Building A Bridge To The Future p6

Robotics Spur Gripper, Suction Cup Growth p18

Hydraulic Motion Control: Going Beyond PID p22

Hydraulics & Pneumatics®

THE AUTHORITY ON FLUID POWER TECHN

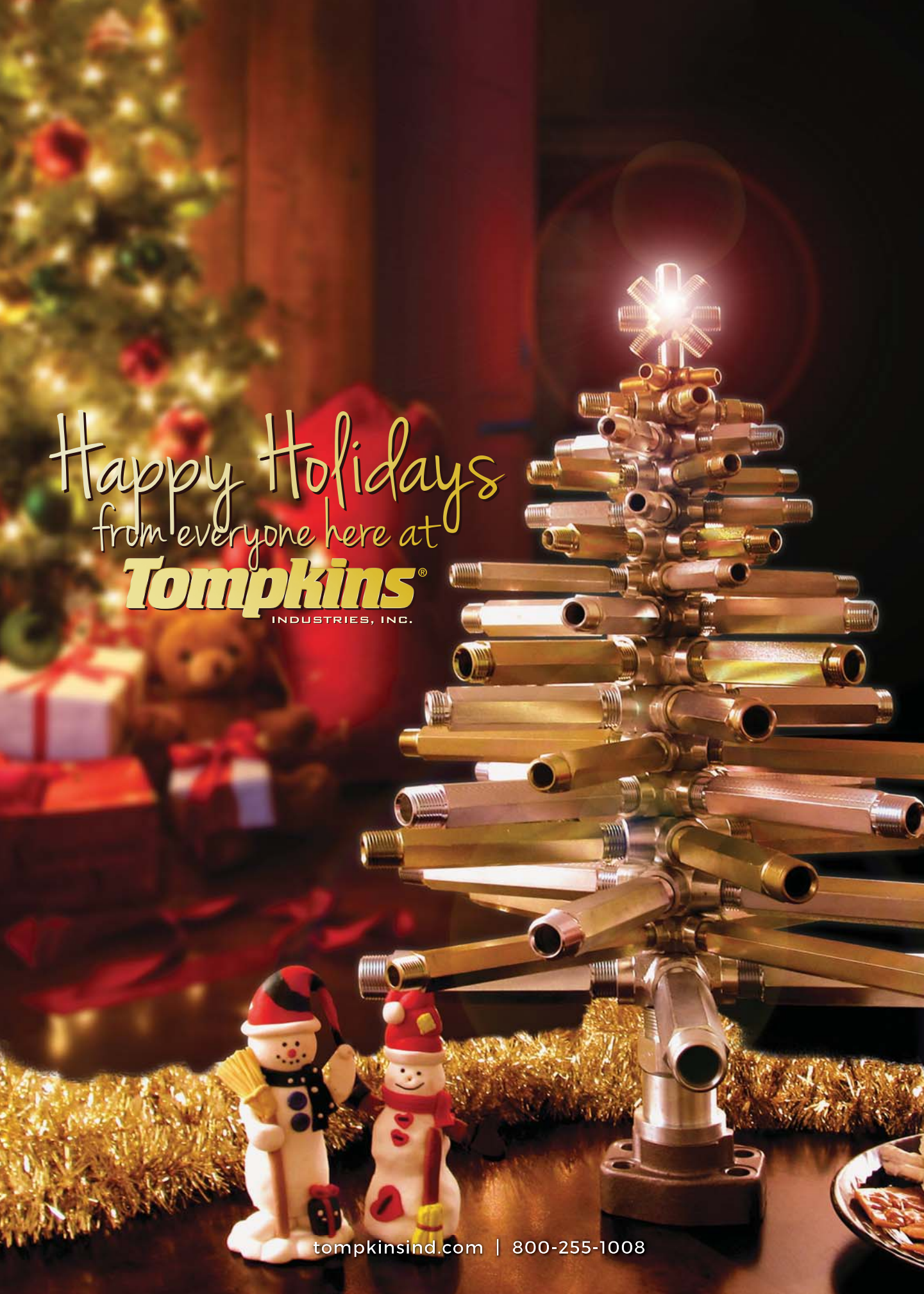
R 2021 hydraulicspneumatics.com

SATISFACTION In Finding SOLUTIONS

Salary & Career Survey Uncovers The Hidden Fun Of Engineering p10

A Look Back At The IDEA! Conference 8

$10.00


Happy Holidays
from everyone here at
Tompkins®
INDUSTRIES, INC.
tompkinsind.com | 800-255-1008

VELJAN

Modular Power Units for Machine Tools

55 Years of Excellence

POWERFUL FORCES WORKING TOGETHER · NFPA · Member

Features

- A wide variety of fixed and variable displacement vane and piston pumps can be specified as standard
- Compact designs with manifold blocks and valves all manufactured by Veljan's component divisions
- A range of electric motors in various sizes can be specified
- Options to couple pumps and motors through bell housings and flexible couplings or through hollow shaft motors
- Long experience resulting in standardized, time tested designs serving the CNC machine tools sector and Special Purpose Machine Tools sectors

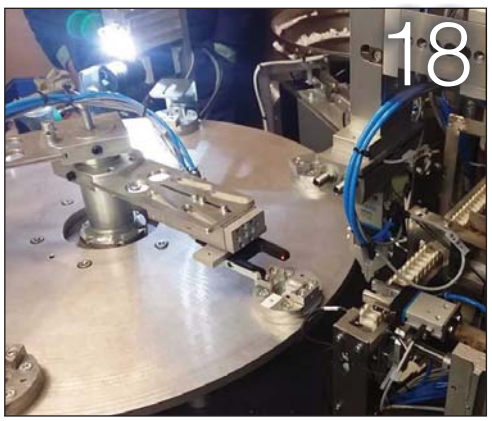
Please contact us:

Veljan Hydrair Inc.

Sales & Warehouse: 4034, Chamblee Road, Oakwood, GA 30566 (USA). Phone: 877.793.6405

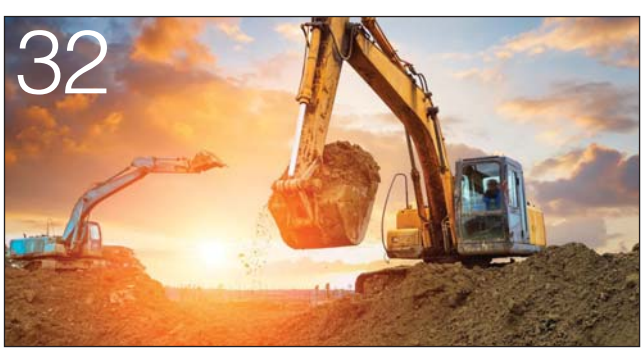
Website : www.veljan.in | E-mail : sales@veljanusa.com

We help you see your ideas work



IN THIS ISSUE

FEATURES



DEPARTMENTS

JOIN US ONLINE

twitter.com/H_and_P_knows
facebook.com/HydraulicsPneumatics

ISSN 0018-814X

Subscriptions — U.S. and possessions outside U.S.: $60/yr; $90/two yrs. Single copies: $10.00 each. In Canada: $70.00/yr, $110.00/two yrs. Canadian GST #R126431964. International: $90.00/yr, $140.00/two yrs. To order, phone 847-763-9670. Fax orders to 847-763-9673. Send subscription payment to: *Hydraulics & Pneumatics*, PO Box 3257, Northbrook, IL 60065-3257. Out-of-print copies available in complete volumes as positive microfilm from NAPCO 800-420-6272 x 6578. Photocopies of articles $5.00 each. Payment must accompany request. Volume 74, No. 10, December 2021.

WE ARE ATOS, THE SMART ELECTROHYDRAULICS

Smart Electrohydraulics is our response to the everchanging market, a mission we pursue thanks to a team of specialists working with great passion and operating in more than 80 countries, with a unique approach in which every process is analyzed and optimized: from research to design, from production to delivery, up to after-sales service.

atos
the smart electrohydraulics

Hydraulics & Pneumatics DECEMBER 2021

Value AND Variety in Valves

Save big on all types of pneumatic valves

Stacking Solenoid Valves

AVP Series starting at $22.50

- 3-way valves (poppet style)
- 2-position, normally closed, spring return solenoid valves
- 24VDC or 120VAC solenoid coil

Manifold Solenoid Valves

AVS Series starting at $21.50

- Body ported, spool valves
- 3-port and 5-port models
- 2 and 3-position with single or dual solenoids
- 2 to 8 station manifolds and control distribution blocks available

Modular Solenoid Valves

BVS Series starting at $31.00

- 2-position, single solenoid, spring return
- 3 or 4-way, spool or poppet styles
- 12 or 24 VDC, 24 or 120VAC coils
- Low power (0.5W) models for portable applications
- 2 to 8 station manifolds and control distribution blocks available

CMV Series starting at $79.00

- 3-way/2-position, 5-way/2-position and 5-way/3-position valves available
- Single or dual solenoids per valve
- Up to 16 valves per assembly
- Locking manual operator
- IP65 (when NITRA DB25 cable used)

Pipeline Solenoid Valves

Starting at $25.00

- 2 or 3-port designs with 2-position
- Poppet or diaphragm types
- 24VDC, 24VAC or 120VAC solenoids
- Designs for air, oil, liquids, inert and other gases (media separated models)
- DIN style wiring connector
- Stacking models available

Also Available

Air Pilot Valves

Manual Valves

Air prep, cylinders, fittings and more…

Research, price, buy at:

www.automationdirect.com/pneumatics

Order Today, Ships Fast!

TOP RATED BY CUSTOMERS

AUTOMATIONDIRECT.com

1-800-633-0405

the #1 value in automation

BOB VAVRA | Senior Content Director | bvavra@endeavorb2b.com

A Bridge to the Future

THEY'RE BUILDING A NEW BRIDGE across the interstate near the community where my mother lives. When she and my father moved there 25 years ago, the traditional four lanes of traffic with a left turn lane across the highway was adequate. In the intervening time, distribution centers grew up around the interchange and the area's population continued to grow along with the interstate's traffic. That bridge and the roads leading to it needed something better.

Simply widening the lanes across the interstate was one option, but new ideas in bridge design suggested another. The new traffic flow is designed in such a way that it will eliminate left-hand turns to enter the interstate. With the increase in truck traffic in the area, allowing traffic to make safe left-hand turns will end the practice of trucks piled up into the left turn lane and still allow traffic flow to continue across the bridge to the right.

There also have been changes in the way the bridge is being built. Improvements in construction techniques and strategies have allowed traffic in the area to continue to move effectively despite the chaos of construction. Drivers made adjustments, of course, but for now everyone gets where they need to go and, when it's all completed, the bridge will be an improvement over the previous model. The users of that bridge—the long-time area residents such as my mother and the new developments such as the distribution centers—will benefit from this improvement for years to come.

And yes, this is a parable.

When we reconvene next month with *Power & Motion*, we will have finished building our bridge to the future of fluid power. That bridge will have been built after a year of conversations with industry leaders. They observe, as we have, that this industry has changed and evolved rapidly in recent years. The way to deliver information about the industry has changed.

Power & Motion is doubling down on fluid power—on the technologies, the innovation, on the people and on the constantly improving best practices. It is a far more complex industry today than 30 years ago, one that includes electrification, sensors, motion control and hybrid systems. *Power & Motion* arrives as the off-highway vehicle industry faces a new push for autonomous vehicles and as the U.S. embarks on a long-needed and comprehensive infrastructure overhaul—one in which hydraulics will be the primary mover of earth, and of progress.

AIGNEP

FRL EVO

Aignep USA's New Line of Modular Air-prep Components

7121 Loblolly Pine Rd. Fairview, TN 37062
(615) 771-6650 | Service@AignepUSA.com

News

IDEA! Conference Focus is on Value in Actuators

by Stephen Mraz

The event looked at emerging trends and innovations in design and engineering.

