Salary & Career Survey: Young Engineers Sound Off On Old Issues *16*

November/December 2022

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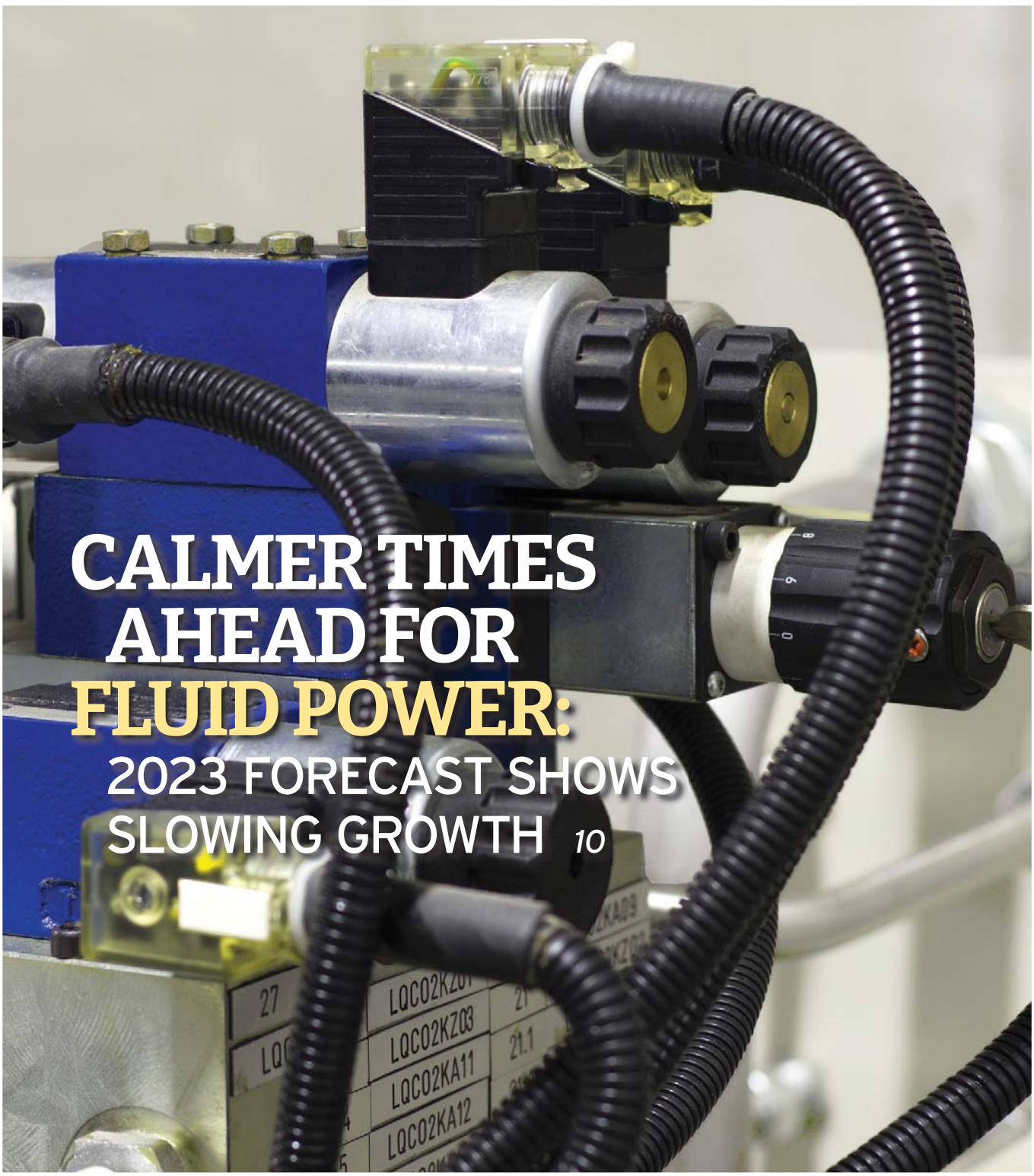

CALMER TIMES AHEAD FOR FLUID POWER:

2023 FORECAST SHOWS SLOWING GROWTH *10*

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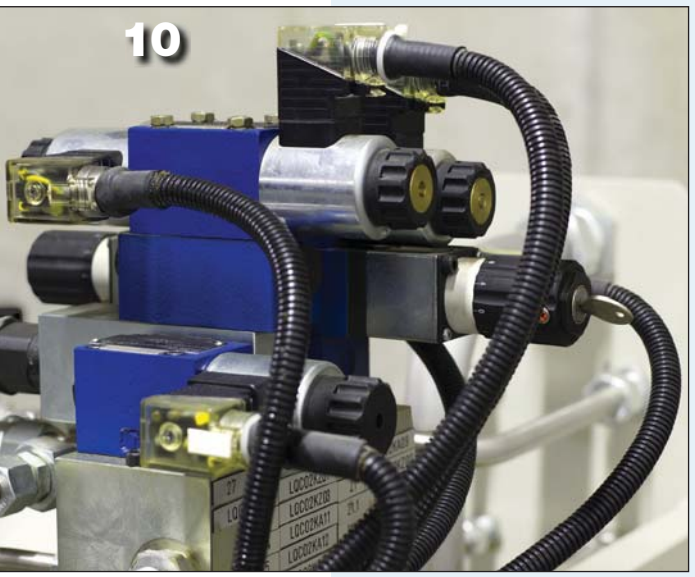

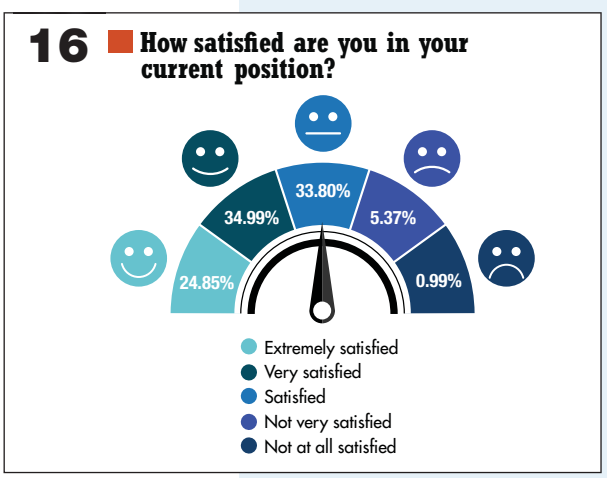

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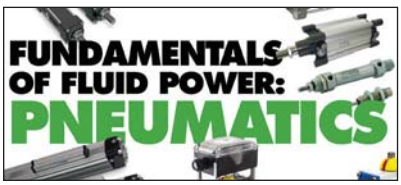

Fundamentals of Fluid Power: Pneumatics
Download our guide highlighting key technologies and design methods for developing efficient and modern pneumatic systems.
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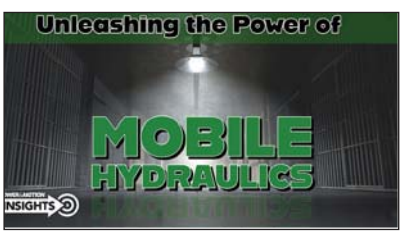

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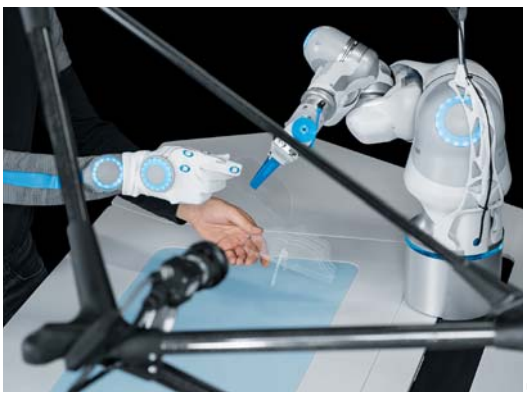
SARA JENSEN
Technical Editor
sjensen@endeavorb2b.com

The Future of Manufacturing and its Impacts on Workforce Development

Like many industries, manufacturing continues to evolve as new technologies enter the market. Automation in various forms—such as robotics and automated systems, for instance—are becoming more common to help improve efficiency and productivity as well as overcome labor challenges.

In September, the American Society of Mechanical Engineers (ASME) and Autodesk, Inc. released results from their research project on the "Future of Manufacturing." Their goal was to provide industry and academic guidance for advanced manufacturing and determine the future workflows and skills needed for mechanical engineering, manufacturing engineering and machinist roles over the next decade as those roles converge and evolve.



FESTO

Festo and SICK's training program is brand agnostic so students can be prepared to work with robots of all types.

Per the report and survey findings, manufacturing is on a clear path toward Industry 4.0 which is expected to bring new opportunities for productivity and efficiency improvements to meet increased demand for products delivered in a short period of time. But with this transition also comes the need to train workers. Industry perspectives included in the ASME and Autodesk report indicate there is currently a large skills gap which is expected to widen as Industry 4.0 progresses.

