is a member of the *Power & Motion* Editorial Advisory Board

"I think what's driving most of this… we separate out electrification from what's going on in the light duty passenger market to what's going on in heavy duty off highway construction and agriculture," said Mike Terzo, founder and CEO of and a member of the *Power & Motion* Editorial Advisory Board. "There is electrification based on productivity, TCO (total cost of ownership), performance, maintenance. Those are the drivers on connectivity that are bringing actual value to different stakeholders. So, it's a different set of value drivers than we see in the light duty market."

> **Remember that in most of the industrial applications of fluid power, the prime mover is already an electric motor. So, the interface between electric power and a hydraulic [system], or especially a pneumatic system, is pretty well understood,"**
>
> —Eric Lanke, *president and CEO of the National Fluid Power Association (NFPA)*

"We think we can play a large role because the hydraulics are going to be a necessary actuation technology, regardless of the how the vehicles are propelled," Lanke added. "So, we're watching that closely, but we think that's going to be a net positive for the association and for the industry."

Designs on the Future

A number of companies have invested in technology and applications solutions to meet the industry changes. That emphasis on innovation has been important. It's also been invigorating.

"It has engineers and designers really excited to be trying new things that work—applying strengths of electrification and strengths of hydraulics to come up with really clever machine designs," said Paul Carlson, CEO of Tolomatic and a member of the *Power & Motion* Editorial Advisory Board. "I think a lot of it was motivated during this pandemic period when people were forced to do things better and faster and the demand for certain things in the industrial space. And having been in a number of those factories, you can actually put your hands on these hybrid solutions and watch the complex motion and control in these factories."

Our of this, Carlson said, has come a hybrid solution to product development as well as to products themselves. "They aren't dedicated to one science anymore. It isn't just, 'Sorry we're a hydraulic house,' or 'Sorry, we just do things pneumatically,'" Carlson said. "'We welcome all [solutions]' is the answer I'm seeing from these really bright engineers."

As with most innovation, there are multiple sources engaged in the process. "We pride ourselves on being applications experts, so not just knowing the products or the components in the system, but actually going beyond that," said Alstrom. "And many times, we reach out to our own customers, end-users, and bring them in for clinics and workshops. Maybe it's a little bit audacious to say that we're almost as good as our OEMs and understanding the end customer, but it has become a strength of ours."

There's also a sense that opening up those lines of communications allow for a closer relationship between suppliers and end users. "We've changed our messaging a bit in the last 12 months from, 'Come see us here at Tolomatic for a hydraulic replacement.' We don't really use that language anymore," said Carlson. "It's really, 'Come talk to us about your application where the strengths of electric might complement the strengths of an air- or hydraulic-based machine.' And it's really been an effective message."

A New Future for Pneumatics

The pneumatics market is challenged with the expanding use of electric solutions for

actuation and motion control, particularly in electric vehicles. Even here, however, there is no single solution.

"That's an area where there's a lot of linear actuators being utilized right now, and it's anything from a simple single axis all the way up to more complex multi-axis systems and working together as they go and then on the other end, the assembly of the vehicles themselves," said Richard Vaughn, automation engineering manager at "The trend there on the EVs is they're being utilized a lot upfront, more so than I've ever seen them in the automotive industry."

Vaughn said he's noticed the combination of pneumatics and electric actuation has led to utilizing benefits for both solutions. "It was "bang, bang" with pneumatics. Now at the end of travel, you can change the stroke a little bit," Vaughn told *Power & Motion*. "I've got several customers that are actually doing that to save the parts on the end. Now, at the end of the motion, you're still getting the same cycle time, but that last five millimeters is a lot slower. You just can't see it.

"It used to be just two positions that you could get out of pneumatics and now [you're] able to do multiple positions," Vaughn added. "But then the precision and what you need now with the with the electric coming into play, we're seeing the electric actually evolving into larger sizes than we've ever seen before—being able to do that motion and actually optimize it. And that's one of the things, at least with the servo-driven."

I think you're going to see the continuing trend towards electrification," Wanke said. "I think it's pretty much a realization at this point because in certain applications, you can probably do it more efficiently and more sustainably with electric, and it might be easier to implement it."