The intersection between motion control and automation was among the topics covered at the Industrial Design, Engineering & Automation (IDEA!) Conference, held in conjunction with the M& T Conference Nov. 9-11 in Cleveland. Both conferences were presented by Endeavor Business Media.

The M&T Conference's goal was to help manufacturing executives improve their firm's operational efficiencies and product quality despite the constant of change. The three-day event featured an executive conference and two days of seminars focused on improving productivity, safety and operational efficiency.

Among the speakers on the first day of the IDEA! Conference was Richard Vaughn, automation engineering manager for Bosch Rexroth Corp. His presentation, "Smart Linear Actuators – Another Value Proposition for Factory Automation," focused on mechatronics, the marriage of electrical and electronic technologies with mechanical components and assemblies for linear motion and automation. He pointed out how actuators are getting smarter and why that makes them even better value propositions for factory automation.

The first day of the IDEA! Conference also featured the announcement of the 2021 IDEA! Awards, jointly presented by *Hydraulics & Pneumatics* and *Machine Design*. Branson GMX 20DP ultrasonic spot welder received the Big IDEA! Award, given to the product that received the most votes among all entries. The GMX 20DP has a durable, reliable mechanical design and can monitor its own performance in creating precise welds on thin, fragile nonferrous foils and films. This will make it useful for making lighter, more "energy-dense" battery cells and packs that deliver more power per pound.

Other highlights on day one included the IDEA! Conference keynote presentation from Billy Taylor, CEO, LinkedXK, talking about "Driving Excellence Through Diversity and Inclusion." It gave attendees ideas on how to give a company a diverse and inclusive culture that encourages communication and cooperation throughout the company. He cited the advantages of diversity and offered advice on how to get companies on the road to enlightened and profitable treatment of employees and in hiring practices.

Next up was Scott Dixon, director of Digital Manufacturing at EY, discussing the "Digital Transformation and the Factory of the Future." He explained how the Factory of the Future concept will help

Brian Mueller and Mike Suttenberg, Assembly and Welding, district sales engineers at Emerson, accept the 2021 Big IDEA! Award from Bob Vavra, senior content director for *Machine Design* and *Hydraulics & Pneumatics*, at the IDEA! Conference Nov. 10 in Cleveland.

manufacturers prepare for the future changes, whether expected or not (like COVID), and achieving success despite those changes.

The sessions ended on Wednesday with Mo Abuali, a partner at IoTco LLC, talking about IoT and Industry 4.0 and how they are working "Toward Zero Downtime, Zero-Defect Manufacturing." He gave attendees ideas and approaches for why to get involved in IoT/Industry 4.0 and how to get started. He also outlined why artificial intelligence (AI) and predictive analytics are competitively necessary for IoT and Industry 4.0.

Abuali also gave a quick synopsis of several case histories of companies adopting innovative mechatronics and the rewards they reaped. His advice to companies looking to jump on the IoT/Industry 4.0 bandwagon: "Think big, act small and keep an eye on ROI."

Nov. 11's presentations started with Aaron Lichtig, VP of marketing at Xometry talking about how to "Digitize Your Manufacturing Process to Stay Ahead of the Competition." He also explained "Manufacturing as a Service" (MaaS), and how it can help companies succeed. In MaaS, a firm like Xometry acts as a networked middleman, connecting people and companies who want to have parts made but lack the equipment or expertise with shops that have the capability and capacity to make them.

The conferences wrapped up with Jeff Christensen, vice president of product, Seegrid, explaining "The Keys to Building a Successful Supply Chain with Mobile Automation." It gave attendees a look at how to define measurements of success metrics and to use data for generating a strong ROI today while preparing for tomorrow.

He also focused on one aspect of automation: electric vehicles that transported parts from one part of a factory to another. He noted that "Automation is hardly new, but it is very different from what it was 20 years ago. But the question for companies remains the same: Are you applying it in the right place?" hp

Registration Now Open for the 2022 NFPA Annual Conference

by Staff

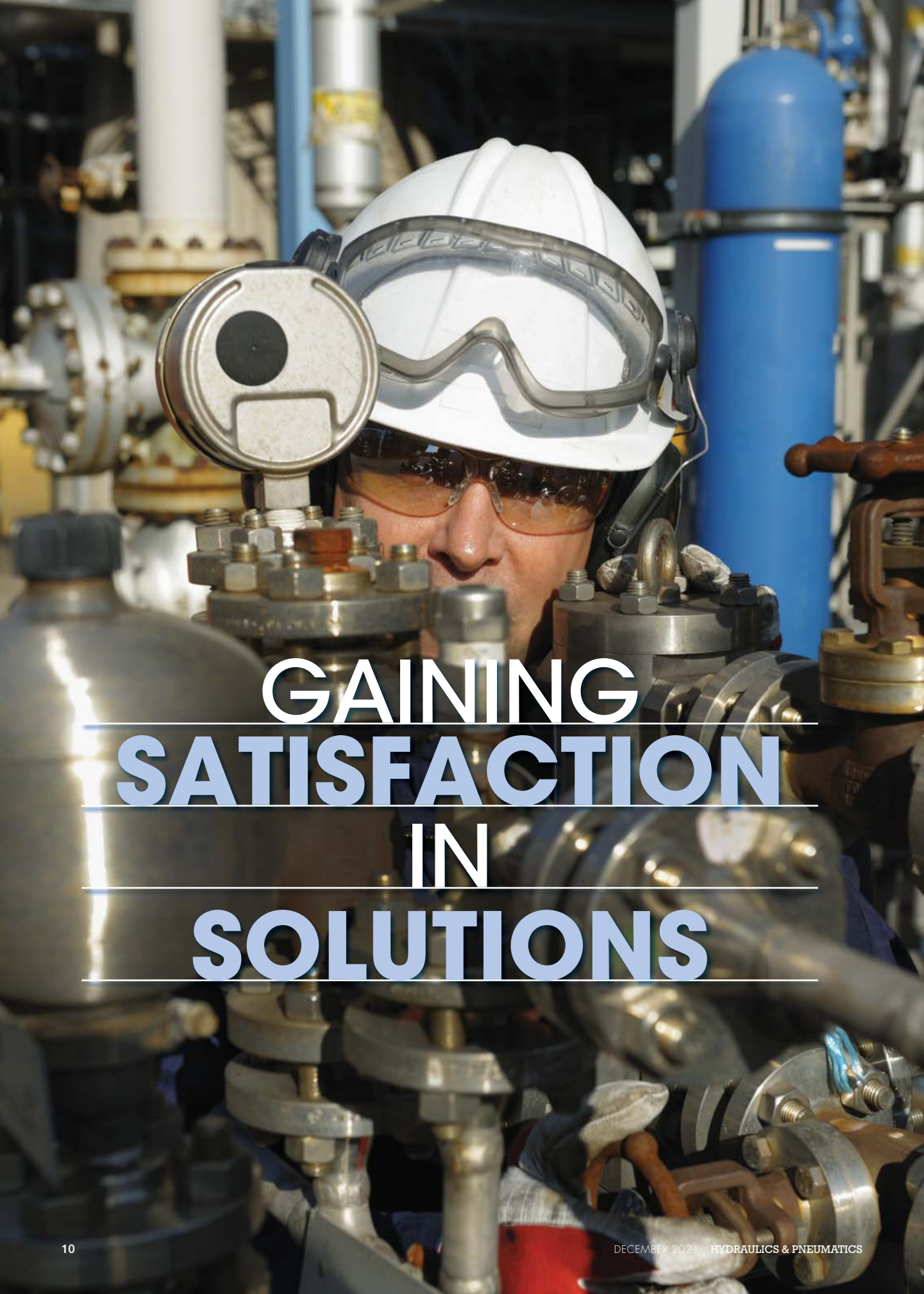
Registration is now open for the 2022 NFPA Annual Conference, taking place at the Arizona Biltmore in Phoenix from Feb. 22-24. This members-only event will offer in-person networking opportunities with fluid power executives, in addition to presentations from expert speakers covering topics like geopolitical events, executive wellness and retaining employees in a high-turnover environment.

For those unable to travel, there will also be a virtual option that allows users access to livestreamed and recorded content from the three-day event for a limited time. In-person attendees will also have access to this content portal to view on-demand sessions after the event.

The event will also host the NFPA Foundation Golf Fundraiser, an opportunity to network informally with industry peers and raise money for the workforce programs shaping the minds of future fluid power professionals. The fundraiser offers the choice of three donation levels featuring varying player perks and sponsor exposure.

Emerging company leaders are also encouraged to register for the conference and join NFPA's Future Leaders Program. Participants will have access to exclusive networking and educational opportunities and enjoy a reduced registration rate. Learn more about the Future Leaders Program by visiting the NFPA website at www.nfpa.com or contacting Joe Zwier at (414) 778-3369 or jzwier@nfpa.com.

For members attending in person, hotel reservations at the NFPA rate of $399/night will only be available until Jan. 21, 2022, or until the block is full. Attendees who register by Jan. 14 will be entered in a Suite Deal Contest, which will bump two registrants to free, upgraded rooms. The contest is only available to members who have 1.) registered for the conference; 2.) booked their hotel room; and 3.) have either added a spouse/guest to their registration or are representing a company with more than one registered and booked employee. hp



GAINING SATISFACTION IN SOLUTIONS

BOB VAVRA | Senior Content Director

Salary & Career Survey uncovers the hidden fun of engineering

Despite a global pandemic, a broken supply chain and a continuing difficulty hiring the next generation of workers, the business of fluid power remained remarkably fluid in 2021.

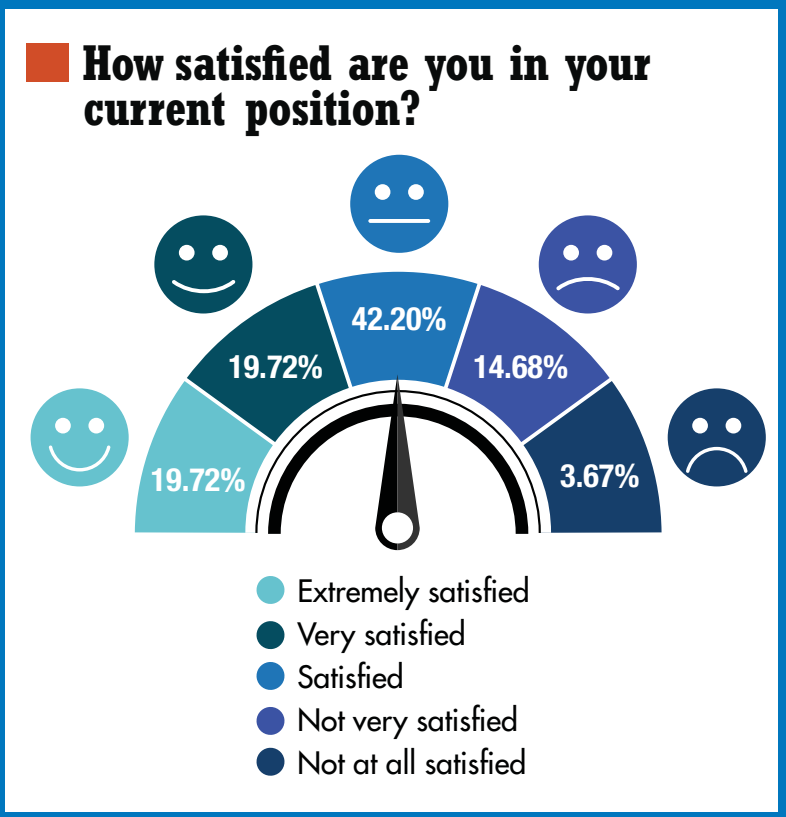
That's the key finding in the 2021 *Hydraulic & Pneumatics Salary & Career Survey,* which polled readers from around the U.S. on topics ranging from compensation to COVID to the next generation of technologies. Even after two years of uncertainty in the overall manufacturing landscape, the fluid power industry remains stable and focused on overcoming the near-term challenges.