This is a common theme among many of the industries we cover, including the fluid power market. As the results of our annual Salary & Career Survey show—which you can find starting on p. 16— keeping up with current technologies is a major challenge for many in the industry as well as having the time and resources available to get educated on them. It will be necessary for academia, industry and more to work together to help educate the current and future workforce. *Read an extended version of this Editor's Note at powermotiontech.com/21252951.*

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Advancements in fluid power technology will aid the development and efficiency of electric-powered machinery.

S. JENSEN

IFPE White Paper Outlines Efficiency Benefits of Digitalization & Electrification for Fluid Power

by Sara Jensen

In the lead up to the International Fluid Power Exposition (IFPE) 2023, the National Fluid Power Association (NFPA) is releasing trend reports and white papers highlighting key technologies and market trends impacting the fluid power industry. Many of these will be shown during IFPE, providing an opportunity to see first hand the latest advancements in fluid power and motion control.

The latest white paper to be released, "How Digitalization & Electrification Improve Efficiency in Fluid Power," looks at how the growing use of digital technologies and alternative energy sources can benefit hydraulic and pneumatic systems. Fluid power companies which provided their insights into the effects of digitalization and electrification for the white paper include:

- Bosch Rexroth
- Casappa
- ifm efector
- Parker Hannifin
- Poclain Hydraulics

Market Drivers for Digitalization and Electrification

According to the white paper, three of the key global trends causing an evolution of fluid power systems through the increased use of digitalization and electrification technologies include:

- increasing urbanization and global population
- updating and replacing infrastructure
- regulations driving use of more sustainable solutions.

Adam Kimmel of ASK Consulting Solutions, author of the white paper, states in its introduction that fluid power can aid these market trends by accelerating the transition to electrification. Integration of sensors and other electronics into hydraulic and pneumatic components provides opportunities to improve efficiency and maintenance. Doing so leads to improved efficiency of the machines in which the components are integrated, such as the construction equipment that will be utilized for infrastructure and other related projects.

The mobile equipment market is an important one for the fluid power industry, particularly the hydraulics segment. Although many OEMs have started development or brought to market electric-powered construction and other heavy equipment, there is still a need for hydraulic components in many of these machines. As such, the fluid power industry needs to ensure it is developing the right products to meet the needs of electrified equipment.

In its recent report on the mobile hydraulics market, Interact Analysis found there has not been as high a rise in demand for hydraulic alternatives as the researchers expected despite the growing transition toward electrification in heavy-duty mobile equipment. This is due in part to the higher costs associated with some of newer technologies being brought to market. However, the research firm expects the efficiency gains which can be achieved through use of hydraulics with more integrated electronics and other new technologies will become more desirable to OEMs in the coming years leading to increased sales of these solutions.

Overall, the fluid power market is expected to remain positive. Kimmel cites a *Power & Motion* article in the white paper which explains how the fluid power segment is forecast to grow 7% in 2022, due in part to growth in the heavy equipment industry—driven also by the aforementioned global trends impacting fluid power.

So by continuing to advance their products through implementation of digitalization and electrification, fluid power manufacturers can ensure their components remain relevant options for construction equipment and other machinery OEMs.

The full white paper can be downloaded at IFPE's website. **P&M**

S. JENSEN

A range of hydraulic solutions will be on display once again at IFPE 2023.

The Lee Company Acquires TPP Ventus

by Stephen Mraz

The Lee Company recently announced it has acquired TTP Ventus Limited from TTP Group. TTP Ventus, based near Cambridge, UK, designs and manufactures silent, compact micropumps and pump modules that are used in the medical, life science, environmental and industrial sectors. These devices complement The Lee Company's existing range of miniature fluid control components widely used across the same sectors.

"TTP Ventus brings exciting new technology to The Lee Company, enhancing our offering in the strategically important life science and medical markets," said Bill Lee, president and CEO of The Lee Company. "The fit with our existing product lines is strong, and we expect our global force of sales engineers to accelerate Ventus' growth. The Lee Company's unique capabilities in miniaturization and engineering keep our company at the forefront of fluid flow technology and the addition of Ventus is the latest advancement of our technologies.

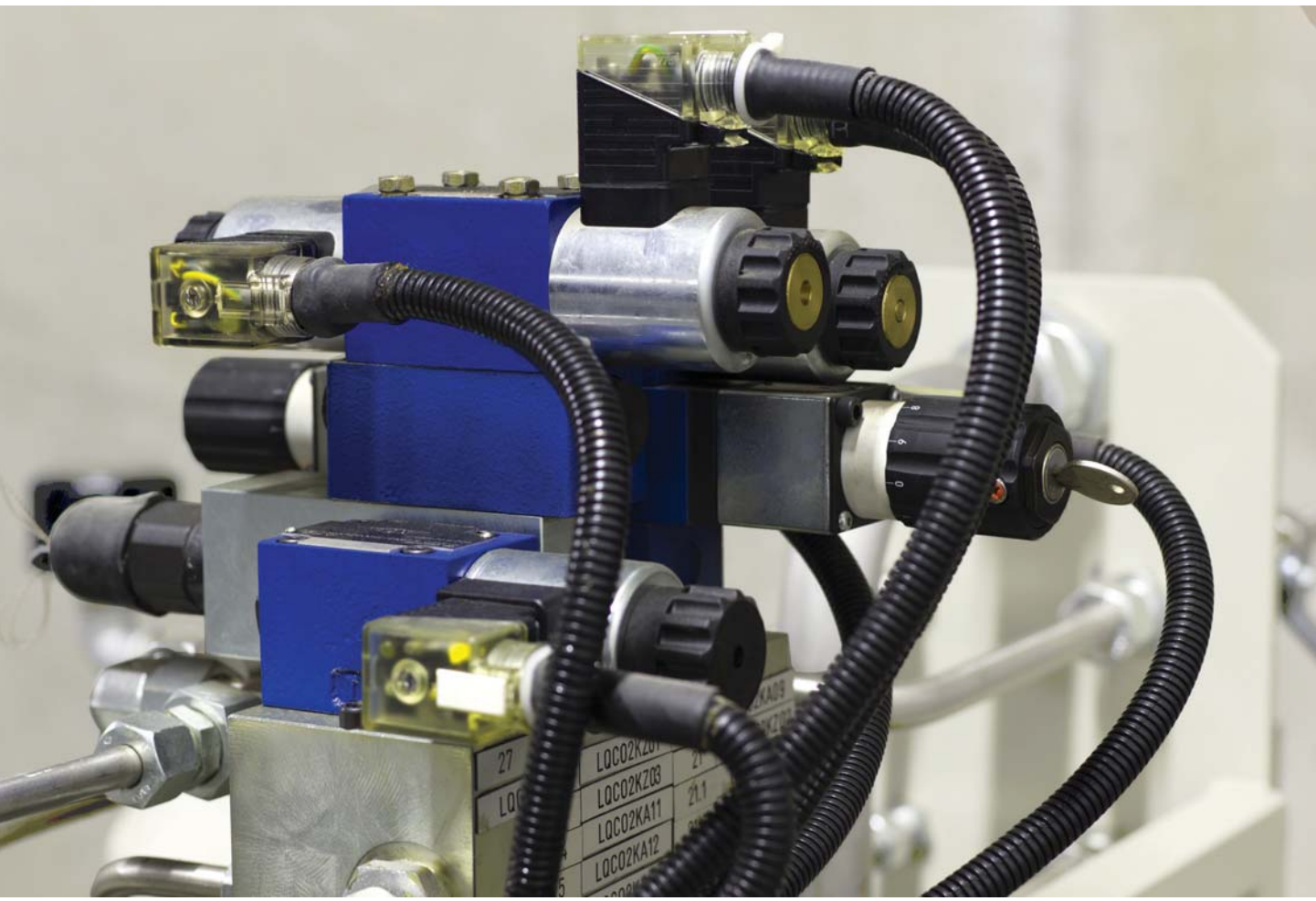
"The renamed LEE Ventus will become the eleventh production group for The Lee Company and the fourth member of the Electro Fluidic Systems (EFS) division," he added. "Our customers will now have even greater performance range and precision control of pressure and flow conditions in both liquid and pneumatic applications."

COURTESY THE LEE COMPANY

Executives from The Lee Company, LEE Ventus (formerly TPP Ventus Ltd.) and TPP Group sign the agreement making LEE Ventus part of The Lee Company. Shown are (left to right) Bill Lee, president and CEO of The Lee Company Inc., Tom Harrison, managing director of the newly named LEE Ventus Ltd., and from the TPP Group Keith Haddow, financial director, Sam Hyde, CEO, and James McCrone, head of business operations.

LEE Ventus will continue operating in the UK, becoming The Lee Company's first international production unit.

