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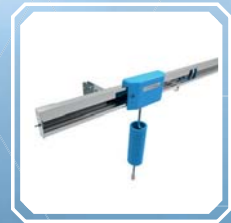


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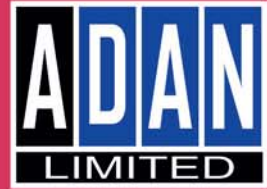






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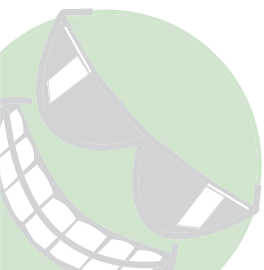


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## What Role is Automation Playing in Fluid Power Systems?

Various forms of automation are entering the industries served by fluid power, bringing with it new technologies and capabilities—as well as new design challenges. But how exactly will hydraulics and pneumatics be impacted by automation?

A greater integration of electronics, particularly sensors, is a key change taking place. While not a new phenomenon, technology improvements and increased interest in efficiency and accuracy—both of which can benefit automation—have helped to grow the pairing of electronics with fluid power components and systems. And with the rising use of electronics has come the ability to increase the connectivity and communication between systems, which is again beneficial for the implementation of automation.

Because hydraulic and pneumatic components are becoming more electronic and software controlled, autonomy can be

added explained Peter Bleday, head of Autonomy at Danfoss Power Solutions, in an interview with *Power & Motion* (see p. 32). That digital control is a key interface between the automation system and the parts of the machine which do the work—which are typically powered by hydraulics and pneumatics.

The needs and capabilities of automation, and its impacts on fluid power systems, will continue to evolve as the technology develops further to improve safety and efficiency, as well as overcome labor challenges in various industries. Throughout this issue, you'll find articles which look into the ways automation is coming together with fluid power systems, starting with our cover story on p. 10 reviewing a recent survey we conducted of our audience to learn how they are being impacted by the implementation of fluid power.

What impacts are you seeing? How do you think the fluid power industry could benefit from automation? Let us know! **P&M**

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# Danfoss Forms New Partnerships to Enhance Automation Software

Integration of technology from Swift Navigation, Bonsai Robotics and HARD-LINE into the Danfoss PLUS+1 Autonomy software will enhance the performance of autonomous machines.

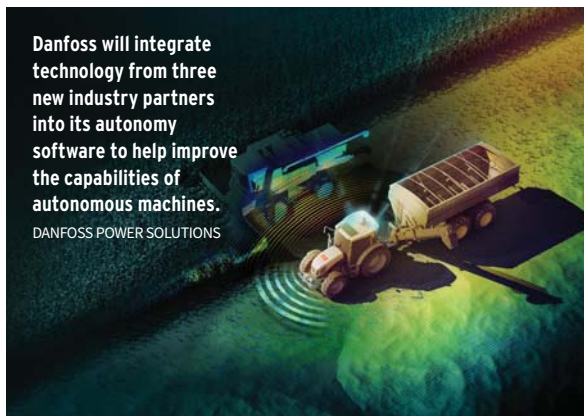
by Sara Jensen

**D**anfoss Power Solutions is partnering with three companies to integrate their technologies into its PLUS+1 Autonomy software. Inclusion of camera and positioning technologies from Swift Navigation, Bonsai Robotics and HARD-LINE in the Danfoss software is expected to enhance the performance of autonomous machines.

The Danfoss PLUS+1 Autonomy software platform is designed to help OEMs with the development of autonomous and semi-autonomous off-highway equipment. All necessary algorithms for autonomous machine navigation are built into the software as function blocks; users select the appropriate function blocks to create their autonomous vehicle systems. This eases development for OEMs who may not have the necessary expertise in house to design such systems.

By making it easier to design autonomous machines, overall development time can be reduced and products can be brought to market faster.

Development of autonomous vehicles continues to grow in the off-highway industry as a means of helping overcome the labor challenges it is facing, like so many other industries. There is a lack of skilled labor entering the industry, bringing about the need to make machines easier to use which is possible through integration of automated systems. These systems can also help get work done in a safer and more productive manner as human error is reduced, or completely eliminated.



“Autonomous off-highway machines are becoming more sophisticated. As we advance towards Level 4 and even Level 5 autonomy, high-precision navigation and remote control beyond line of sight will become requirements,” said Peter Bleday, head of autonomy, Danfoss Power Solutions, in the company’s press release announcing the new partnerships. “Swift Navigation, Bonsai Robotics, and HARD-LINE are very different companies that each have a reputation for technology leadership and flexibility. These are natural system partnerships for us and strategic business fits. We look forward to integrating their solutions into our PLUS+1 Autonomy platform and helping our customers stay ahead of the curve in their autonomous vehicle development.”

## Technology to Improve Autonomous Operation

Each technology from the new industry partners which is integrated into the Danfoss PLUS+1 Autonomy software will help to further improve autonomous vehicles’ ability to safely navigate in various application environments.