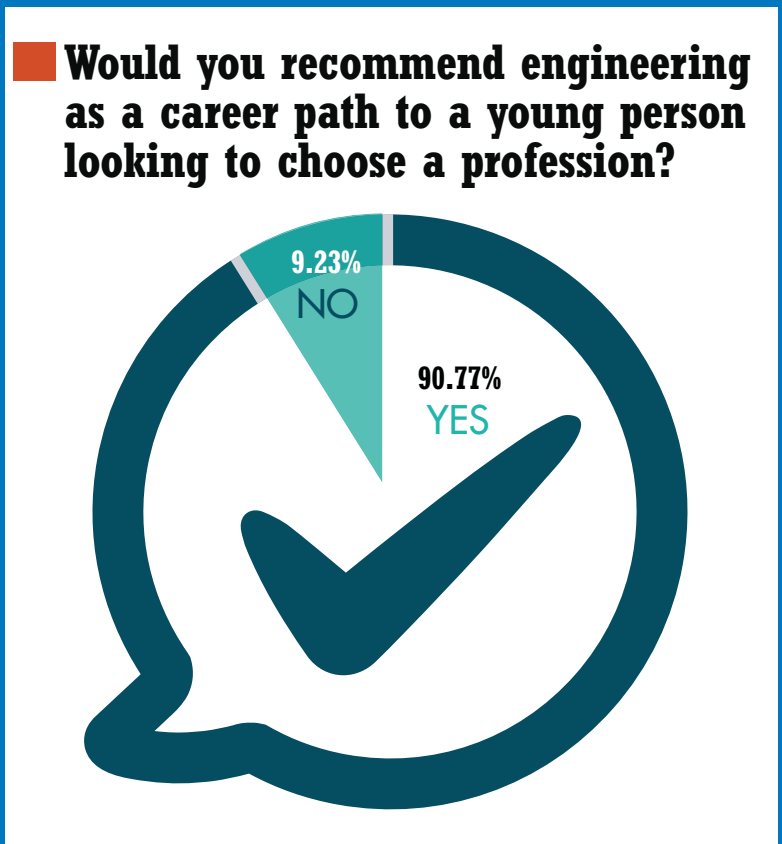
Some of that is born of experience: 33.5% of respondents to the *Salary & Career Survey* have at least 30 years of experience in the industry and 24% have been at their current company for at least 20 years. They also like their jobs and career choice: 83% described themselves as at least satisfied with their job and almost 20% say they are extremely satisfied.

A large reason for this is their fundamental enthusiasm for their work. "Engineering and engineers rule the world—this is what I have learned throughout my college life and my personal life," one respondent wrote. "Even though we are engineers we have many opportunities to prove ourselves."

And another wrote, "There is no bigger satisfaction than seeing a machine working smoothly and getting the work done that you have designed and manufactured from scratch. It's the only force getting me out of bed every morning."

But he added, "And my wife yelling to shut my alarm also plays a major role."





> "There is no bigger satisfaction than seeing a machine working smoothly and getting the work done that you have designed and manufactured from scratch. It's the only force getting me out of bed every morning."

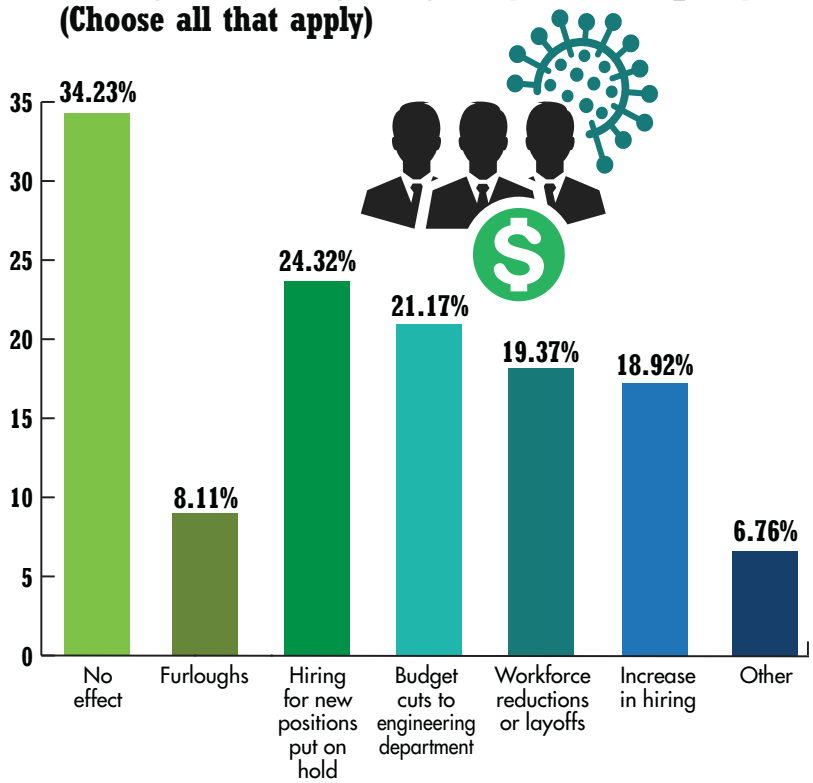
PROFESSIONAL SATISFACTION

Most engineers surveyed love the work they do. Two-third said they would not consider leaving the profession, and 91% would recommend the work to a young person looking for a career.

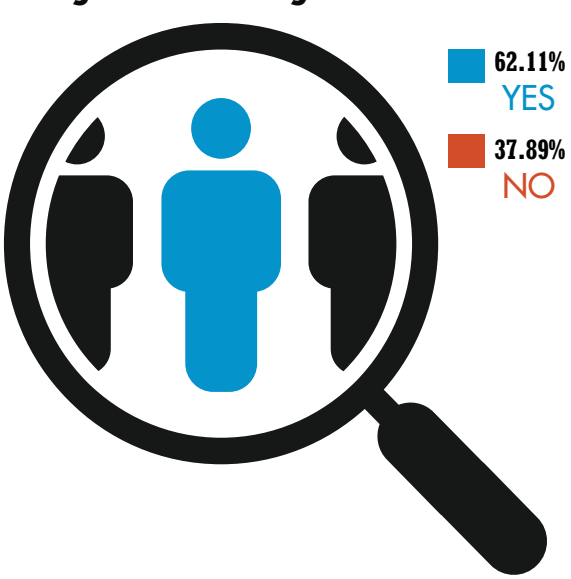
One reason is a bullish outlook on growth in the coming year. The survey found that 41% of respondents

How has COVID-19 continued to impact hiring and budgeting at your company?

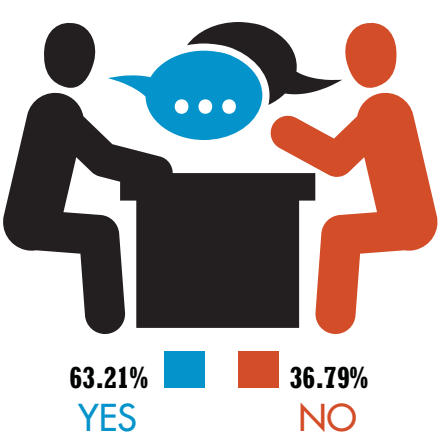
(Choose all that apply)



Do you believe there is an engineer shortage?



Is your organization having difficulty finding qualified candidates for open engineering positions?



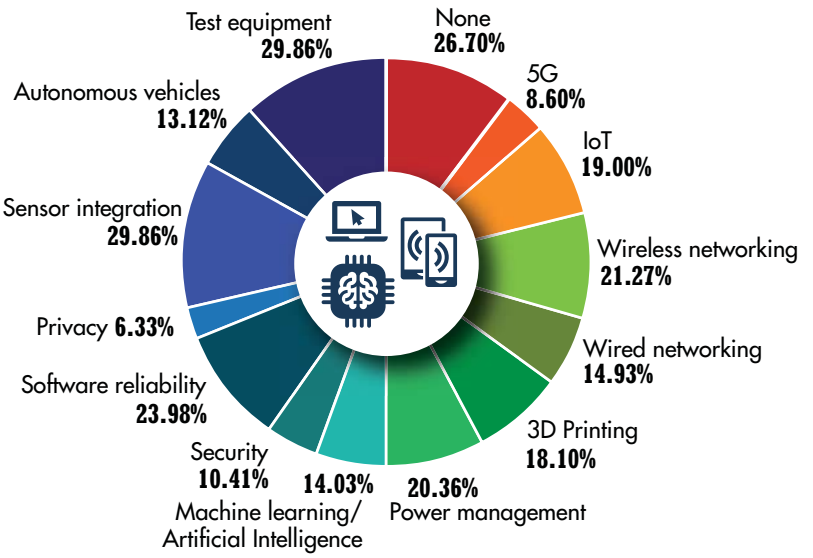
> “Engineering and engineers rule the world—this is what I have learned throughout my college life and my personal life,”

expect their company to add engineering jobs in the next year, while half say their company will maintain current engineering levels. Just 13% describe themselves as actively seeking another job, while almost 35% said they cannot imagine looking for work elsewhere.

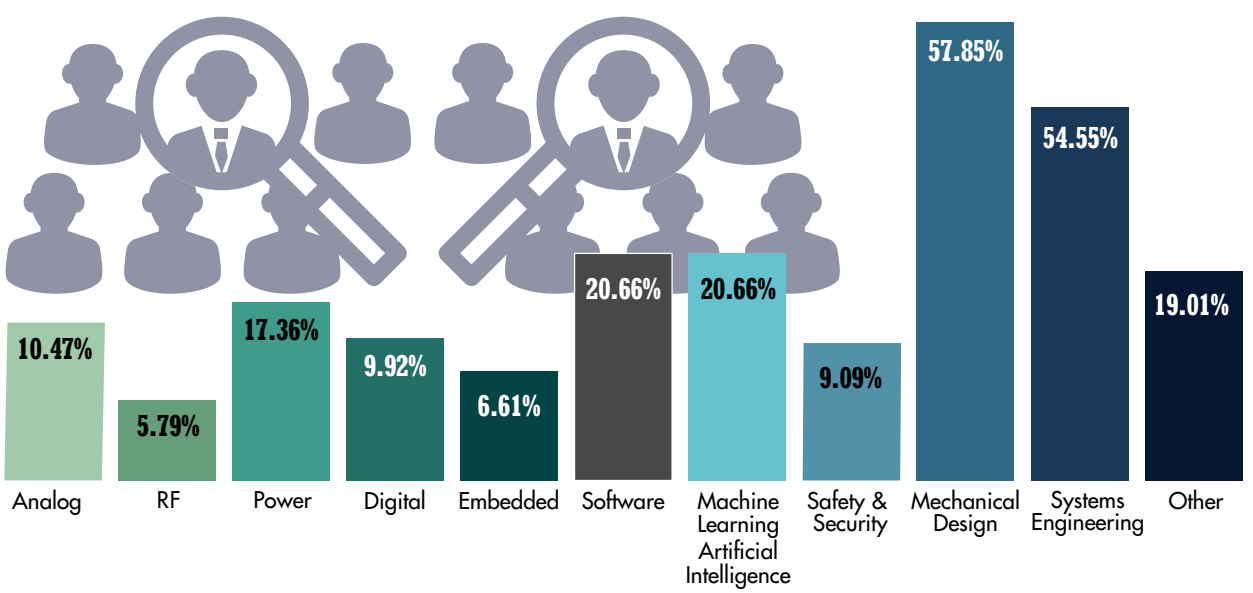
But there are recognized challenges. The most significant is the need to replace an aging workforce, and 62% of those surveyed agree there is a shortage of engineers. That matches almost exactly the age of the workforce: 59% of respondents are 50 or older, and 31% are 60 or older. On top of that, 63% of the respondents said their company is having difficulty finding qualified workers.