James McCrone, head of business operations at TTP Group, commented, "We're delighted with this successful outcome for TTP Ventus as it enters an exciting new phase in its growth. The Lee Company's established leadership in precision fluidic control and their global sales reach makes them the ideal acquisition partner." **P&M**



2023 Fluid Power Market Outlook: **SLOWING GROWTH CYCLE AHEAD**

The slower growth trends forecasted for 2023 will provide opportunities for manufacturers to catch up and potentially ease supply chain pressures.

by Sara Jensen

Positivity has been the general sentiment for the fluid power industry in 2022. Strong demand from the various markets served by hydraulic and pneumatic components, such as construction machinery and manufacturing, kept order and shipment totals in growth territory for much of the year.

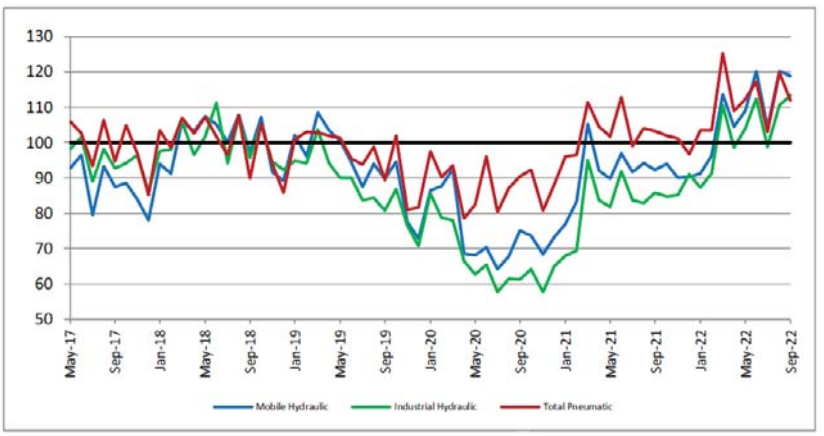
The National Fluid Power Association's (NFPA) industry data for September – the most recently available at the time of publishing – showed continued growth for shipments of pneumatics, hydraulics and total fluid power on a 12-month moving average. This was a common trend in NFPA's monthly industry data reports throughout the year.

However, as we head into 2023 some of this positivity seems to be waning due to inflation and interest rate increases as well as global factors causing uncertainty about the economy. Growth for 2023 is expected to be lower, but this does not necessarily spell trouble for the fluid power industry or the greater economy.

During an economic webinar hosted by NFPA, Patrick Luce of ITR Economics emphasized several times that while a recession is ahead, it will be a mild, cyclical one. Growth will be slower in the coming year, but it will still be growth.

He noted it is important to put the forecasted trends for 2023 into perspective as the declines will be nothing like those seen in 2008, and the past 2 years were periods of robust growth as the global economy returned to a semblance of normalcy after the onset of the COVID-19 pandemic.

There are of course various factors which could alter forecasts and which could directly impact the fluid power industry, but the consensus is 2023 will be a period of slow growth followed by higher growth trends in 2024.



NATIONAL FLUID POWER ASSOCIATION

Shipments of pneumatic and hydraulic components and systems continued their growth trend in September 2022.

U.S. and Global Economic Factors

Many U.S. and global indicators are showing a trend to slower growth in 2023 said Luce. Industrial Production for both the U.S. and the world are trending toward what he referred to as a soft landing in which slow growth will occur but contraction is not expected during the business cycle.

Mixed signals are coming from various parts of the world. Australia, Brazil and China are among non-U.S. trade partners with indicators showing a rising growth trend while other markets such as Canada and the Eurozone are facing declines. For the latter, the energy crisis has the potential to cause some serious impacts.

When it comes to the U.S. economy specifically, Luce said it is important follow the data and not the headlines. Despite some news sources saying the economy is collapsing and Americans believing this is true, he said third quarter 2022 GDP reached record high levels. The quarter saw growth in personal expenditures and exports, both of which are good for the economy.

Inflation is a concern for many. Luce said the economy has entered a disinflation trend from a macro perspective and deflation is occurring with many commodities, such as copper and steel:

Disinflation = price growth is slowing.

Deflation = prices are going down.

This easing of commodity prices will benefit manufacturers of all types by helping to lower their input costs.

There are issues facing the U.S. economy such as the labor market. Finding and paying workers has been challenging for businesses. However, the rise in wages which has occurred due in part to the tighter labor market has benefitted consumer spending and thus the economy.

Signals of cyclical decline are showing for the U.S., however the floor is not going to fall out from underneath us. Luce pointed out these signals existed before the war in Ukraine or the Federal Reserve's interest rate increases.

Further interest rate increases have the potential to disrupt the forecasted trends, although the impacts happen asymmetrically throughout the economy he said. The housing market is already feeling the effects by negatively impacting affordably due to higher mortgage rates. But when it comes to the broader macro economy, it takes more time for the effects of higher interest rates to be felt said Luce and would be closer to the 2024 timeframe if they were to cause a disruption of any type.

How Will Fluid Power Fare?

The fluid power industry and the markets it serves will follow the slowing growth trends expected in the greater economy. Based on current economic conditions, ITR is forecasting 2022 to end on a growth rate of 16.1% and 2023 to dip to -1.8% before rising again in 2024 to 6.2%.

Luce noted there has been more upside movement for hydraulics than previous forecasts likely due to the improvements in supply chain conditions which have slowly started to take shape. This and continued business to business spending have benefited the fluid power industry in 2022. Hydraulic shipments are expected to end the year at 17.7% and those for pneumatics at 7.0%.

Fluid power component manufacturers have reported positive results to date for 2022, reflecting the data from ITR. In August, Danfoss raised its outlook for the year based on its 6-month growth performance. The company noted in a press release on the subject the Danfoss Power Solutions business achieved significant growth during the first half of the year. Danfoss said it expects further sales growth for the second half of the year.

More recently, Parker Hannifin reported a 12% sales increase for its fiscal 2023 first quarter which ended September 30, 2022. The company grew orders in all of its business segments during the quarter, and is expecting fiscal 2023 organic sales growth to be in the range of 4.5-7.5%

After such high growth rates in 2022, both hydraulics and pneumatics are expected to dip in 2023 before rising again in 2024. Hydraulics are forecast to achieve a growth rate of -0.7% in 2023 and rebound to 7.8% in 2024. Pneumatic shipments in 2023 are forecasted to reach -2.1% and 5.3% in 2024.

Heavy Equipment Demand Will Soften

Of the many markets served by fluid power, mobile equipment is one of the largest and has been particularly beneficial for the

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Strong demand for construction and other heavy equipment has benefited the hydraulics segment, though a mild decline is expected in 2023 for the construction equipment market as residential construction weakens.

hydraulics segment due to strong demand for construction equipment, agricultural machinery and other heavy-duty vehicles.

The mobile equipment market has experienced strong demand over the past 2 years with the growth of infrastructure projects around the world and the ongoing need to feed a growing population as well as deliver goods. As such, several OEMs have reported positive results to date in 2022, signifying the strength of these markets.

For instance, our colleagues at *Construction Equipment* report construction and mining equipment OEM Komatsu had a 25.3% sales increase during the first half of its fiscal year. Also on the construction and mining side, Volvo Construction Equipment reported a 23% increase in sales during the third quarter compared to 2021. The company said every market outside of Europe and China saw high levels of activity and strong growth.

Agricultural machinery, another strong mobile hydraulics market, has remained in relatively positive territory during 2022. Equipment manufacturer AGCO reported record net sales in the third quarter; sales were up 14.5% due to strong demand from North and South America. The company said its North American sales for the year are up about 43% on a year-over-year basis.

The Association of Equipment Manufacturers' (AEM) October Tractor and Combine report showed double-digit gains for combine harvesters during the month but total tractor sales down in both the U.S. and Canada due to a decline in sales of sub-40 hp tractors. Growth was achieved though in all tractor segments above 40 hp, and total U.S. ag equipment unit sales in October 2022 remained above the 5-year average for the third month in a row.

Similar to the rest of the economy, these and other markets served by fluid power are expected to see slower growth trends in 2023.

Mild contraction is expected in 2023 for the construction equipment market, said Luce during the NFPA webinar. It is an interest rate sensitive industry and is feeling some impacts from the effects rate increases are having on the housing market which is softening demand for construction equipment. But as a counterbalance, he said while single and multiunit housing is slowing non-residential construction is entering a rising trend which will benefit the market. Construction is forecast to end 2022 at a growth rate of 12.9%, dip to 0.3% in 2023 and rise again in 2024 to 5.5%.

Agricultural machinery is also expected to experience a mild decline compared to previous cycles said Luce. Demand and existing backlog will be a factor for this market as well as the fact that food is a non-discretionary item and therefore trends differently than the macroeconomy. This segment is expected to end 2022 at a growth rate of 3.4%, achieve growth of 5.1% in 2023 and grow again in 2024 at 8.5%.