"Room for Everybody"

The passage of the U.S. infrastructure bill points the technology toward a cleaner and more efficient transportation and communications system for the future. For now, the construction of roads, bridges and a new electric grid to handle the power and data will largely be accomplished by the traditional earth moving equipment. But the times are changing, and the change is rapid.

What we learned during the pandemic, especially now with significantly increasing supply chain costs, is that it makes perfect sense both for our flexibility but also from a cost perspective to be more local," Alstrom told *Power & Motion*. "So, from that perspective, this infrastructure bill, at least for our suppliers, will be extremely beneficial because we now have localized the bulk of our supply in the U.S."

"We have a hashtag that we use on social media: #onlyfluidpowercan. And that's what we used to call attention to where you can find fluid power in the marketplace to weigh in positive and exciting things," Lanke said.

"We're going to see a lot of new spending on vehicles, on machines and on the fluid power that drives them in order to make all those projects come to fruition," Lanke added. "So, I think from a from a business growth perspective, it's a net positive for that for our industry."

As it has been for the bulk of the U.S. economy, finding those workers requires the kind of recruiting usually reserved only for point guards and quarterbacks. "We are hard at work in all the communities where we are, of course, working closely with the communities, but also try to make people enthusiastic about a manufacturing job," Alstrom said. "And that also means that we as an employer need to be better than we were in the past for taking care of the people.

"And it's not just wages, but it's also doing things for the community, doing things for the families in the community and being close to the issues in the community, frankly," he continued. "And wherever we do work now, we're doing that."

The industry those workers come into will have change as its only constant. And in that change, Terzo notes, there won't be one dominant solution, but the right solution, tailored to the specific application. "The reality is that it's not going to be one or the other. I think fluid power will lose some ground in some applications," he said, "but it's actually going to gain ground in others because we actually can now—per a given cost point—we can actually now grab some hydraulic ground back from electromechanical. So, it's interesting; that's why it's such an exciting time to be in this industry."

Or as Vaughn noted, "There's definitely room for everybody." P&M

In Their Own Words:
Fluid Power Leaders Look To The Future

Power & Motion discussed the near-term opportunities and long-term challenges faced by the fluid power industry. For digital edition readers, click on the image to access the video clips, and click on the URL at the bottom of the clip for the full interview.

"There's Room For Everybody"

Richard Vaughn, automation engineering manager at Bosch Rexroth, said the electrification of motion control and actuation will mean an expanded role for pneumatics. *"It was. "bang, bang" with pneumatics. Now at the end of travel, you can change the stroke a little bit," Vaughn told Power & Motion. "I've got several customers that are actually doing that to save the parts on the end. Now, at the end of the motion, you're still getting the same cycle time, but that last five millimeters is a lot slower. You just can't see it. There's definitely room for everybody."*

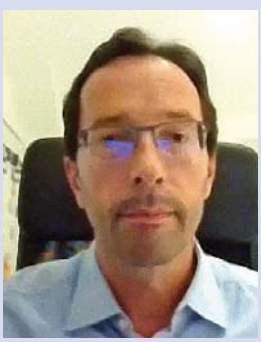
vimeo.com/660731155

The marriage of hydraulics and electromechanical

Mike Terzo, founder and CEO of Terzo Power Systems told *Power & Motion* the relationship between traditional hydraulics and electromechanical systems will be a marriage where each power system brings value to the relationship. *"There are things that you can do with hydraulics that you will know maybe never be able to do with electromechanical," Terzo told Power & Motion. "So, I think there's there are a lot of people that think like, 'Oh, all the all the hydraulics are going to be replaced'. There's just realities again that aren't going to allow that to happen."*

vimeo.com/660735382

The Workforce Shortage Is About More Than Money



Eric Alstrom, president of Danfoss Power Solutions said manufacturers have to do more than simply provide a heftier paycheck to attract and retain manufacturing workers. *"We are hard at work in all the communities where we are, of course, working closely with the communities, but also try to make people enthusiastic about a manufacturing job," Alstrom told Power & Motion. "And that also means that we as an employer need to be better than we were in the past for taking care of the people. And it's not just wages, but it's also doing things for the community, doing things for the families in the community and being close to the issues in the community, frankly. And wherever we do work now, we're doing that."*

vimeo.com/660720514

Off-Highway a Huge Opportunity for Fluid Power

Eric Lanke, president and CEO of the National Fluid Power Association (NFPA) talked with Power & Motion about the role NFPA already has undertaken in shaping the future uses of fluid power, and how hydraulics will figure in that future. *"We think we can play a large role because the hydraulics are going to be a necessary actuation technology regardless of the how the vehicles are propelled. So, we're watching that closely, but we think that's going to be a net positive for the association and for the industry," Lanke said.*

vimeo.com/660726442

Managing Fluid Performance: 4 Steps to Success

Monitor your environment for clues to performance changes.