The search for qualified candidates cuts across several disciplines, but respondents noted that engineers for systems engineering, mechanical design, machine learning/artifi-

Which of these technologies have a major impact on your designs? (Choose all that apply)



For which engineering specialties are you having difficulty finding qualified candidates?



While compensation is one of the drivers that would initiate a career change from engineering, it's not the only consideration.

cial intelligence and software were among the most sought-after fields of expertise.

If the mix between traditional and cutting-edge technologies are being sought, there has been somewhat slower adoption of new technologies. Sensors and tech equipment are two of the more utilized recent innovations mentioned by respondents, but only 30% said they had an impact on their design plans—the highest among any technology mentioned.

Areas such as wireless networking, power management and software are other areas of some interest, but when asked about implementing technology, 27% said 'None of the Above'.

One respondent noted, "We need more brain workers or engineers to improve everything…let go of old ways, methods and products and give way to cheaper, faster and economical to produce."

COMPENSATION SATISFACTION

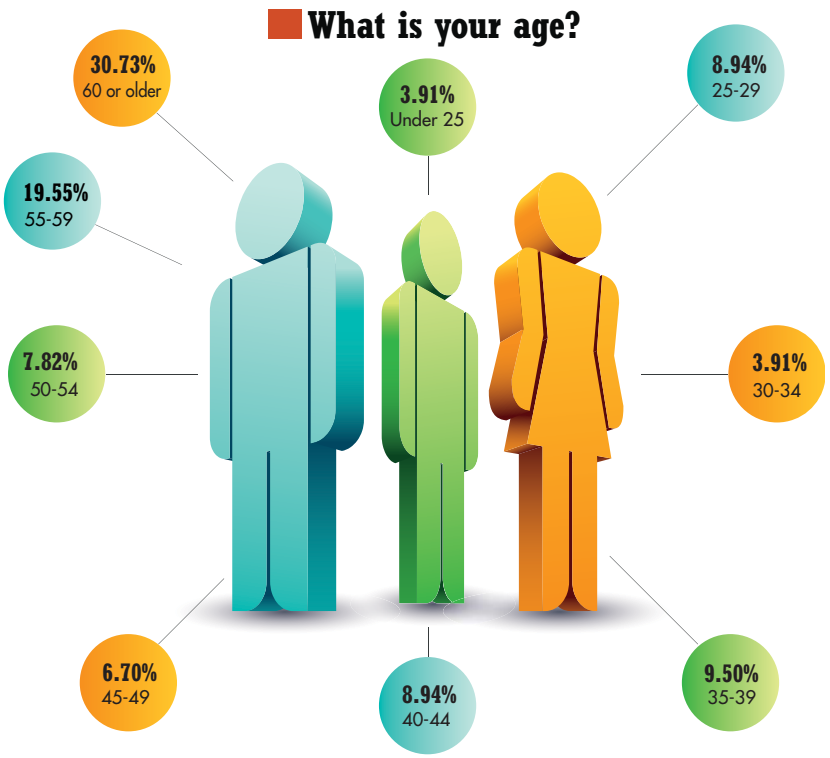
Salary and overall compensation remain key drivers of workplace satisfaction, and even in this area there is a general sense that their pay is mostly in line with expectations. Among the survey findings:

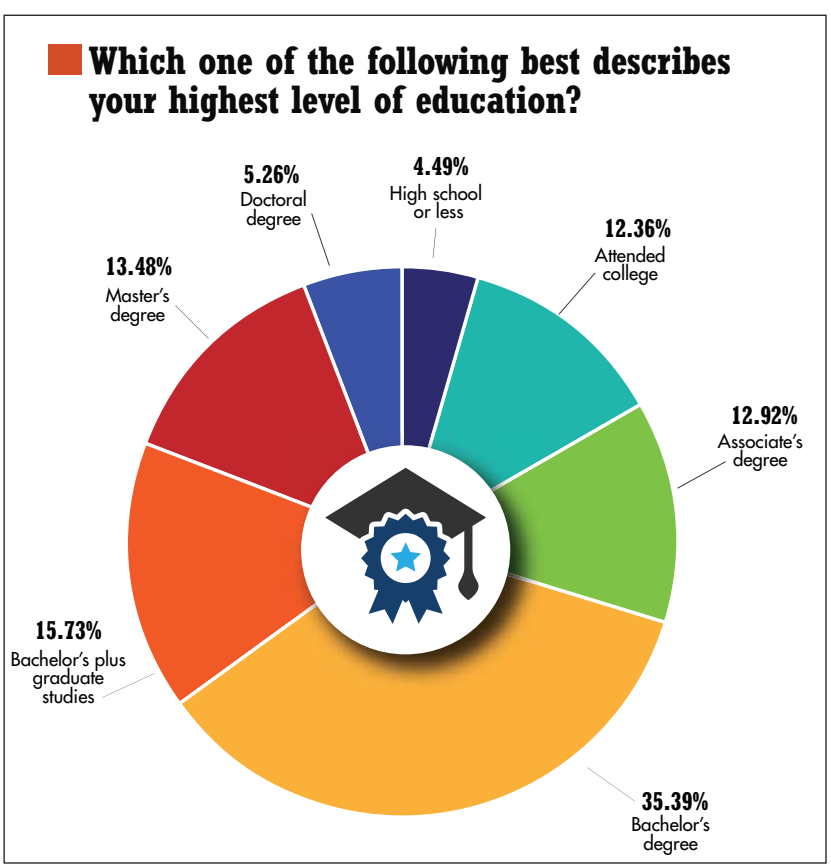
71% said that salary and career prospects are as promising as it was five years ago

62.5% describe their salary as at least competitive in the industry

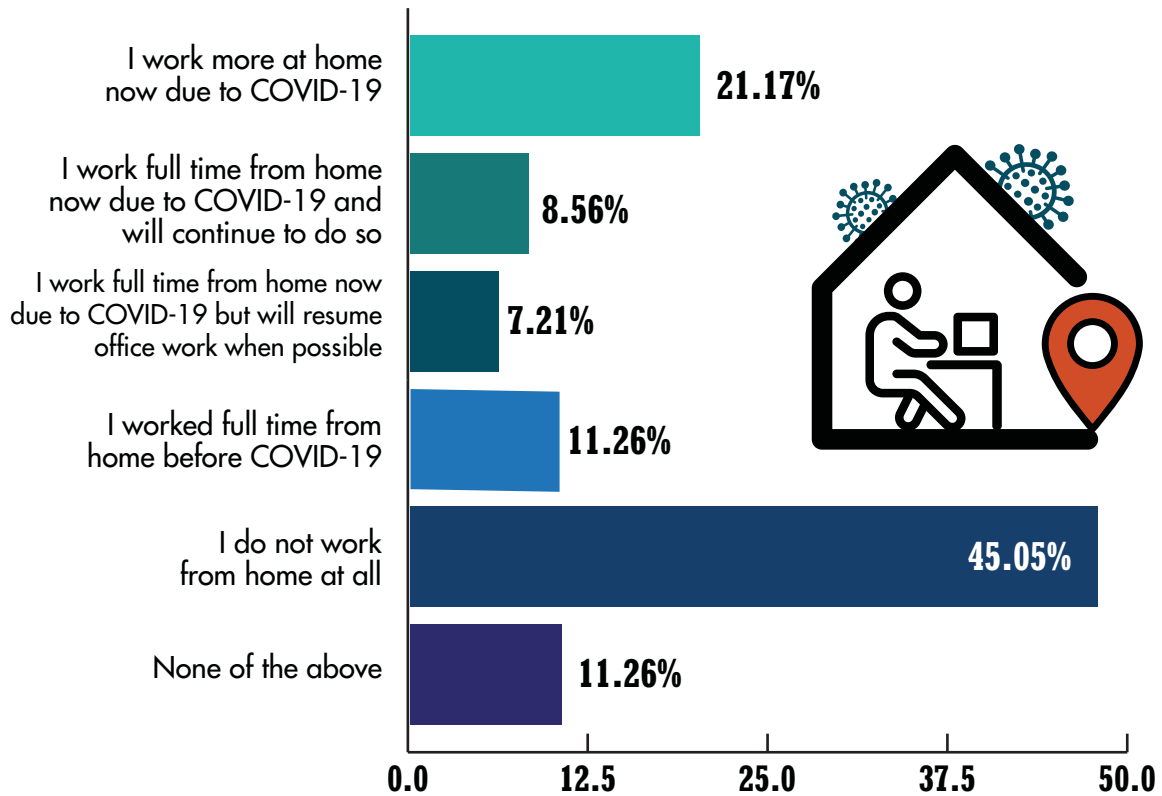
23% describe their compensation as more competitive

58% said they are adequately com-





Which of the following apply to your job situation? (Choose all that apply)

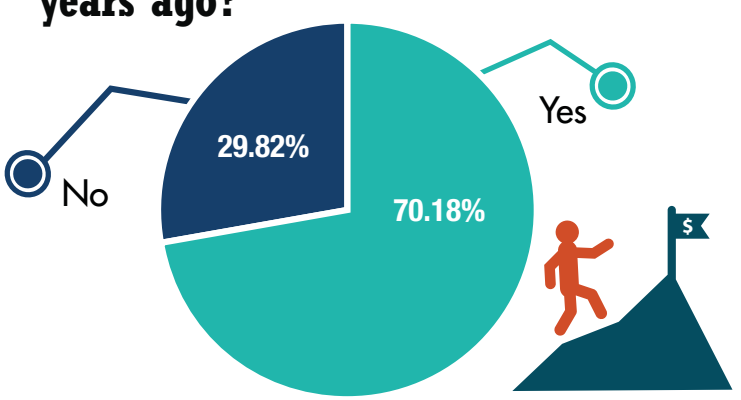


The single greatest issues that keep an engineer up at night don't resolve around compensation or job security, but focus on solving the problems they face each day.

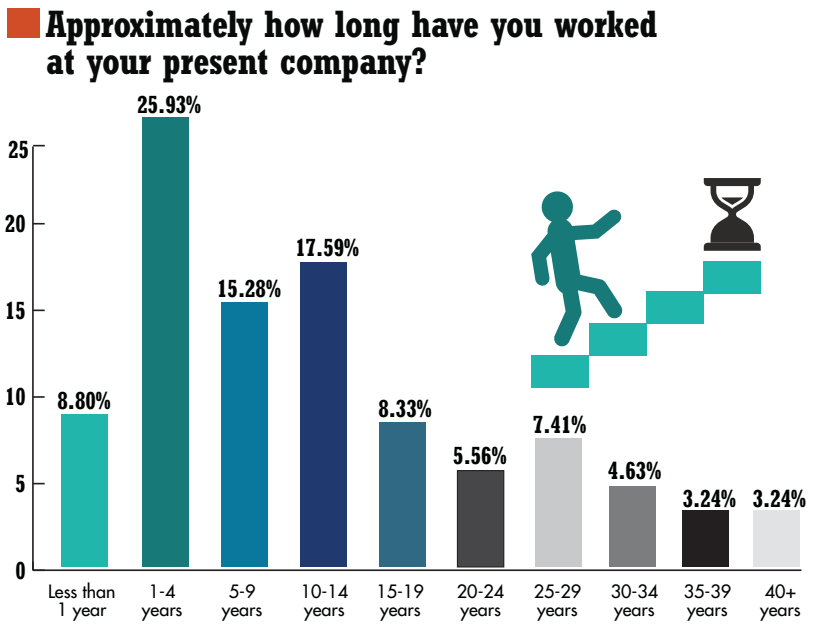
pensated for the work they do.