Material handling has benefited from the growth in e-commerce and distribution as well as the efforts to onshore here in the U.S. and other parts of the world. Interest rate increases are a factor for this segment, causing companies to re-evaluate their capital expenditure spending. Like the other segments, slower growth is anticipated but it is expected to be a very flat rate of change said Luce.

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Easing of Supply Chain Pressures

With the slowing growth trends coming in 2023, it is anticipated supply chain pressures will ease. Already there has been some indication of improvements; Luce said both the global supply chain pressure index and the Purchasing Managers Index (PMI) – which has about a 7-month lead time and is a key economic indicator – are showing further easing of supply chains.

Although some are still experiencing long lead times, he said ITR has heard from many clients that lead times are coming down and shipping containers, especially those from the Pacific, are flowing more fluidly than they were previously.

There are of course still a lot of challenges associated with the supply chain. For example, weakness in activity coming out of Europe and particularly from Germany and Italy is expected. Much of this is due to the energy crisis the continent is likely going to face during the winter months due to the conflict between Ukraine and Russia.

But as noted previously, there are positives in the market with prices lowering for commodities and fuel which will benefit many businesses. Pricing pressures in general will be easing as the economy slows after what Luce termed the post-COVID sugar rush that caused such high demand for so many goods over the past 2 years.

Positivity is starting to show in the global semiconductor industry which will benefit an array of markets. Luce said delivery times declined by 4 days in September, the biggest drop in years.

Light vehicle and heavy-duty truck production are among the markets benefiting from the increased availability of semiconductors. Both are expected to see rising trends going forward as demand will remain at a high level and manufacturers

can now better meet it with the greater availability of semiconductor chips. Growth is expected through 2023 for both vehicle segments before entering a slowing growth phase. Luce said there will be a good ramp up of activities in these markets and if fluid power manufacturers have the ability to get into them, now is the time.

Given most chips come Taiwan currently, the U.S. Government is trying to incentivize catch up after a decades long stagnation of domestic supply said Luce. In August, President Biden signed the CHIPS and Science Act into law to help invest in more U.S. production of semiconductors as well as scientific research and STEM initiatives.

Although construction is underway for production facilities, it takes a long time to get them built and up to full capacity. So it will be some time yet before reaching the needed capacity, so businesses should not expect the CHIPS Act to benefit their 2023 or 2024 plans.

Key Takeaways for 2023

In general, from a financial and economic perspective the U.S. economy is fairing well and will continue to do so in the immediate future as consumers are financially healthy and businesses have recorded record profits, enabling them to weather inflation and higher interest rates.

The higher interest rates could pose a risk to the core markets served by fluid power, making it important for businesses to understand how they interact with those and possible exposure to any risks. But again, Luce noted the growth expected in the light vehicle and heavy-duty truck markets could help counterbalance the lower growth rates of other markets such as construction equipment.

Any risks from interest rates and further increases likely will not materialize into a macroeconomic contraction until 2024. This provides companies with time to maneuver their business and prepare for any possible economic impacts.

Luce emphasized several times during the NFPA webinar that the slowing growth cycle ahead is not necessarily a bad thing. It will provide many manufacturers and other businesses with a chance to catch their breath after working hard to meet the high levels of demand experienced since late 2020.

This period will provide a chance to ease backlogs and focus on longer term plans such as finding ways to improve efficiencies and new opportunities. It will enable companies to schedule downtime for equipment maintenance and prepare for the high rates of growth coming in 2024.

It can also be a time to focus on investing in the company, both in terms of equipment and labor.

There are aspects of the economy and various markets to be mindful of, but overall the economy is not collapsing and 2023 will provide opportunities to reset before the ramp up in activity expected in 2024. **P&M**

A Fresh Perspective On Traditional Issues

Power & Motion's annual Salary & Career Survey features a younger group facing the same engineering challenges.

by Bob Vavra

The annual *Power & Motion Salary & Career Survey* has a younger perspective in 2022 as a new generation of engineers in fluid power and electric motion control design and management are shaping the discussion.

Past surveys have tended to skew toward experienced workers. In 2021, for example, 59% of respondents were over the age of 50. In 2022, 71% of the respondents have been in engineering less than 10 years and 84% are under the age of 45. Their educational experience also is somewhat different—while 28% have a bachelor's degree and another 30% possess a post-graduate degree, 22% have an associate's degree and 18% have attended college.

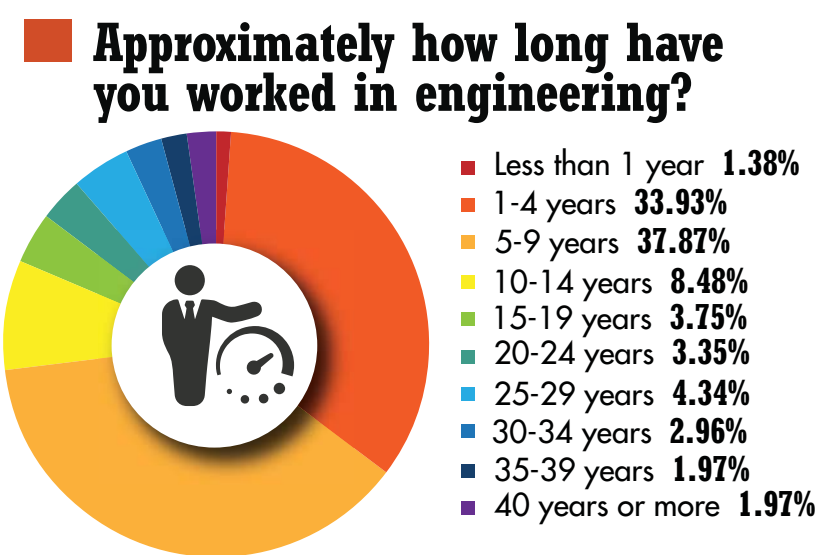
Despite the demographic differences with past survey groups, their outlook on engineering and manufacturing in a post-pandemic, economically challenged world is largely the same. They see great value in their work and in the field of engineering, they recognize the challenges of staying current with the swift adoption of digital technology and their performance concerns center on product reliability, quality and customer service.

Facing the Challenges

Survey respondents cited a wide array of business and professional challenges in the past year. While no one issue dominated the survey, the top concerns were focused on product reliability and the value of their finished products. The lingering COVID-19 pandemic and finding the right product to specify for their designs were also among the things keeping engineers up at night.

One overarching comment from respondents was the issue of time. A respondent said his challenge was "getting the adequate amount of time to get future-proof design knowledge and the willingness of management to learn and innovate and invest into technology."

The adoption of technology has been a major issue in the fluid power industry, and implementing those innovations is another challenge of both time and available skills. One respondent noted the challenge of "finding the time



What are the professional issues that keep you up at night?

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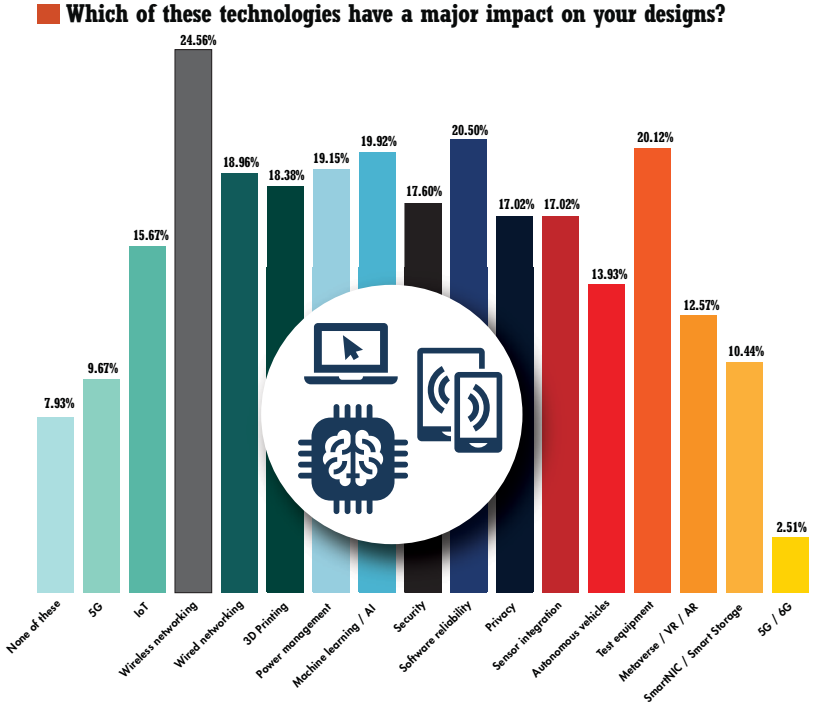
Which of these technologies have a major impact on your designs?



to educate, improve, stay current while still performing all my work duties and maintaining work-life balance and supporting my family." Another noted the "constant additional high amount of time and work parallel to ongoing tasks and prioritization of tasks."