By Loris Medart

It can sometimes feel like fluids are a bottleneck, restricting production performance. Often the answer won't lie in costly chemical alterations to the fluid itself, but simply a better understanding and control of the factors affecting performance.

1. External Environment

It is a little-known fact that the production environment, and particularly temperature, can have a significant impact on the performance of fluids. A production plant operating in the Russian winter will need a whole different set of parameters to one operating in Spanish summer for the same application and fluid.

The temperature changes do not have to be that extreme, though; a shift of just a few degrees from the morning to the afternoon at a site is enough to disrupt what had been a steady production process. In a traditional setting, this will often lead to a lengthy reset as parameters are reviewed and adjusted to achieve optimum performance.

There are some practical steps that can be taken to reduce the impact of the external environment. Ensuring fluid is stored as close to the dispenser as possible is one option, as this will drastically reduce the time that the fluid is outside of a controlled environment. Meanwhile,

insulated feed lines can further mitigate any temperature fluctuations.

2. Internal Environment

Mitigating the impact of the external climate is an important first step. However, that will only be successful if you're able to maintain a consistent internal temperature during production.

A lack of internal temperature control during production can lead to inconsistent performance, parts failure and machine downtime.

Manufacturers and machine builders often will turn to their fluid provider when they encounter such problems. In fact, taking a closer look at the internal environment of the production line will often lead to better results, much quicker and at a fraction of the cost.

While a lot of focus is given to dispensing, industrial fluids can spend as much as 90% of production time in the reservoir. Full temperature control at this stage not only ensures consistency at the point of use but can also enable operatives and line builders to optimize fluid performance, reduce waste and eliminate fluid-related parts failure.

3. The Top-to-Bottom Effect

Surprisingly, the top-to-bottom effect has only been fully investigated by scientists and engineers in the last few years. It gives an indication of why a fluid's performance changes dependent on the amount that remains in the container when all other parameters are set. In manufacturing terms, operatives have long noticed a steadily decreasing flow rate when using a time/pressure system.

The top-to-bottom effect is caused by the constant change in volume of air and fluid inside the vessel. As the fluid level goes down inside the vessel, the volume of air increases, but the ratio of compressed air at a given pressure is not linear in comparison to that of the fluid.

At constant pressure, an increasing volume of compressed air cannot sustain a consistent pressure on a fluid, therefore generating a different amount of force. This can be understood when you consider one of the fundamental differences between pneumatic and hydraulic law—namely, that air is indefinitely compressible, whereas water and a vast majority of fluids are not. As such, air is always the variable and yet it is an essential part of a process that requires consistency.

The solution can be pieced together by a combination of using the right-sized vessel and managing the pressure in a more precise way, enabling control over the amount of compressed air inside the tank to deliver a consistent amount of force.

4. Agitation

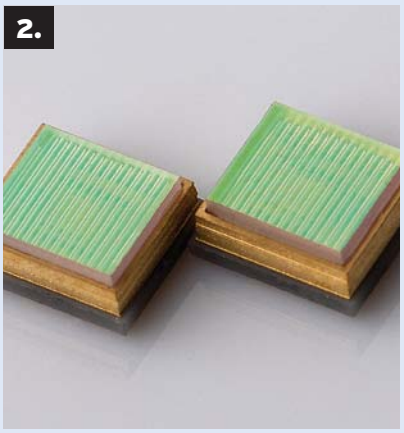
One of the other major impacts on the chemical composition and performance of fluids is movement—whether that be too much or too little. These are known as thixotropic fluids. Examples include anything from UV adhesives, epoxies, silicone, RTV (room temperature vulcanizing), rubber sealants and heat sink compounds.