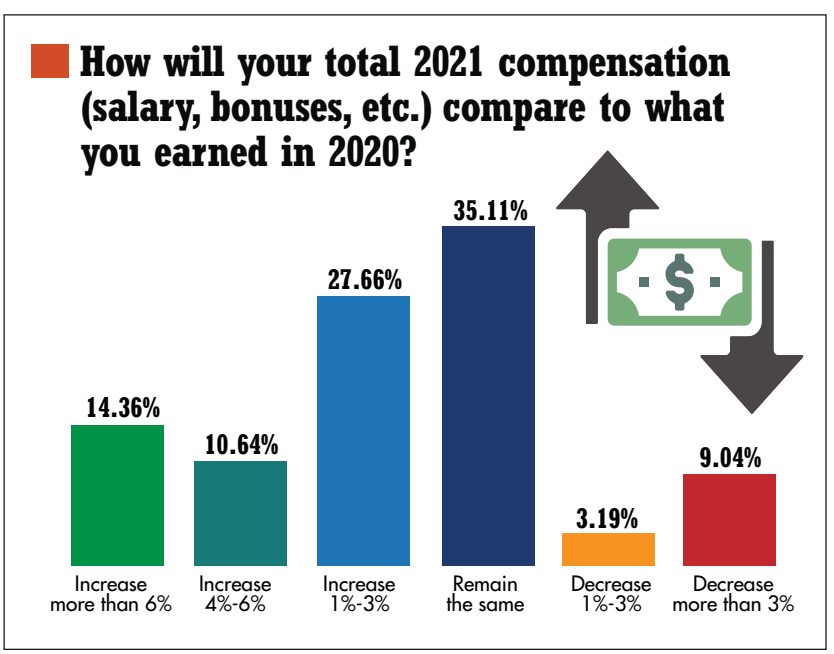
While compensation is one of the drivers that would initiate a career change from engineering, it's not the only consideration. While 54.3% said making more money might get them to look outside engineering for another job, 42.9% it could be the chance to do

Do you believe that a career path in engineering and the potential for salary advancement is as promising today as it was five years ago?



> "We need more brain workers or engineers to improve everything…let go of old ways, methods and products and give way to cheaper, faster and economical to produce."





something different and 40% said it would be because of a lack of an opportunity for advancement.

While you would expect a wide salary range in such a survey that stretches across the country, the majority of salaries fell between $60,000 and $150,000, with 46% of respondents reporting they made between $100,000 and $150,000 and 20.5% stating they made between $80,000 and $100,000. And while 29.8% report receiving no bonuses, 30.1% said their bonus ranged up to $5,000, 21.5% said the bonus was between $5,000 and $10,000 and 18% said it was greater than $10,000.

There's even wider optimism about pay increases for the coming year, with 27.7% expecting a raise of up to 3% in 2022 and 25% expecting pay will increase by at least 4%. Just 12.1% are expecting a pay decrease in the new year.

PROBLEM-SOLVING SATISFACTION

While compensation rewards the *Hydraulics & Pneumatics* reader, it is the work itself that brings the greatest satisfaction. Part of understanding that satisfaction is a clear-eyed look at the issues they face each day.

The single greatest issues that keep an engineer up at night don't resolve around compensation or job security, but focus on solving the problems they face each day. The availability of components in a time of tight supply chains was the top concern at 34.9%, but issues such as product reliability issues (31.8%), product deadlines (29.2%), product quality issues (28.2%), and staying current with emerging technologies (24.1%) also were cited by respondents.

That problem-solving attitude has personal and professional rewards, readers noted.

"In the purest form, it is quite satisfying to turn your efforts into a working solution," one respondent wrote.

"Engineering has the basic concepts of every field at its core," said another reader. "When you understand a field from its basics, applying the knowledge in the real world becomes easy." hp

INTRODUCING RYCO HYDRAULICS NEWEST LINE OF CRIMPERS

RY137 EVO

RY230 EVO

RY350 EVO

RY300 EVO

RY420 EVO

Introducing RYCO Hydraulics Newest Crimper Line. Intelligently designed the all-new RYCO Crimpers are specifically developed to suit any crimping needs. No matter how big or small the project, RYCO Crimpers can do the job. High performance and long lasting with reliable service, RYCO Crimpers can take on any task.

RYCO

www.RYCO.com.au

Discover More!

MICHAEL GUELKER, DAREN O'DRISCOLL | Festo Inc.

Robotics Spur Growth in Grippers and Suction Cups

A look at some key facts and features behind several gripping technologies.

Pneumatically powered grippers move parts from one manufacturing process to another. Right Mechanical gripper.

Grippers have become an important part of material handling in industries ranging from electronics manufacturing to automotive assembly. In North America alone, for example, the gripper market is worth roughly $100 million, and that number is expected to grow by 5% annually.

The growth in the use of grippers is tied to the rise of robotics, including the need for robots to take on special tasks and handle increasingly complex workpieces. So, now designers have more types of grippers to choose from than ever. But with all the recent developments in robotics and gripping technology, it can be difficult to know which gripper is best for a specific application.

To provide engineers and designers with some guidance, here is an overview of common types of grippers, including mechanical, soft, adaptive, vacuum and magnetic, along with their key design features and benefits they offer.

MECHANICAL GRIPPERS

When it comes to handling applications, pneumatic and electric mechanical grippers are the most common. Pneumatic grippers, which make up 90% of the market, tend to be lighter and more cost-effective than their electric counterparts. They also have higher grip forces, handle faster cycle rates and are more suitable for harsh environments.

Electric grippers, on the other hand, offer greater precision and give users better force and travel control. At the same time, they tend to be heavier due to their motors and other internal components, which also increases their upfront costs.

Whether electric or pneumatic,

mechanical grippers fall into several design classes. Parallel grippers, for example, incorporate fingers that pull directly apart. Two-finger parallel grippers are the most common, making up 85% of the mechanical gripper market. Three-finger designs can handle round objects and perform centering functions.

Other mechanical rippers include radial and angular versions with fingers that open at an angle. Radial grippers open to 180 deg., letting them handle workpieces of varying sizes. Angular grippers only open to 30 deg., but they are faster than radial grippers.

Other important considerations when selecting a mechanical gripper include the gripping force, the jaw's guiding strength and the gripper itself, all of which depend on the nature of the workpiece. In general, the longer the gripper fingers, the longer the lever arm, which exerts more torque on the jaws. In addition, flat-finger designs provide a friction-based grip for bulky or durable parts, while encapsulated designs work best on slippery parts requiring precise placement. Encapsulated fingers are shaped to match the object being moved, such as curved for round objects, which helps the grippers hold the object in position and prevent parts from dropping if pressure is lost.

For example, a company approached us wanting a gripper for a food processing application. The grippers had to pick up large trays of dried pasta, rotate the trays to dump the pasta onto a conveyor belt and then return the trays to their stack. The trays were large, roughly 4 × 2 ft. They were also made of metal and weighed 15 lb. Other important considerations included:

Environmental. The grippers would operate at room temperature. The air was dry but contained some pasta dust.

Design constraints. The gripper had to handle high forces, as the 15-lb trays had to be frequently rotated and shaken.

To meet these requirements, we recommended four heavy-duty HGPT mechanical grippers. Their oval-shaped piston gave them 30% more gripping force for heavy objects. They also have sealed air ports to keep pasta particles out of the gripper jaw guide.

SOFT AND ADAPTIVE GRIPPERS

Soft and adaptive grippers can handle workpieces of various shapes, sizes, and orientations, letting companies install automation in areas where it couldn't previously fit. They don't have sharp edges, and so can lift and move food, glass and other delicate objects without damaging or marking the surface. They're also ideal for small work areas. Compared to mechanical variants, however, soft and mechanical grippers are less precise and operate slower. They are also more susceptible to dirt, oil and other contaminants.

> In North America alone, for example, the gripper market is worth roughly $100 million, and that number is expected to grow by 5% annually.

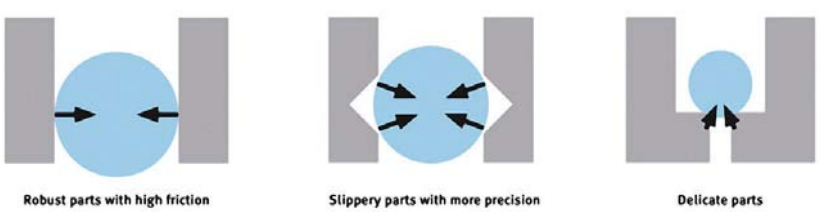
Soft and adaptive grippers often incorporate innovative tweezer-like designs that adapt to workpieces' contours workpieces. For example, Festo's DHAS features a Fin Ray structure, named for the movement of a fish tail. Two flexible bands which meet at the top like a triangle are connected by ribs. Using flex hinges, these ribs are spaced at regular intervals, creating a flexible, yet sturdy connection. Available in lengths of 60, 80 and 120 mm, this series is well-suited for pick-and-place applications involving fragile or irregularly shaped parts. The grippers are made of materials that comply with FDA standards, making them a good fit for the food and beverage industry.

VACUUM GRIPPERS

Vacuum grippers combine suction cups and vacuum generators. Compact and flexible, these grippers need little workspace and can handle a variety of objects at high speeds. But vacuum grippers can run up the maintenance and operating costs; suction cups are susceptible to quick wear, while generators consume lots of compressed air and can easily clog if dust or other contaminants are present.

When it comes to suction cups, it's

Suction-cup grippers hold a solar wafer as its moved from one manufacturing process to another.



Comparing gripper fingers.

important to consider the workpiece when selecting a material. Buna, polyurethane and Viton suction cups, for example, are ideal for oily and plain workpieces, while silicon is best for food, as well as hot or cold objects. Polyurethane is also good for rough workpieces, while Viton can handle hot objects. And anti-static buna is ideal for electronics.

Cup shape is another important factor, especially when it comes to gripping objects: Flat cups are good for round, slim or sturdy objects, while round cups work best with round, large or delicate pieces.

In general, use standard cups for flat or slightly undulating surfaces. Specify bellows cups for pliable workpieces, as well as parts with beveled, domed and rounded surfaces. Bellows cups are also suitable for glass bottles, lightbulbs and other delicate objects. Oval cups are a good choice with slim or oblong workpieces. And extra deep cups are well suited for round and domed workpieces, providing more rigid support compared to a bellows type and handling dynamic, high-speed lateral movements.

Vacuum sources fall into two categories: electro-mechanical vacuum pumps/blowers and compressed air-driven vacuum generators/ejectors. In general, electromechanical pumps and blowers can deliver high vacuums (up to 99.99%) and suction rates (up to 1,200 cubic meters per hour). However, these machines tend to be heavy and large, requiring a reservoir with complex piping. They also run continuously, so they consume a lot of current, which generates heat.

Compressed-air-driven generators, especially single-stage units, overcome many of these limitations. Compared to electromechanical pumps and blowers, they are more compact, lighter and easier to install. They include simpler piping subsystems, require lower upfront costs and have no electrical connections that add complexity and create harmful heat buildup. Although these units can run up air consumption rates, many machines now have energy-saving

The Festo HGPT gripper is well suited for handling medium-size workpieces. It uses a T-slot guide that resists torque. It also has sealed air ports to prevent particles, dust and other contaminants from entering the gripper jaws. And its oval piston lets the HGPT gripper increase its gripping force, providing twice the force for half the stroke length.

Mechanical grippers come in a variety of sizes with different types of gripper fingers.

functions to lower those rates.

In general, vacuum grippers are ideal for material handling applications, such as steel fabricators, conveyors, electronic assembly and industrial robotics; food and packaging tasks, including canning, bottling, capping, tray making, filling, bagging, sealing, conveying, box making and labeling; and printing applications, such as sheet feeding and paper handling.