Technologies which are impacting designs were wide ranging with wireless networking as the only one which approached 25% among survey respondents. Test equipment and software reliability were cited by at least 20% of respondents, and machine learning, power management and wired network were next on the list. One anomaly among the *Power & Motion* survey results that reflects on the younger skew of this year's survey: the recognition of augmented reality and the emerging concept of the metaverse. It was cited by 12.5% of engineers—more than

four times higher than any other result from similar surveys conducted by sister publications to *Power & Motion* within Endeavor Business Media's Design & Engineering Group.

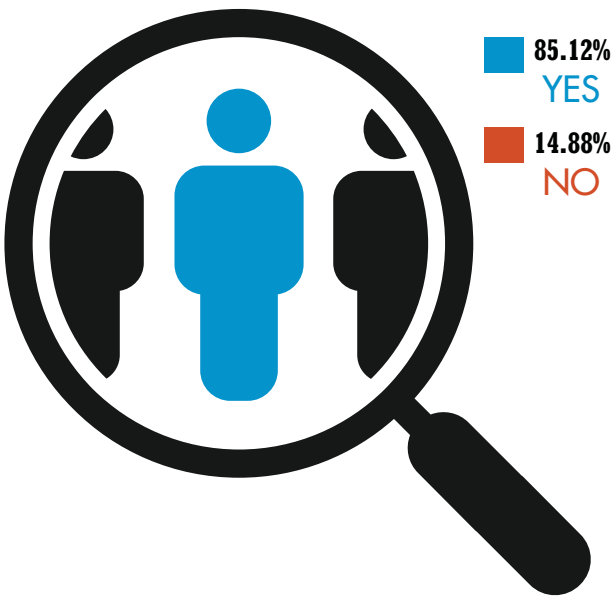
That was reflected in the comment of one respondent: "The increasing depth of engineering knowledge and ease of using recent technologies would require tech savviness," he said. "There are at least three approaches to measure tech savviness: assessing what a person knows, what a person does (or reports doing), and what a person feels (attitudes, especially tech savvy self-assessments).

"Generally, this would mean more training on hands-on experiences which is, more often than not, time consuming as well as money consuming," he added. "These efforts definitely have to be rewarded for any organization to attract good hands and meet up with the current technological demands."

Compensation and Recruitment

With a more diverse group of respondents, the levels of compensation in the *2022 Salary & Career Survey* also demonstrate a wide range. A year ago, 46% of engineers reported a salary between $100,000 and $150,000; in 2022, that number fell to 34%. But salaries above that level rose to 40% of respondents, and 16% were between $80,000 and $100,000.

Do you believe there is an engineer shortage?



The upward pressure on salaries driven by the continuing shortage of engineers is evident in respondents' views on future compensation. Salaries will continue to rise in 2022, with 71% of respondents expecting some sort of salary increase, and almost 37% expect that increase will exceed 4%. The engineers also feel well-appreciated for this work; 87% said they are adequately compensated for the work they do, and 95% declare themselves satisfied with their profession.

Finding the engineers to continue industry growth remains a challenge. The survey found:

- 85% believe there is an engineering shortage.
- 83.8% said their company is having difficulty finding candidates for engineering jobs.
- More than half of companies said they are seeking engineers with about 3 years of experience, and another 41% are looking for about 5 years of experience.
- Engineering companies are seeking a diverse group of engineering specialties. Mechanical design and power management are the most sought-after specialty, but technologies from software to machine learning to safety and security are needed as well.

Continuing Education

In the past, the challenge of staying current with technology traditionally meant attending trade shows to scope out new products and participate in seminars to get more information about innovative technologies, as well as partake in continuing education at universities or events.

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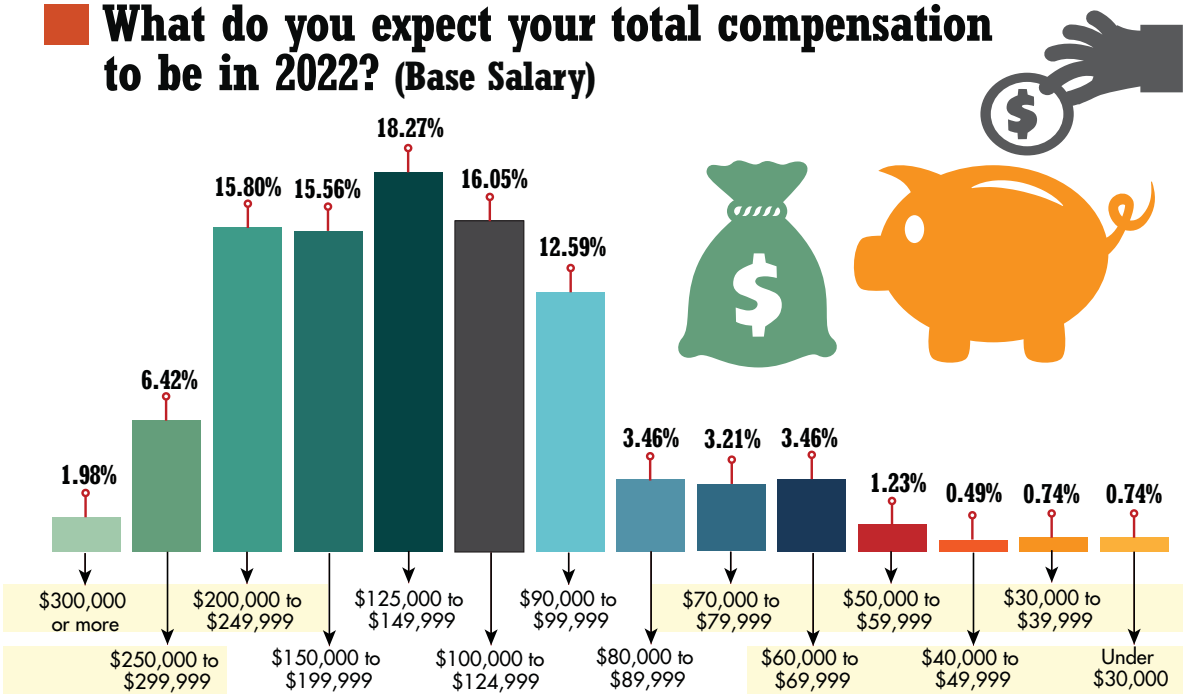
HN 8-WD | SCREW PLUG

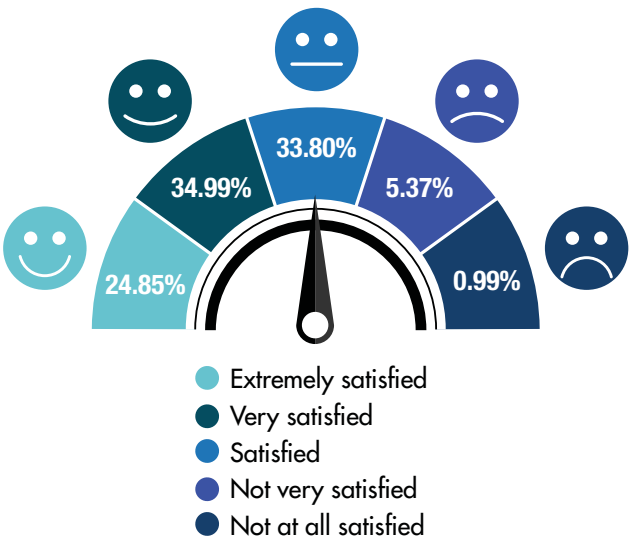
Our solution

SALARY & CAREER REPORT 2022

What do you expect your total compensation to be in 2022? (Base Salary)



How satisfied are you in your current position?



The pandemic changed the equation.

Remote sources of learning and information are in wider use among engineers in a digital age, and those resources gained even more acceptance during the pandemic. Engineering videos, white papers, webinars and seminars all were cited by at least 25% of respondents as a source for continuing education. Other in-person events, such as in-person trade shows or user group meetings, fell back during the moratorium on travel and in-person events.

In the interim, more than 35% of respondents said their company paid for registration at online trade shows, more than 28% pay for engineering association dues and engineering textbooks, and 26.6% have paid for college tuition.

That interest in continuing education comes at a time when engineers recognize the need to continue to adapt their knowledge to changing technology. "A lot of engineering industries adjusted to the decrease in demand during the pandemic and are now going back to full operation," said one respondent. "With that, they have the opportunity to either continue to use the same technology or venture into new ones."