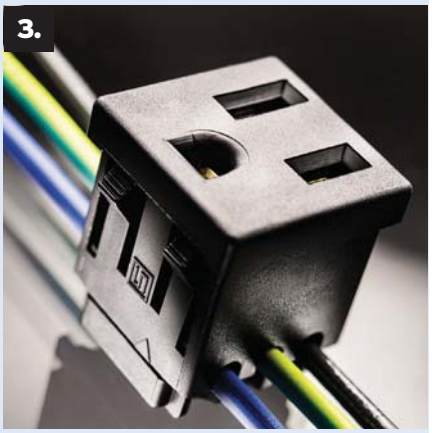
Thixotropic fluids are more common than you would think, as anyone who has had the pleasure of wallpapering or painting a room can attest to. Both paint and wallpaper paste are significantly affected by movement, with the latter being the best example. The paste is often difficult to stir at first, but the more you stir, the easier it becomes to mix. What is happening here is that the viscosity of the material is changing as a result of the movement applied to it.

While this might not be so much of an issue for those doing home décor, in a production setting it can lead to dramatic inconsistencies. These can result in too much or not enough material being added to parts, which may then have to be reworked, cleaned or in some cases even scrapped. The answer lies in viscosity control through agitation. This can be either set as a fixed parameter for a full production day or coupled with sensors to adjust to changes within the fluid itself.

Fluid handling needn't be rocket science. Controlling, monitoring and adjusting parameters where needed will enable continuous improvement, reduced waste and a significant reduction in unplanned downtime. P&M

Loris Medart of SR-TEK is the author of the newly released Complete Guide to Fluid Management. SR-TEK specializes in the development and supply of pressure feed systems as well as systems designed to a variety of fluids, applications and industries. You can connect with Medart on LinkedIn at www.linkedin.com/in/loris-medart-srtek.





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2. Wide-Angle Diffuser Useful in Vision, AR Systems

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3. Receptacles Have Vertical, Horizontal Options

A new version of the NR010 series NEMA 5-15R receptacles, with IDC terminals for bussing insulated wires perpendicular to the Pin-Axis, completes the range with both vertical and horizontal bussed wire options. All three terminals (L, N and E) can be bussed, or other variations thereof such as IDC for N & E only, leaving the line terminal independent. The independent line terminal allows for the application of maximum load to each outlet according to UL rating 15 A, 125 V or for extending functionality to each outlet. The NR010 series feature increased temperature ratings and IDC options; NEMA 5-15R appliance outlets NR020 and NR021 meet increased fire protection and safety standards.

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5. Touch Probe Accurate for 5-Axis Machining Use

The TS 760 touch probe provides 3D accuracy, making it especially useful during 5-axis machining and more. The TS 760 has an accuracy of ±1 µm and homogeneous switching behavior over 360 deg. For 3D measurement, the feed rate/probing speed of 1 m/min is four times faster than other commercially available products that offer the same impressive repeatability of ($2\sigma \leq 0.25$ µm). The TS 760 also offers an ultra-low trigger force of (≈ 0.2 N; axial: ≈ 1.5 N), eliminating form and surface damage. And if desired, the probing point can be cleaned with the integrated flusher feature by using compressed air and cooling lubricant of up to 60 bars.
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6. New Modular Enclosure Kits Provide Flexibility

The Quadritalia modular enclosures line adds enclosures that can be easily assembled on-site to fit any application while maintaining the required NEMA rating. Quadritalia modular enclosures are available as kits that include all the necessary components and hardware (with the exception of plinths) to assemble a complete NEMA 12-rated freestanding single-door, double-door or dual-access enclosure. The OKK series modular enclosure kits are available with assembled enclosure heights of up to 78.74 in. (2,000 mm) and offer various widths and depths.
AutomationDirect
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7. Power Supplies Save Space, Improve Efficiency

As an economical solution for standard applications, the ECO 2 power supplies maximize space in the control cabinet while providing an efficiency

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rating up to 90%. These power supplies, measuring 25 mm and 38 mm respectively, come with the Push-In CAGE CLAMP technology for reliable connections and equipped with orange integrated levers, allowing for a tool-free installation experience. The ECO 2 power supplies have a Mean Time Between Failure (MTBF) of greater than one million hours and are approved for worldwide location use according to UL 61010.