MAGNETIC GRIPPERS

Magnetic grippers—e.g., Magswitches—can handle metallic objects such as metal sheets, and can carry out tasks such as de-stacking, fixture tooling and bin picking. Magnetic grippers are limited to applications involving ferrous metals. On the upside, they need minimal air consumption to actuate, so they save up to 90% in energy costs compared to suction cup grippers. Other benefits include:

- **Strong gripping.** Magnetic grippers use a shallow magnetic field that enables them to handle de-stacking. For example, with a stack of metal parts, magnetic grippers can pick up just one part at a time.
- **True On/Off.** Magnets can be switched completely off and stay clean; any metal fillings left from production processes instantly fall away.
- **Fast.** Magnetic grippers can actuate in 250 msec, saving valuable cycle time.
- **Safe.** They provide fail-safe performance and will not drop parts if there's a loss of power or air.

Ultimately, choosing the right gripper depends on several variables, including workpiece size and shape, operating conditions, industry, energy requirements and cost. In some cases, an application may require a custom gripper. If that's the case, your engineering team will need to work with a company that can supply them. hp

MICHAEL GUELKER and DAREN O'DRISCOLL work in product management/pneumatic drives at Festo Inc., Canada.

UNDERSTAND THE APPLICATION

TO GET THE right gripper, it's important to first consider the nature of the task, operating environment and workpiece, including its size, mass and material. Here are some key considerations and questions that will help determine which gripper type will get the job done as safely and efficiently as possible:

Environmental. What temperature range will the gripper operate in? Will the gripper be exposed to dirt, dust, oil or moisture?

Industry. Does the application involve food or other hygienic workpieces? Will the gripper be exposed to cleaning processes? Does the application require antistatic materials?

Design constraints. What direction of motion is needed? What is the application's maximum operating speed? How large is the workspace? Will operators share space with collaborative robots?

Costs. What are the upfront, operating and maintenance costs, as well as the energy consumption?

AARON HEINRICH

Going Beyond PID in Hydraulic Motion Control

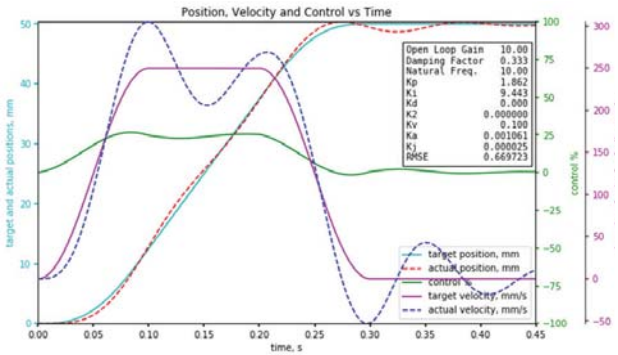
Early on, systems relied on basic start/stop and limit switches, but as processing power and speed have increased, electronic industrial system controls have grown to be the more sophisticated option and become ever more capable.

The design constraints of this press required advanced 2nd order hydraulic controls.

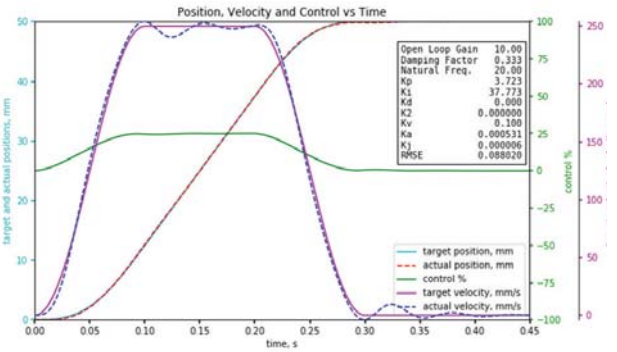
In the nearly 40 years since electronic control systems first became common features of industrial machines, controls theory has necessarily evolved to keep pace with machine design. Early on, systems relied on basic start/stop and limit switches, with perhaps the added sophistication of two-speed valves. It then became possible to coordinate various parts of the system's action, with sensors indicating various states; early microprocessors kept track of those states and issued command signals based on programmed instruction sets. As processing power and speed have increased, electronic industrial system controls are growing ever more sophisticated and becoming ever more capable.

WHY ENERGY TRANSMISSION MAKES A DIFFERENCE

Electromechanical systems transmit energy to the load with solid material parts like shafts and gears. Therefore, these systems feature near instantaneous on/off capabilities, and controls are essentially unaffected by environmental or system changes, such as temperature. From a controls standpoint, these systems are stiff and linear, meaning control algorithms can be simpler. However, electromechanical systems are challenged by shock or dynamic load-



1. Ratio of ωN to FoA is 2:1, 10 Hz to 5 Hz. Note the RMSE value and velocity oscillation.



2. The same move as Fig. 1, with the system's ωN increased to 20 Hz (4:1 ratio). Notice the RMSE value.

ing, and experience mechanical wear, resulting in a finite working life before refurbishment or replacement.

Fluid power systems have tremendous power density and are significantly more tolerant of shock loading. That is due to the use of hydraulic fluid as an energy transmission media. When the system is shocked, the hydraulic fluid exhibits compressibility effects and will also transmit forces to the pipes, hoses and tanks that contain the oil in fluid power systems. Shock distribution does not typically result in permanent damage to a hydraulic system, and the system can continue to operate normally after long periods of shock loading events. As a side note, hydraulic fluid characteristics will exhibit slightly different behaviors depending on changing environmental conditions such as temperature.

Getting precise and repeatable control on a fluid power system has been a challenge historically. As processors have increased in power, what were previously theoretical control algorithms can now be implemented on real systems. Algorithms that simply could not be calculated, or could not be calculated in a short-enough time to be useful for controlling an actual machine, are now easily implemented. The capabilities of control electronics have caught up with the physical world.

DESIGN CONSIDERATIONS

To reliably and precisely control a hydraulic system, it is important that the system response be as linear as possible. This means that unit changes in control output should result in consistent changes in system response. To some degree, advanced controllers can bypass this system linearity requirement through system modeling, but the linearity premise remains. If the system design is nominally linear, controllers can use straightforward algorithms on the system and provide control output to produce exactly the desired response with minimal error.

There are design best practices that can help achieve a highly controllable system. What can be challenging about controlling hydraulic systems is the compressibility of the oil and the flexibility of hydraulic hose. Therefore, minimizing excess oil volume between the powered side of the cylinder and the servo valve increases the system's stiffness. It is best to mount the valve directly on the cylinder; if that isn't possible, using hard pipe for plumbing instead of flexible hose between the valve and cylinder increases stiffness and, therefore, controllability. Making sure the system's static friction is not high allows the control output to be efficient and effective, and enables more precise system control.

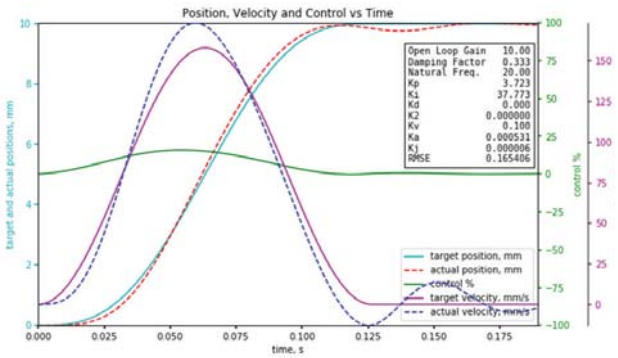
Using high-resolution feedback sensors gives the best information for control. An advanced controller will not just use the high-resolution position feedback for control but can also derive velocity and acceleration of the moving axis, using those values in the control algorithm.

Designers should not just consider the maximum desired system velocity and design and size system components for that value. If a simple PID controller is being used, they should consider how fast the system must accelerate or decelerate, and make sure the frequency of this acceleration is less than or equal to one fourth of the natural frequency (ωN) of the system. *Figure 1* shows an example of system response where the frequency of acceleration (FoA) is just half the system ωN.

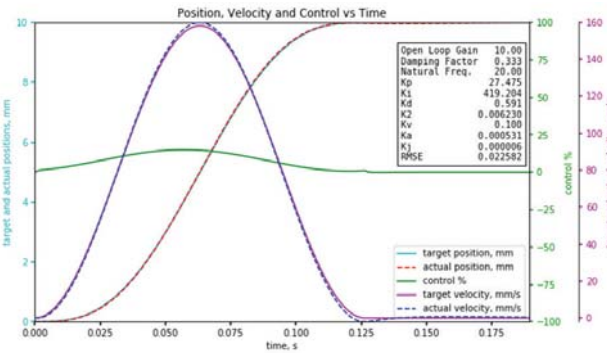
Figure 2 shows the same motion profile, but with a ratio of FoA to ωN of exactly 4:1, resulting in actual motion that much more closely matches the target. The 4-to-1 frequency ratio applies to the use of standard controllers; motion controllers with more advanced control algorithms can achieve good system control at ratios of about 2-2.5 to 1. The result is the ability to use smaller cylinders, smaller valves and smaller power units—and therefore, achieving smaller system component costs.

SOPHISTICATED CONTROLS

PID controls must have some amount of error between the desired (target) output and the actual system response. Therefore, the response of a system controlled by PID terms alone slightly lags the target. If velocity and acceleration feed-forward control factors are added to the control algorithm, the result is



3. A short, quick move using PID and velocity feed-forward. ωN to FoA ratio is 2.5:1.



4. Same move and conditions as Fig. 3, but the control algorithm is using acceleration feed-forward. Note the minimal error.

excellent tracking with a lag-free control output generated based on the target position, velocity and acceleration.

As the cylinder moves along the calculated target trajectory, the control system can accurately anticipate system response and achieve final position with no perceptible overshoot. Getting this result requires adding enhancements to the basic PID algorithm.

Figures 3 and 4 are plots of short, quick moves, illustrating the difference between a basic PID control algorithm and a PID with velocity and acceleration feed-forward terms added.

Processing power is now at the point where implementing other advanced control algorithms for controlling hydraulic systems is not only possible, but realistic for everyday usage. That power opens up new realms of system control. As long as the control system receives regular, electronically clean, high-resolution reports on the motion system's position—and can control the hydraulics through responsive, reasonably linear servo-quality valves—fast response and repeatable high-accuracy moves are possible.

The above discussion suggests the benefits of adding feed-forward terms to the control algorithm, but a second derivative term (D2) can also be added to the PID which results in a PID + D2 + feed-forwards. With the addition of the D2 term to the basic PID, the controller can now fully compensate for the compressibility of the oil in a large volume system or compensate for the flexibility of hose in a sub-optimal system design. Of course, it's always desirable to design the system to minimize hose between the valve and actuator and other contributors to 2nd order system effects.

What's the next step in advanced control algorithms? The next step is the use of observers and mathematical system models to augment the quality of the feedback that the system is using for control. An observer is an algorithm that estimates the state of a system, based on the inputs and "observing" the output. A good system model that is used with an observer can increase the quality of the position feedback, and allow a system to ride through short durations of feedback failure.

This same model/observer combination can not only significantly improve

the quality of the velocity and acceleration feedback, but can also reduce the phase delay of this information to zero. From a control standpoint, this is a very big deal.

SOLVING REAL-WORLD PROBLEMS

An automotive parts manufacturer uses a four-corner press produce tight-tolerance auto body panels. At 30 ft (~10 m) in height, the press is very tall. The servo valves controlling the four hydraulic rams were mounted at floor level, while the cylinders they were controlling were up higher on the press.

An advanced motion controller was able to account for the non-linearities and lag in system response resulting from the fact that the system had extra oil between the valve and cylinder, as well as flexible hose which expanded under pressure. Once the system was characterized, the controller was programmed to correctly anticipate system response, and smoothly position the die cushion and maintain a constant force on the workpiece. The resulting press produces parts to a high degree of accuracy and moves smoothly between pressing and retracting with no oscillation. Prior to setup, the press would oscillate, shaking the building where it was installed!

To study hydraulic control problems like this in more detail, Delta Computer Systems' engineers built a hydraulic lab apparatus which was intentionally designed to be difficult to control. It features a sizable mass on a long, thin cylinder—a classically underdamped system that is prone to oscillation. To demonstrate and test different system challenges, the oil can be routed from the valve to the cylinder either through short runs of hard pipe, or long runs of flexible hose.