That quest will continue, added one respondent, "because human progress will never stop, and human progress will never happen without progress in engineering." **P&M**

WEBINAR: A Deep Dive Into The Salary Survey

ON Nov. 21, editors from *Power & Motion* and sister publication *Machine Design* conducted the webinar 'The State of Engineering in Fluid Power and Motion Control.' The editors discussed the results of the *2022 Salary & Career Survey*, examined some of the more interesting trends revealed by the data and looked at how this data will impact the industry and topics editors will follow in the coming year.

Bob Vavra, senior content director for *Machine Design* and *Power & Motion*, moderated the discussion with Rehana Begg, senior editor with *Machine Design* and Sara Jensen, technical editor for *Power & Motion*. The discussion provided further details and examination of the reader survey, how it compares with past years and how it relates to other issues facing the engineering industry.

Register for the webinar to watch it on demand at: powermotiontech.com/21250187.

Danfoss Remains Invested in Hydraulics

Danfoss Power Solutions President Eric Alström discusses benefits of the merger with Eaton to date, as well as the continued growth potential he sees for hydraulics.

by Sara Jensen

Danfoss Power Solutions first announced it would acquire Eaton's hydraulics business in 2020. The acquisition was completed in 2021, bringing together two of the industry's largest hydraulics companies. Danfoss made the acquisition because of the growth opportunities it sees in hydraulics and the complementary

nature of the two companies.

In September 2022, the first Danfoss Distributor Meeting was held since the merger. During the event company executives provided insight into how the companies have come together under a single brand, and what work yet needs to be done. They also offered a look at current market conditions and the various technological areas in which the company is investing.

Power & Motion had the opportunity to speak with Eric Alström, president of Danfoss Power Solutions, while at the distributor meeting about how things are fairing since the acquisition of Eaton as well as current company and industry trends.

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

Power & Motion (PM): How has the merger since the acquisition of Eaton been going and what still needs to be done?

Eric Alström (EA): I'm immensely proud that [from] day one, Aug. 2 last year (2021), we started working together without any IT glitches. We had set a target to try to have the new organization up and running Jan. 1 (2022). And bringing two $2 billion companies together was very ambitious, but I'm really proud of the team that we actually managed [to do so]. So, Jan. 1 all of our employees knew to whom they report, they knew the new structure, the new organization, and we actually had financial transparency as of Jan. 1 this year. It was a really aggressive target to try to be done with all that by January 1, in just five months, but we did [it]. What remains to be done now is that some of the IT systems, the backbones, need to be homologated and so we're embarking on one ERP, which we already started in Danfoss. We've invested significantly in that and now we're bringing all Eaton or the whole legacy Eaton organization onto that one ERP structure. So, it's basically IT homologation that remains to be done. Other than that, we are operating as one new, cool business.

PM: What have been some of the biggest benefits you have seen from the merger so far?

EA: For Danfoss it was always a dream to have fluid conveyance. It was always a dream to be in industrial. But it's awfully hard to build that organically, the massive investments and know-how you would have to build from scratch, it becomes very difficult. And so that's of course, two major assets that we acquired. It's not just the product, it's the people behind those assets that made a difference. But then it's also the geographical reach, and what you have witnessed here [at the distributor meeting], a fantastic distribution network.

And we want to keep and nurture this distribution network, and not downsize it or anything like that. This industry is big, there is enough business for everybody out there. Those are sort of the big, tangible things that make us super excited about this. And also, maybe then if you turn it around from a customer perspective, it is this significantly larger product portfolio and that we have a better network, especially for distribution partners, but also our OEMs can benefit from a bigger product portfolio. And additional capacity available.

PM: You were saying during your presentation Danfoss is really bullish on hydraulics. Why is that and can you go into what makes hydraulics such an important industry to be in?

EA: Absolutely. If you look at the industry growth over the last 20 years, it's around 2.5-3% annually, but actually, over the last 10 years or so it's accelerated and become a little bit more. And it's driven by many different things such as ag and food production in an increasingly populated world and there's simply more to be done there. Also, in terms of thinking about how to do it [while] being more efficient and more productive, those are things that are at the top of the agenda for us. But also, construction, there is a strong trend towards urbanization, and the machines that our customers produce are used in those instances. Now, electrification is coming, you've seen it, it's coming in a big way. But there are many machines where power and energy densities simply speak in favor of hydraulics. There is no solution to batteries as an energy source, putting it on a tractor — where are you going to put it? Basically, [you] put it behind on a trailer and then drive around; that's not going to work. But that said, there's also electrohydraulic solutions. And regardless if a machine becomes electrified or not, it will still have hydraulic content because a lot of the work functions that you're doing, you can't package electric motors, for instance. So, maybe the diesel engine goes away as a power source and you will have a battery pack and electric propulsion, maybe, but a lot of the functions in machines will remain hydraulic for the foreseeable future. It is important to recognize there is nothing harmful for the environment with hydraulics as long as we don't leak oil, which we tend not to do nowadays; it used to be a big issue in the past. It really isn't anymore. So

actually, hydraulics is as green as anything else, if you look at it from that perspective, without a diesel engine.

PM: Are there areas of the hydraulics market you see as having better growth opportunities versus others?
EA: I think you will see this steady growth, just driven by economic growth, frankly. Our industry is very cyclical, also, so when there is a downturn farmers typically don't buy machinery, governments stop spending on infrastructure and so forth. So, it will go up and down a little bit, but over the longer-term perspective—like we like to think at Danfoss a little bit more long term—we still see tremendous growth for years to come. And not just in off-highway machinery, but also hydraulics for industrial solutions.

PM: You were mentioning during your presentation about regionalizing Danfoss' supply chain, could you go into what the company is doing and the benefits?
EA: I think it's been a challenge for everybody in most industries these past two years, of course amplified by the pandemic. But for a while now we have recognized that we're tying up a lot of inventory, which means a lot of cash and long supply chains, and we can put that cash to work in a better way if we pull supply chains closer. That's just the financial aspect. The other one is supply chain risk. Things happen when you ship [products] over long distances. And we've had so many instances over the past two years, whether it gets stuck in customs or there's a hurricane somewhere and you can't ship out of a certain port, those things happen. So, it's just become very prudent for us to pull everything closer. We're just doing it step by step by looking at basically, which are the components that are costing us the pain, and we take them one by one, and we localize them, many times by having to invest locally, finding new suppliers locally. So, that's not done overnight.

PM: Are there any specific areas that have been the biggest pain points or where you've seen the biggest challenges regarding the supply chain?
EA: If we put semiconductors [to] the side because that's a very specific issue driven by tremendous demand in all industries, we've had other supply chain shocks in terms of container freight, where demand rose exponentially and therefore prices

S. JENSEN

Eric Alström spoke at the 2022 Danfoss Distributor Meeting about the strength of the company and its offerings since the merger with Eaton's hydraulics business.

rose. Also, availability of containers became difficult. Electronics is not such a big issue for us, because part of our business model is to fly those components; they're small, they're not heavy. That's how we calculate the business case when it comes to electronics. But heavier stuff like end caps [and] housings, these are cast iron parts that are being hauled between regions. That's where we focus our attention now.

PM: Are you seeing any sort of reprieve to the supply chain issues? Do you anticipate any alleviation to the supply chain challenges?

EA: I think it's easing a little bit. We see that across the board. We don't have to buy semiconductors on spot buy like we did this past year, which can be extremely costly. We sometimes had to pay 50 times more than our serial production price that we normally would pay because that was the only way of keeping our customers running. So, I think that's easing up and I also think that the availability of containers seems to be easing up, not because there's less demand necessarily but I think there's simply more containers available now. Also some of the things that took a lot of time because of the pandemic where people couldn't interact is sort of behind us now. We're still careful, because COVID is still around everywhere, but ports is a good example [where] during the pandemic a lot of extra precautions were taken that actually kind of choked the material flow through the ports. And that's eased up a little bit, so in general it is better, but these times will come again, driven by the cyclicality. So, we're still going full force on regionalization and localizing our supply chain.

PM: Changing topics, I know workforce development is an industry-wide challenge. Is there anything in particular Danfoss is doing to help with that and to attract people into fluid power or into Danfoss specifically?