WAGO
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8. Terminal Interfaces Connects Stepper Motors

The EL7062 dual-channel EtherCAT terminal enables the direct connection of two stepper motors in the medium power range of up to 3 A and for a voltage range of 8-48 V. With flexible parameterization and minimized channel costs, the flexible motion interface is ideal as a low-cost drive for a wide range of stepper motor applications. With a compact form factor, the 24-mm-wide EL7062 EtherCAT Terminal contains two stepper motor output stages, two digital inputs for limit switches and one encoder interface per channel for a wide range of 5 V encoders.

Beckhoff
www.beckhoff.com

Advertiser Index

Quality Pump Parts Revolve Around Grinding Precision and Consistency

Gerotor tolerances are small, so exacting grinds are required.

Manufacturers who produce generated rotor positive-displacement pump (gerotor) components need process precision. They also need consistency. High-quality surface finishes must be achieved and exacting size tolerances held from the tenth to the ten thousandth part produced.

Such stringent requirements are needed because a pump's performance and reliability depend on it. A pump's inner rotor includes a specific number of teeth and rotates inside an outer rotor with one more tooth than the inner rotor. The distance between their two surfaces must be exact. If it's too close, the components will bind, causing pump failure. Conversely, if the distance is too great, the pump's efficiency will falter.

Gerotor pumps are used in applications that range from hydraulic motors to automotive oil, gas and power steering. Part material is often either powdered metal or steel forgings, depending on pump application, and finished dimension tolerances are typically as tight as 0.0002 in. The parts also require extremely fine surface finishes.

Grinding is integral to the production of gerotor components, in particular the inner gear (stator) and the external gear (rotor), as well as the housing and other subassemblies. To simplify complete gerotor component production and obtain optimal results, manufacturers rely on specific grinding platforms, including ID, creep feed, cylindrical and tool grinding. In production, these machines will run continuously, pumping out gerotor components every 15 sec., further emphasizing the critical need for process stability and precision along with performance consistency.

With grinding, every produced part is identical throughout the life of the grinding wheel and the next wheels as well.

Quality and tolerance are easily maintained when gerotors are ground, and the process improves process capability while boosting process consistency.

The Production Process

In production, typically about six parts are loaded onto a shaft/arbor, which is then mounted to the indexer and tailstock/steadyrest within the machine work envelope. The setup can accommodate multiple arbors as well. This allows shops to set up arbors with parts outside the machine while it continues to work uninterrupted.

At between 50 and 60 ipm, this is an extremely fast creep feed process, as opposed to normal speeds of 4 to 20 ipm. Multiple gerotor parts are ground at the same time. The machines index and grind until parts are complete.

The process uses two conventional grinding wheels: a 60-grit for roughing and 80-grit for finishing. Wheels are dressed for every grinding cycle to ensure the form is perfect, because in the end, the parts must be held to very tight tolerances. Since the process uses two grinding wheels—roughing and finishing—a tight-tolerance 6-in. table-mounted dresser shapes both grinding wheels during one dress cycle.

Every aspect of the process is controlled, from dressing to automatic compensation and machine steadyrests. This also includes coolant delivery. To ensure the highest quality surface finishes, coolant nozzles that once provided basic flood coolant are now drilled and ported with tubes. As such, they deliver a coolant stream shape that matches the part to pinpoint the stream directly into the dressed form/profile on the grinding wheel.

Grinding will continue to be integral to the production of gerotor components such as stators and rotors, but also to housings and other subassemblies.

Grinding machine OEMs such as UNITED GRINDING continue to advance grinding platforms specifically for gerotor production. For example, the BLOHM PLANOMAT 412 48-in. surface and profile grinding system would be outfitted with a special workholding setup, indexing unit, tailstock and steadyrests for gerotor production. For exacting precision, the machine has one-tenth-micron glass scales for its X, Y and C axes. The indexer makes it a four-axis machine and ensures 1-arc second part indexing accuracy. P&M

Phil Wiss is a regional sales manager at UNITED GRINDING North America. He can be contacted via email at phil.wiss@grinding.com.

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