These paths are selected with manual ball valves. This system is intentionally difficult to control and breaks a few "best practice" principles.

With Delta's RMC75 motion controller, the system is tuned easily using the company's RMCTools Tuning Wizard. The controller characterizes the system, and applies the correct gains and generates a smooth motion profile to move the system with nearly zero overshoot or oscillation.

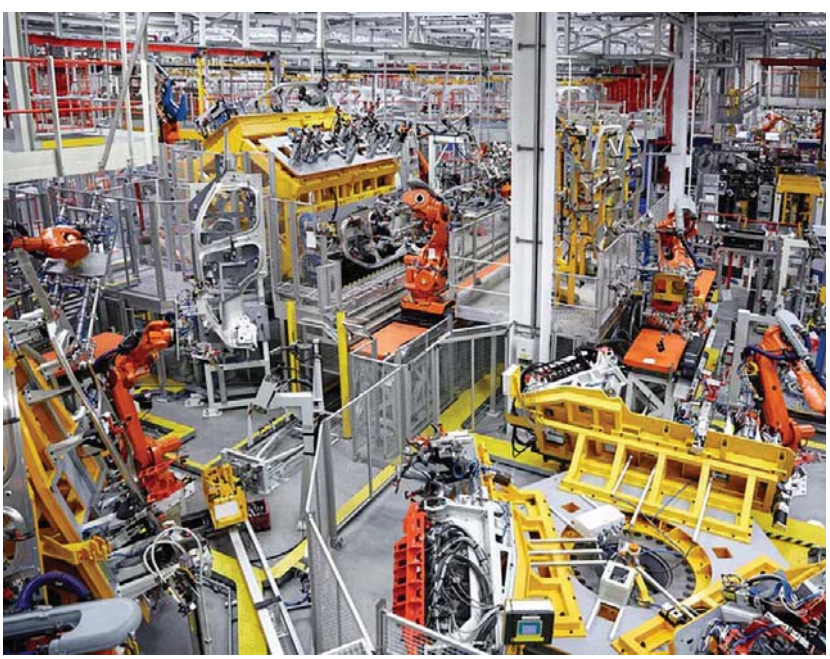
FREEDOM FOR DESIGNERS

Advances in processing power and feedback resolution have opened up new opportunities for system design. As power and speed increase, controls engineers are able to move from theories and models to actually implementing these ideas in physical control hardware, which benefits designers and end-users alike. These advances enable industrial controllers that can be pushed to solve previous practically impossible control problems. This opens up new possibilities to apply fluid power to applications that require power, precision and speed. hp

JIM HAUSER, RADE KNEZEVIC | Parker Hannifin Corp.

Specifying the RIGHT HYDRAULIC CYLINDER for the RIGHT JOB

Designers should understand the key factors that influence cylinder selection.



Engineers specify hydraulic cylinders for handling many types of equipment, including machine tools, CNC turning, metal stamping and assemblers.

Hydraulic cylinders essentially convert fluid pressure and flow into force and linear motion. They are available in a wide range of styles, sizes, materials and configurations. Many OEM engineers play it safe by over-engineering cylinder specifications. But less can sometimes be more when it comes to complex hydraulics. Let's first identify some of the key factors that should be considered when specifying hydraulic cylinders.

DESIGN FACTORS FOR HYDRAULIC CYLINDERS

Specifying hydraulic cylinders is essentially a balancing act or a cascade of compromises, as each design factor influences one or more of the other design factors. Designers must weigh each positive effect against potential negatives to get the best performance. Here's a concise look at those factors:

Capacity. Most industrial hydraulics are considered medium-duty and operate at 1,000 psi. Heavy-duty hydraulics, which are common in presses and automotive machinery applications, can handle pressures up to 3,000 psi. If loads are extremely high, tandem cylinders are preferred to larger-bore or custom high-pressure cylinder designs.

Stroking distance. Stroke distances can exceed 10 ft (5.05 m) for custom-built cylinders, but pressure ratings can be a problem with such long strokes. The rod diameter needs to be determined in order to gauge its ability to handle the load. If necessary, a pressure rating on load in thrust (push mode) must be specified. In horizontal applications, which are common, premature rod bearing wear can lead to rod sag over long strokes. Although custom stroke distances above 10 ft (3.05 m) are possible, pressure rating can be a concern.

Speed. Every application engineer has their own definition of "excessive speed." A good rule of thumb is that standard hydraulic cylinder seals can easily handle speeds up to 3.28 ft/sec. (1 m/sec.). The tolerance threshold for standard cushions is roughly

two-thirds of that speed. Standard low-friction seals are often a better choice for high-speed applications, but what you gain in one aspect of performance you lose in another. The higher the fluid velocity, the higher the fluid temperature. So, when opting for higher speeds, it is essential to consider how higher temperatures will affect the entire hydraulic system. In some hydraulic systems, over-sizing the ports may eliminate concerns over higher temperatures.

Temperature. As previously noted, hydraulic cylinders using standard components can be designed to meet application temperatures as high as 500°F (260°C) and as cold as −65°F (−54°C). But temperatures affect both the "hard" and "soft" design components of cylinders. That means engineers designing applications that will see high and/or low temperature extremes must be aware of individual components interdependency to best balance short- and long-term performance. For example, seals and metal parts used in cold environments will contract.

Mounting styles. There are basically three mounting styles. Load, speed and cylinder motion are the parameters that help determine which is best. For example, fixed and pivot mountings absorb forces on the cylinder's centerline, the preferred way for mountings to handle the thrust or tension. These two types of mountings can usually be medium- or heavy-duty. A third style, fixed, supports the entire cylinder on its mounting surface below the cylinder's centerline rather than absorbing forces only along the centerline.

Several standardized mounts within these styles give engineers alternatives for meeting application requirements. NFPA tie-rod cylinders, for example, are used in most industrial hydraulics and are typically mounted using trunnion-style heads and extended tie rod caps and/or head end styles; flange-style heads; side-lug and side-tapped styles; spherical bearings; and cap-fixed clevis designs. Most mounting options are available for single-acting and double-rod cylinders.

The purpose of the mount is to absorb forces, stabilize the cylinder and improve performance. For rods loaded primarily in compression (push), cap-end mounts are recommended. For those in tension (pull), head-end mounts are preferred. The amount of tension or compression determines piston rod diameter. The amount of pull or push determines the bore diameter.

Specifying hydraulic cylinders is essentially a balancing act or a cascade of compromises, as each design factor influences one or more of the other design factors.

Every mounting type comes with its own benefits and limitations. For example, trunnions for pivot-mounted cylinders won't work with self-aligning bearings where the small bearing area is at a distance from the trunnions and cylinder heads. Self-aligning bearings would introduce bending forces that could overstress the trunnion pins.

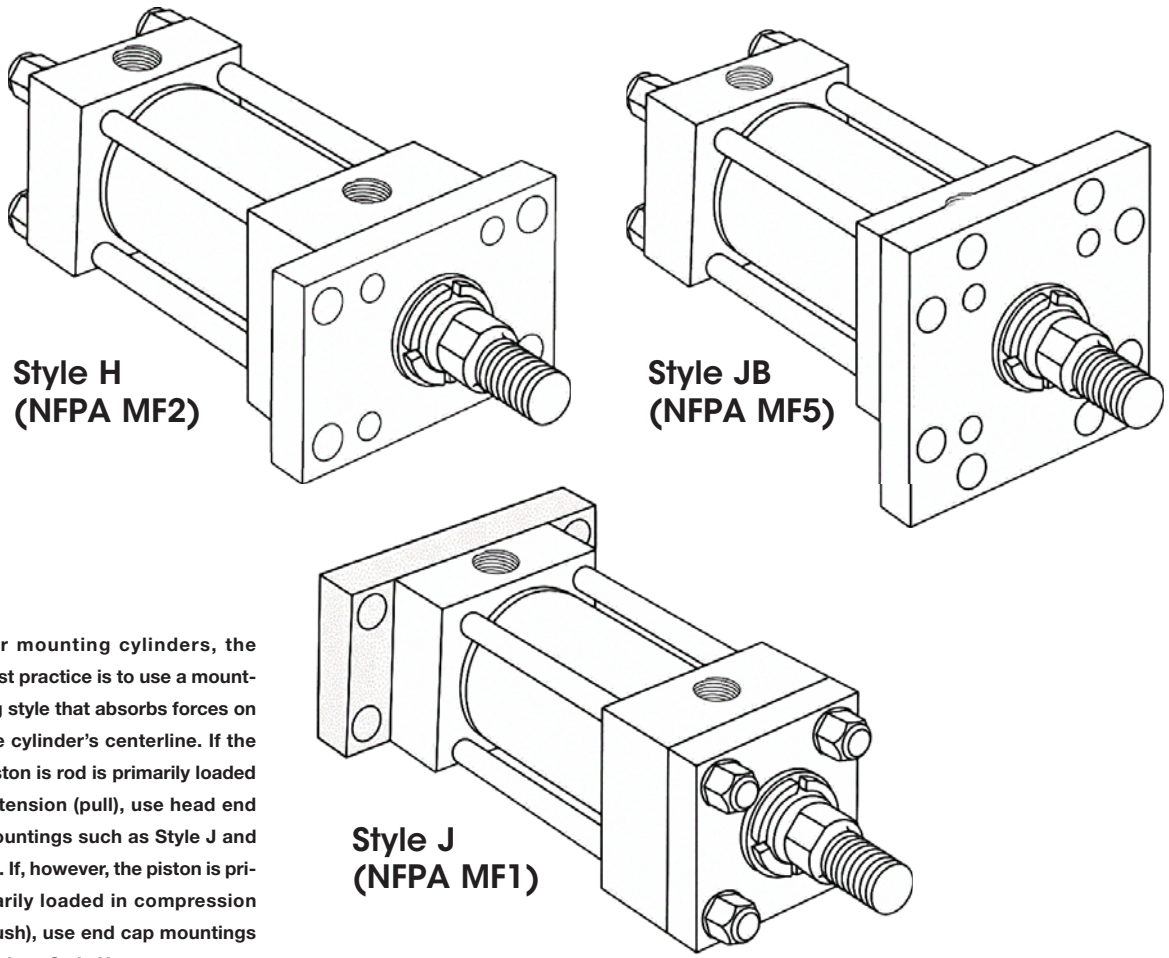
Many applications might seem like they need atypical mounts, but most can be handled by existing styles with only slight modifications, which simplifies replacement and reduces costs.

Other relevant factors to consider when selecting a mounting style include:

Cylinder bore size. Bore size is a function of operating pressure. The amount of push or pull (force) needed determines the bore size. In the past, steel and aluminum mill equipment often used non-standard bore and rod sizes. Today, virtually every industrial requirement can be met with NFPA standard and/or ISO-compliant components.

Piston rod size. Engineers probably request custom piston-rod sizes more than any other customized hydraulic-cylinder component. What they ignore is that push or pull are never independent of stroke length. Rods under compression or tension tend to diffuse force in non-linear directions. Specifying costly materials such as stainless or alloy steels for rods is another common example of over-engineering. But in extreme applications, chrome plating might be needed for corrosion resistance.

Cylinder configurations. For applications requiring equal force (pressure) on both sides of the piston, the preferred configuration is a



For mounting cylinders, the best practice is to use a mounting style that absorbs forces on the cylinder's centerline. If the piston is rod is primarily loaded in tension (pull), use head end mountings such as Style J and JB. If, however, the piston is primarily loaded in compression (push), use end cap mountings such as Style H.

Experienced hydraulics manufacturers offer seals compatible with a range of temperatures and fluids and can help choose seal materials that meet application requirements.

standard double-acting cylinder using pressure to extend and retract the cylinder, combined with a four-way directional valve directing pressure to the head or end cap. It is almost always better than a customized set-up.