EA: Yeah, great question because like many people say, it's [fluid power] perhaps for engineers coming out of the universities not the first industry they think about. When we put what I call the Danfoss box on the table and open the lid, they have a chance to look inside and see we're working with really cool things like software, advanced algorithms for autonomous solutions [and] connectivity. We supply hoses for data centers; our

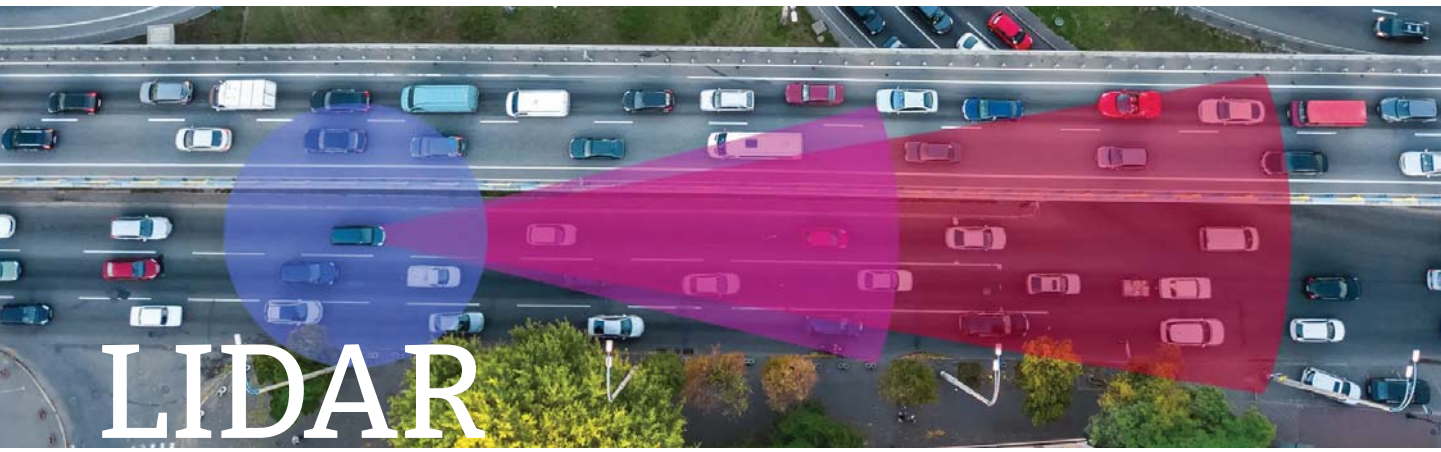
colleagues in climate solutions are doing the entire cooling system, reaping excess heat and heating family homes with excess heat from the datacenter. This is just one example. And people say, 'Wow, this is actually pretty cool.'

And the other thing which is very high on our agenda is that we aspire to be a very green company, and that resonates with Generation Z. University students coming out [of school] and younger employees, frankly, feel that is as important as having cool technologies. And so, we're really emphasizing that. We're also working together with universities where we are present. Just one example here in the U.S. is Iowa State University, which is right next door to our Ames campus. It's a great partnership over many years, where we've funded some of the research labs, and of course the students all hear about Danfoss and that's been great for us. But we are also doing some bold moves through what we call the Danfoss Innovation Accelerator in Cambridge, Mass. So, it's basically at MIT, where we have a team, and by opening the Danfoss box there we've been really, really fortunate to get a lot of great people actually joining the company there. And that's sort of the academic side of things or administrative positions. When it comes to our hourly employees, we're also doing things to make it attractive to come to Danfoss.

There's a wide range of things we're trying to do to make us attractive. In Europe, all of the offices are being converted from traditional high wall partitions to an open landscape where you don't have your dedicated desk. I don't have an office; I just go and pick a desk and sit next to any employee who happens to be in the office that day. But we're also doing other things such as having soft drinks available, water, coffee, snacks, healthy snacks that we provide for employees in those offices. And that has been a great way of bringing people in, because when they come to the interview, and they say, 'Well, this is not a stodgy old-school hydraulics engineering company. It's a pretty progressive company.' And we're going to embark on doing that here in the U.S. as well now.

PM: To wrap up our conversation, what technologies or trends are you most excited about either that are happening now or that you see coming in the future?

EA: That's a great question, because there's so much, so where do I start? But I think what excites me the most is that we are going to invest and keep investing in our core. And from a lot of the partners that I spoke to here [at the distributor meeting], they are super excited, because maybe the previous owner of the hydraulics business didn't see it as so strategic or didn't invest so much for the future. So now people are seeing the tremendous investments we are making in the core [business of hydraulics]. But also, many of the new things that we're doing with autonomous solutions. On-highway autonomy is a very difficult problem to solve, the liability and all those things. In our industry [mobile off-highway], we're usually in a controlled environment so it's much easier to solve those issues. I think we can do things in our industry actually a little bit quicker and be even more progressive than perhaps even on-highway automotive. That's what I mean with the Danfoss box, when we show all these cool things, people get excited. I'm pretty excited about everything we do. I mean, it sounds a little bit odd, maybe but I really am because we're not only changing Danfoss but I think we're actually changing our industry. **P&M**



LIDAR Enters the Digital Age

A visualization of the range capabilities possible with Ouster's digital lidar technology.

The transition from analog to digital lidar sensor technology brings a range of benefits for autonomous systems.

by Sara Jensen

Light detection and ranging, better known as lidar, sensors detect ranges by measuring the time it takes reflected light to return to the receiver. This capability makes them a vital component for object detection, mapping and a variety of other use cases in a range of applications.

Historically, lidar has been an analog technology, said Angus Pacala, CEO of Ouster, in an interview with *Power & Motion*. But like other sensing technologies such as cameras or accelerometers, digital versions are entering and transforming the market. Ouster was founded in 2015 to bring digital lidar technology to the market.

"We've taken analog lidar and integrated all of that capability onto a CMOS digital chip, [which is] a fantastically complex but low cost, power efficient, and incredibly small digital chip that does everything that a traditional analog lidar does," he said.

This brings a range of benefits including a reduction in cost and form factor. "All the things you associate with digital technology are being brought to lidar in essence."

Key Benefits of Going Digital

According to Pacala there are three key benefits to digital lidar technology like Ouster's versus analog versions:

- affordability,
- performance,
- and flexibility.

The affordability benefit comes from the fact a complex system is integrated into a single silicon chip. Thousands of discrete analog components are put onto a single chip which combines "all of the logic and intelligence of an analog lidar sensor into the digital logic on that chip, and all the photo sensing and pixels as well," explained Pacala.

He equated it to the transition from film to digital cameras—instead of a large, expensive camera containing several components digital versions are tiny devices integrated into every smartphone for a minimal cost. Essentially, he said it is affordability through simplification.

Also benefitting affordability is the fact silicon chips are a high-volume, low-cost technology. Silicon CMOS (complementary metal oxide semiconductor) chips are used in so many applications today, every phone and every digital camera, and thus produced at an extraordinarily high scale with trillions manufactured every year said Pacala.

Flexibility benefits come through size, weight and power. "That's something that I think is often discounted as a core attribute to products, but when things get smaller, more power efficient, more space efficient, they become fundamentally more flexible," he said.

He again equates it to digital cameras—they can go everywhere because of their small size and affordability which is the same case for Ouster's digital lidar. And this flexibility was achieved because of the company's ability to integrate so much technology onto a small form factor.

The final key benefit of digital lidar is the improved performance possible. CMOS digital technology has greatly advanced over the past decade which has enabled a number of new

technologies available today, including the introduction of digital lidar.

A Range of Applications and Industry Partnerships

Technological breakthroughs in algorithms and chip design have enabled Ouster to develop digital lidar and apply it to a wide range of applications and industries. However, the broadening scope of what digital lidar can be applied to presents challenges as well said Pacala.

The company's technology is being applied in agriculture, construction, smart infrastructure, robotaxis, autonomous vehicles and more. "The breadth creates challenges because customers require unique capabilities in each of those sub-markets," he said.

Perhaps a customer in the agricultural industry wants the lidar sensor to aid plant analysis whereas long-range collision avoidance is more important for robotaxis and consumer vehicles. Understanding those varied needs and creating a product which can meet them has been an important aspect of Ouster's technology development efforts.

"The major challenge we have overcome is building a comprehensive portfolio of products that can do it all, that can really play across all these markets," said Pacala.

Aiding Ouster's ability to create lidar sensor products which meet various application requirements are the many industry partnerships the company has formed. Pacala said the company sees itself as being at the forefront of automation technology as lidar powers the eyes of autonomous machines in various segments such as automotive and industrial. Because of that, he said Ouster gets to work with some very interesting companies.

For instance, in the agricultural space, the company is working with Blue White Robotics which is developing autonomous tractors. This application has unique challenges such as understanding plant phenotyping while also doing collision avoidance with their tractors said Pacala.

The company's robotaxi customers, on the other hand, are concerned with all-weather highway driving and understanding how lidar sensors perform in different weather conditions such as snow, rain or extreme heat.

By working with a large number of industry partners, Pacala said Ouster is able to improve its technology for each of the sectors it serves.

Going forward, Pacala said he expects lidar to be the dominant sensing technology in autonomous robot applications. Lidar is a good fit for these and many other applications because the data these sensors collect is "so rich, so reliable and so trustworthy," he said. "You can literally trust your life on the data that a lidar sensor produces. That's how good it is and how consistent it is across environments."

Pacala said the challenge is to get the technology into the hands of real production, everyday users which requires making it affordable, manufacturable, and quality controlled in addition to providing performance advancement which is Ouster's mission. "And I think we're well on our way," he concluded. "Our mission is to allow digital lidar to be the dominant sensing technology across all of these autonomous systems." P&M

The OS1 is Ouster's mid-range digital lidar sensor capable of providing high resolution object detection.