Experienced hydraulic manufacturers are familiar with practically every cylinder configuration—and the unintended consequences of customizing components versus creatively combining standard cylinders to meet unusual performance requirements.

Rod ends/rod threading. This is one area where the standard options are so all-encompassing that customization is rarely needed. Additionally, standard threads can be made in inch or metric formats. Typically, each diameter is available in four distinct rod end styles. Even in rare instances where modifications seem to be called for, it is important to consider the effects of modifications on accessories. The relatively small performance increase from using standardizing rod ends is almost always warranted by the versatility standardization brings.

Even modest modifications, such as under-sizing threads, may require de-rating the cylinder and necessitate special tooling for a non-standard pitch. These actions cause delays, add expenses and leave the cylinder unable to easily mate with accessories.

Cylinder body tube. Standard cylinder bodies are plain or chromed-plated and will handle most applications. Alloy steels, stainless steel and brass are common in special applications such as wet environments.

Stop tubing. Stop tubing increases the distance between the rod and piston bearings to reduce bearing load on push-stroke cylinders when the cylinder is fully extended. Stop tubing is critical for horizontally-mounted

Partnering with an experienced hydraulics manufacturer early in the design phase saves engineering teams time and money while ensuring the final system does its assigned duties as efficiently as possible—for as long as possible.

Standard NFPA Tie Rod Cylinders are used on machines critical in all phases of metal production, from smelters, casters and extruders through grinders, rolling mills and strip processing. Each cylinder can be customized to the application's needs.

cylinders as it limits the rod's extended position. In such applications, increased distance yields greater stability and longer bearing life.

Seals. Experienced hydraulics manufacturers offer seals compatible with a range of temperatures and fluids and can help choose seal materials that meet application requirements.

There are applications that require cylinders customized in size, material or configuration. However, partnering with an experienced hydraulics manufacturer early in the design phase saves engineering teams time and money while ensuring the final system does its assigned duties as efficiently as possible—for as long as possible.

HYDRAULIC VERSUS PNEUMATIC

Although pneumatic systems are in some respects simpler, they generally cannot handle the high loads and forces that hydraulic cylinders can. Hydraulic cylinders also have smoother, more controllable movement as they do not have the spring-like action associated with the release of pressurized air. As an added benefit, hydraulics can perform ancillary functions such as lubricating and cooling.

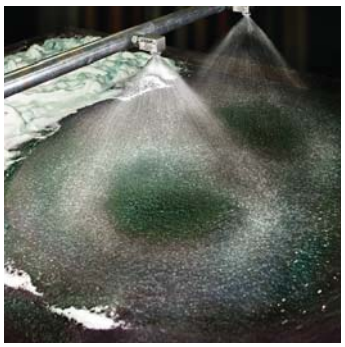
However, since the availability of power and media is a non-negotiable factor in fluid power system design, it should be noted that a properly designed and sized pneumatic system can achieve higher performance where a compact footprint is not required. Further considerations of pneumatic cylinder design are outside the scope of this article.

Although NFPA standards and ISO-compliant guidelines are a great starting point for hydraulic system design, many industries have guidelines of their own. hp

JIM HAUSER and RADE KNEZEVIC are with Parker Hannifin Corp.

Useful Products

For more products, visit the Equipment Product Directory link at *www.hydraulicspneumatics.com.*



Nozzle Design Creates Better Spray Pattern

THE 1/4 NPT HollowStream liquid atomizing spray nozzle provides a hollow cone spray pattern for pressurized liquids. They are applied to solve cooling, cleaning, foam breaking, rinsing and dust suppression applications for industry. The tangential flow design is vaneless, with wide-open internal features to resist clogging while producing a uniform distribution in a ring pattern with medium to large droplets. Their right-angle design is compact and works well with liquids containing particulate. Liquid operating pressure is up to 250 PSI. With HollowStream nozzles, the liquid is supplied into the body of the nozzle, creating a swirling action within a vortex chamber. This vortex produces the spray pattern when the machined nozzle breaks the liquid surface tension as it exits the orifice and into a controlled spray angle. Stainless steel construction of liquid atomizing nozzles adds to their durability and corrosion resistance.

EXAIR, EXAIR.COM

Compact Robot Mounts at Any Angle

THE LR-10IA/10 ROBOT is designed for machine tending and a variety of picking applications found in the warehousing and logistics markets. Weighing just 46 kg, the LR-10iA/10 robot mounts to the floor, upside-down or on an angle. It's also very easy to mount the robot to an AGV or other mobile platform to accommodate a variety of repetitive tasks or automate machines that are standing idle. The LR-10iA/10 has a 10 kg payload and a large work envelope with a long reach of 1,101 mm. Its compact size makes it an ideal solution for companies with limited floor space, and the slim arm fits into machine tools to load and unload parts. In addition, a fully enclosed structure features built-in airlines, solenoid valves and electrical utilities for easy integration, and an IP67 rating allows it to operate in industrial environments with dust, water and oil mist.

FANUC, WWW.FANUCAMERICA.COM

Inductive Angle Encoder Good for Harsh Conditions

THE MULTITURN INCODER INDUCTIVE ANGLE encoder enables precise and reliable absolute angle measurement over multiple revolutions, even in harsh environments. It is easy to install in a wide spectrum of applications, including robot joints, servo motors, linear stages, cartesian robots, cranes, wind turbines and antenna masts. The Multiturn IncOder is a robust absolute inductive encoder with non-volatile turn count storage. It is designed for applications where motion exceeds one turn, such as rotary-to-linear motion and geared rotary systems. Perfect for more compact and lightweight systems, the Multiturn IncOder is a low-profile ring encoder with a large through-hole. Unlike traditional multiturn encoders, the gearless design is wear-free and does not require a battery backup supply.

CELERA, WWW.CELERAMOTION.COM

Rugged Control Cable has Flexible Uses

THE LUTZE SILFLEX multi-conductor control cable is a rugged industrial cable ideal for stationary and flexible applications (not intended for continuous flexing use) with multiple ratings, including UL Type TC-ER or UL PLTC-ER, which eliminates the need for metal conduit and/or armor, resulting in installation and maintenance savings. These cables are available in sizes from 20 AWG to 10 AWG with 3 to 41 unshielded or shielded conductors marked with numbers for easy identification and include a convenient ground conductor with easily identifiable green with yellow stripe insulation. The rugged outer jacket provides resistance to sunlight, oil and moisture penetration, making these cables suitable for wet and dry locations as well as outdoors.

AUTOMATIONDIRECT, WWW.AUTOMATIONDIRECT.COM

Mini Terminal Block Series has 12 AWG Version

THE TOPJOB S Mini terminal block series includes a version for 12 AWG. Like the rest of the Mini family, this version features all of the advantages of the TOPJOB S terminal block line but comes in at a size 60% smaller than our standard terminal blocks. The 12 AWG variant is able to operate at up to 600 V and 20 A and has UL 1059 approval, as well as AEx, ATEX and IECEx for hazardous locations. Featuring the Push-in CAGE CLAMP connection technology used throughout the TOPJOB S series, this Mini terminal block is available with open tool slot or the easy-to-identify orange push buttons that can be easily actuated with any standard tool. It can also be mounted in various ways: miniature rail, snap-in mounting foot for chassis mount or direct mount with fixing flange.

WAGO, WWW.WAGO.COM

Advertisers Index

A "GREENER" Hydraulic Lubricant Gets a Lift

Market is changing, and fluid performance is keeping pace.

Spurred by new demands for efficiency, hydraulic equipment across the industrial and mobile markets is rapidly evolving. For hydraulic fluids and lubricants, this kind of evolution represents both a challenge and opportunity. Not only must these fluids be able to deliver robust protection under increasingly strenuous operating conditions, but they also can directly improve operational efficiency.

Among the current market trends and their implications for hydraulic fluids:

Increasing power density and internal pressures. Modern hydraulic system design increasingly prioritizes lightweighting and power density in order to best compete with electric systems that continue to gain marketplace traction. These design parameters result in much higher internal operating pressures, which can be as high as 450 bar in current mobile equipment.

However, higher pressure increases the potential for internal fluid leakage. This phenomenon can lead to a reduction in the clearances between moving parts, which can severely compromise machine durability. As such, lubrication here has needed to move from hydrodynamic protection into the mixed film region, requiring new additive technologies and formulation expertise.

Finer filtration. Higher pressures and lower clearances in hydraulic components also mean that fluids must remain very clean throughout components' operating life. Wet filterability has become a critical fluid performance parameter for fluids.

Smaller oil coolers and reservoirs. In order to save space and further reduce weight, the size of new oil coolers and reservoirs are smaller. The challenges here for hydraulic fluids are significant—in smaller applications, operating temperatures can increase by as much as 10°C, effectively halving the fluids' life. Smaller cooler and reservoir sizes also mean that less fluid is doing the same amount of work, which may increase the severity of operating conditions. Such fluids must be formulated to demonstrate thermal stability.

Increasing electronic and digital control. It's more common for electronic control systems to match hydraulic pressure and flow to torque requirements, allowing machines to be automatically optimized for specific duty cycles. Digital valves allow more precise control of equipment both dynamically and statically. These valves are 25 to 100 times faster than analog valves and require special hydraulic lubricants. In these applications, hydraulic lubricants must demonstrate low air content and compressibility to enable such valves to function as designed.

In addition to hydraulic fluid's ability to withstand modern hydraulic application conditions and provide robust protection, there are several areas in which the lubricant can directly contribute some important benefits. These include:

Improved machine efficiency. Hydraulic efficiency can be measured in several ways, including lowering fuel/electricity consumption, more work completed per shift, easier cold starts or some other criteria. For OEMs, specifying an upgraded hydraulic fluid that allows the machine to move more efficiently can provide instant gains at a fraction of the cost and time of reengineering the machine itself. For end-users, a higher-performance lubricant can help lower the total cost of ownership.

Sustainability. In hydraulic applications, large volumes of lubricant can inadvertently enter the environment via leakage or spillage, equipment breakdown or careless disposal. For these reasons, it's increasingly important that fluids and lubricants are formulated in such a way that minimizes environmental impact. Sustainable and biodegradable formulations will likely become more common.

A lubricant solution that delivers robust protection can help a hydraulic machine live a longer and more useful life, preventing premature replacement—another way in which lubricant technology can contribute to holistic sustainability. hp

This article was authored by The Lubrizol Corporation.

FluiDyne
FLUID POWER

FluiDyne Pumps, Motors & Valves: *truly versatile.*

Get Instant Answers.

Providing *solutions* that work.

Powered by Customer Service

FluiDyne
FLUID POWER

586-296-7200
sales@fluidynefp.com
www.fluidynefp.com

THE FPDA MOTION & CONTROL NETWORK MEMBER

NATIONAL FLUID POWER ASSOCIATION NFPA MEMBER

FLUIDYNE FLUID POWER OVER 40 YEARS OF QUALITY 1976-2016

Hydraulics & Pneumatics

A Human Commitment

Our readers are committed to us, and we're committed to them. It's our responsibility to understand what they expect from us, and it's our privilege to write for each individual reader. No one else engages with key fluid power audiences like we do.

A Team of Individuals

Debbie Brady

Manager of User Marketing

Debbie has been working in audience development for most of her career. She has a soft spot for Hydraulics & Pneumatics and takes personal pride in ensuring that all subscribers have requested the magazine, and they all specify fluid power components.

Our Audience by the Numbers

- Average monthly reach: **264,284**
- Average unique monthly visitors: **146,013**
- Qualified print circulation: **28,885**
- Reader makeup
  - **75%**: Managers or above
  - **25%**: Other
- eNewsletter reach: **49,423**

Hydraulics & Pneumatics

ENDEAVOR BUSINESS MEDIA

To learn more about opportunities with Hydraulics & Pneumatics, visit us at *www.hydraulicspneumatics.com*