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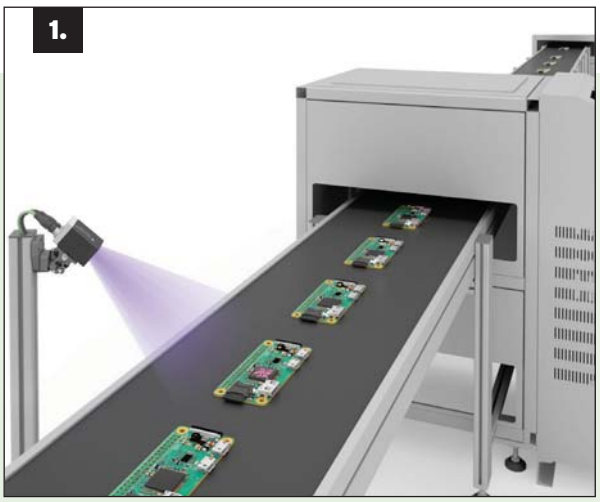
> "You can literally trust your life on the data that a lidar sensor produces. That's how good it is and how consistent it is across environments."
>
> —Angus Pacala



1. AI Vision System Learns as it Scans

The VISOR Object AI independently learns distinguishing characteristic features based on a few images of the object to be detected. Even strong process and product variations such as fluctuations between batches, contamination, reflections, changing shapes or varying 3D orientation can be taught with just a few mouse clicks. It then is able to reliably recognize the objects appearing in front of the lens and assign them to different classes. Once a classification has been taught, it works reliably and robustly, without the user having to worry about suitable detection rules and parameters, as is the case with classic, rule-based image processing (e.g., using pattern comparison, contour or contrast recognition). Because the VISOR Object AI is capable of learning, it typically only needs around five sample images per object class to sufficiently achieve a stable detection process. The AI algorithm is implemented in the sensor itself and therefore does not require any network or cloud connections.

SensoPart
powermotiontech.com/21254780

2. Safety System Switches Control Gate Access

The IDEM Skorpion rotary trapped key systems control access to running equipment with locks and rotary keys. To disable power to machinery and unlock a gate, the key is turned and removed from the control switch. The released key is then inserted into the gate access module to unlock the gate. Standard and solenoid-locking control switches and associated gate sets (sold separately) are available for one to three stations and provide mechanical safeguarding in partial or full body access versions. They are rated for safety applications up to PIe/Category 3 according to EN/ISO 13849-1.

AutomationDirect
powermotiontech.com/21254781

3. Digital Wrench Can be Connected With Wi-Fi

The OPEXplus digital torque wrench can measure both the torque and the angle of rotation. It covers a range of torques from 3 to 800 Nm, and it transfers the tightening results to any IT system without the need for additional control. OPEXplus torque tools are recognized in networks via the embedded Wi-Fi module. When a tool in an assembly line is changed, the module can simply be plugged into the new screwdriver. The supplied software allows parameterization via a hotspot, the customer network or a serial interface. The intelligent OPEXplus transmits the tightening results with a tightening curve, as well as maximum torque and angle of rotation, directly to any of the user's IT systems without the need for additional control.

Bosch Rexroth
powermotiontech.com/21254782

4. DeltaV Update Helps Improve Operator Performance

A new version of the DeltaV distributed control system (DCS) helps plants digitally transform operations through improved production optimization and enhanced operator performance. New software designed to reduce the burden of IT support and modernization spend coupled with expanded analytics will help increase flexibility and speed to market and drive operational improvements. Users can increase their speed to market through the DeltaV Spectral Process Analytics Technology (PAT). The DeltaV Spectral PAT integrates two analytics solutions with the DeltaV DCS for real-time closed-loop control. This tighter control helps reduce human error and increase speed to market of quality therapies by moving plants closer to continuous manufacturing of drugs.

Emerson

powermotiontech.com/21254783

5. Safety Air Gun Provides Power and Control

The TurboBlast Safety Air Gun is capable of producing up to 23 lb of force with a simple press of a button trigger. It is a solution for blowoff applications requiring maximum force such as removing stubborn or heavy debris like slag and flash, part drying or cooling from a distance, as well as heavy-duty cleanup in busy facilities. The TurboBlast features a cast aluminum handle with a rugged elastomer grip that's not only comfortable but UV resistant, chemical resistant, and insulated from heat or cold. The light touch activation trigger creates a powerful blast of air and also includes a "Dead Man's" grip that turns air off if the air gun is dropped. All models include an integrated nozzle guard for safety. Models are available with an adjustable gate valve to control blowing force on the fly, or without the gate valve.

EXAIR

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Advertiser Index

The Intersection of Hydraulics and Electrification

Sun Hydraulics' ENERGEN™ cartridge valve converts hydraulic flow to electric energy, benefiting efficiency and electrification initiatives.

by Sara Jensen

In September 2022, Helios Technologies Inc. announced the launch of the ENERGEN™ cartridge valve from its Sun Hydraulics brand. The ENERGEN™ valve is designed to convert hydraulic flow into electric energy.

Development of the ENERGEN™ valve came from the company evaluating how its core business, cartridge valve technology, can meet the future state of the hydraulics industry said Steven Meislahn, global director of engineering, Sun Hydraulics, in an interview with *Power & Motion*. "The opportunity was solidified when evaluating the intersection of electrification, battery-electric vehicles and a drawback of hydraulics which is energy loss associated with pressure drop," he said.

The rise in electrification and a desire for more energy efficient solutions is bringing new design opportunities to the hydraulics market and will be a focus for Sun Hydraulics going forward.

In the following Q&A with Meislahn, he explains how the new ENERGEN™ valve technology works as well as potential applications and opportunities within the field of electrification.

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

Power & Motion (PM): Can you provide an overview of how the valve works, and how it converts hydraulic flow into electric energy?

Steven Meislahn (SM): The first application of ENERGEN™ has the functionality of a check valve which is designed to allow hydraulic flow in a certain direction within a hydraulic circuit. When the poppet comes off the seat allowing flow, hydraulic fluid passes through the valve across a turbine. The turbine is connected to a generator, which converts the mechanical flow into electrical energy.

PM: What is the benefit of being able to convert hydraulic flow to electric energy?

SM: Sun has been in discussions with potential customers looking at ENERGEN™ for three different applications. First, there are applications where hydraulic power is sufficient, but electrical energy is not. An example of this is attachments at the rear of a tractor. A new attachment may require electrical power that can exceed what's available on an older tractor.

Second are applications where the designer cannot or does not want to run a wiring harness. Sometimes regulatory restrictions do not permit this, such as maintaining electrical isolation in an aerial work platform that works on electrical power lines. Another example is demolition machines that would require extensive guarding of the harness to protect it.

Last, machines can utilize ENERGEN™ to recoup energy that would otherwise be wasted. This feature would allow for regenerative energy into battery operated equipment by converting lost backpressure of a hydraulic system through the simple act of gravity lowering.

The initial ENERGEN™ will have the ability to generate 250W of peak power at a flow rate of approximately 30 GPM.

PM: Are there other benefits this new valve technology provides?

SM: An interesting opportunity ENERGEN™ creates is to have isolated electrical circuits. With its own power source, ENERGEN™ could be paired with sensors and a controller such as Sun's XMD to be a self-powered, closed loop valve controller that does not need to be connected to a machine's main power source; it [would] just need hydraulic flow.

PM: In which types of applications can this technology be utilized?

SM: Sun is developing ENERGEN™ to be used in applications up to 5,000 psi of pressure. The initial ENERGEN™ will have the ability to generate 250W of peak power at a flow rate of approximately 30 GPM. It is envisioned that ENERGEN™ will evolve into a family of products that can meet a wide range of applications by mixing and matching turbines and generators.

PM: How is your company seeing the trend toward electrification progressing, and what impacts are you seeing on hydraulic systems and components?

SM: Electrification is large part of Sun's new product development, and it's progressively [more] rare for a product to be developed that is purely hydromechanical.

PM: What opportunities, and challenges, are you seeing from electrification?

SM: There are countless opportunities to use electrification to improve control, efficiency and ease of use. Electrification is also opening the doors to digitization, which will only allow the trends to continue by leveraging technologies such as machine learning and artificial intelligence.

A challenge is that product lifecycles in electrical products is much different than hydraulic products...where a hydromechanical product may not change for 20 years, an electrical product is nearing obsolescence after about five years.

PM: How does this new ENERGEN™ technology fit in with evolving customer needs for electrification-related solutions?

SM: ENERGEN™ is a product that sits squarely at the intersection of hydraulics and electrification. As the need for electrical power in hydraulic systems grows, so will the importance of ENERGEN™. P&M

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