Swift Navigation will provide its Skylark precise positioning service which is a wide area, cloud-based GNSS (global navigation satellite system) corrections service. Its integration with Danfoss’ software will enable decimeter-level accuracy from the cloud to PLUS+1 Autonomy states Danfoss in its press release. The company says this eliminates the need for additional ground infrastructure, easing uptake

for end-use customers as they can use the autonomous machine equipped with Danfoss’ software immediately without installing extra devices in order to do so.

With Skylark, more accurate information is provided on machine location. The technology is beneficial for construction, agriculture and other applications requiring high-precision GNSS capabilities says Danfoss. It provides coverage in a range of markets including the U.S., Europe, Japan, Korea and Australia, which will benefit many of Danfoss’ global customers.

“Accurate machine control and autonomy rely heavily on precise positioning. Skylark’s exceptional reliability and extensive coverage make it the ideal solution for these applications,” said Brad Sherrard, executive vice president, Industrial, Swift Navigation, in Danfoss’ press release.

Bonsai Robotics develops camera-based vision systems for use in environments where there may be heavy dust, debris, and vibration which make it difficult to see as well as areas where there is a lack of GPS signal. The ability



to work in adverse conditions like these is particularly beneficial for off-highway equipment which is often working in harsh environments and remote locations.

Use of cameras instead of traditional positioning systems provides autonomous vehicles with more accurate vision so they can safely navigate through various types of environments including those with narrow rows of trees, vines or crops. To achieve this capability, Bonsai Robotics' technology utilizes AI (artificial intelligence) and computer vision models to create three-dimensional maps—and thus a more accurate depiction of the environment—for autonomous machines to follow.

“Bonsai's partnership with Danfoss has allowed us to rapidly integrate with several vehicle form factors in order to add vision-based autonomy and Visionsteer driver augmentation to equipment operating in some of the most challenging conditions,” said Tyler Niday, founder and CEO, Bonsai Robotics, in Danfoss' press release. “The beauty of

PLUS+1 drive-by-wire systems is that an autonomous perception system can drive the PLUS+1 equipped vehicles through CANbus messages in the same way that a human would use manual controls.”

Danfoss is also integrating technology from HARD-LINE, a developer of teleoperation services, into its PLUS+1 Autonomy software. HARD-LINE's technology enables the monitoring and control of machines over the internet and will complement Danfoss' radio-based remote-control technology the company said in its press release.

Teleoperation is well suited for applications in which operators may be remotely controlling and supervising multiple autonomous machines, common in the mining industry where autonomy has been present for several years now.

The HARD-LINE technology enables operators to navigate autonomous machines around obstacles when necessary from a safe distance. If a machine stops due to an unknown

obstacle, the operator can log in to the HARD-LINE system, navigate around the obstacle then resume autonomous operation without needing to be close to the machine explains Danfoss. In applications like mining where conditions can be particularly harsh, having the ability to remotely monitor and control machines ensures the safety of operators while also enabling productivity to be maintained as the machine can quickly be put back to work once it is moved away from the obstacle.

“We feel that HARD-LINE's teleoperation solution is ideal for giving autonomy providers the flexibility to remotely intervene when required during the autonomy process,” said Chad Rhude, vice president of U.S. operations, HARD-LINE, in the Danfoss press release. “We look forward to adapting our API to integrate into the PLUS+1 Autonomy platform and working with a great company like Danfoss to bring autonomy and teleoperation to a wider industrial market.” **P&M**

## Voting is Open for the 2023 IDEA Awards

Voting is now open to select the year's best new product innovations.

by **Bob Vavra**

The nominees are in for the 2023 IDEA Awards, presented by *Power & Motion* in conjunction with its Endeavor Business Media affiliate brands *Machine Design*, *Electronic Design*, *Microwaves & RF* and *Vision Systems Design*. Nominees in 10 categories will have their innovative products, all of which exemplify the IDEA Awards program ideal of innovation, evaluated by the sharpest mind in manufacturing: yours.

The categories in question are:

- Additive and Material Management
- Automation & Controls
- Communication
- Computing
- Design and Operations Software

- Electric Motors, Drives and Components
- Electronic Components
- Machine Vision
- Motion Control
- Sensors & Software

Readers can find a full list of nominees and product descriptions for each category at [powermotiontech.com/21269697](http://powermotiontech.com/21269697), as well as a link to the online ballot. Only eligible manufacturing professionals are eligible to cast votes. All other votes will be disqualified.

Voting will conclude Aug. 7. The honorees will be notified Aug. 16; all winners will be publicly announced Sept. 22. **P&M**



# Opportunities and Challenges for Fluid Power in Automation

Development of automation solutions is bringing new technology capabilities as well as design challenges to the fluid power industry.

by Sara Jensen

Implementation of automation solutions, like robotics, in manufacturing and other applications is bringing technological changes to the fluid power systems used in these applications.

Implementation of automation is on the rise in the many sectors served by hydraulics and pneumatics, bringing with it a variety of technological changes to fluid power systems. With these design changes for automation, there are several opportunities and challenges facing the fluid power industry.

According to a survey of *Power & Motion's* audience, 50% of respondents have seen an uptick in requests from customers for solutions which will aid automation efforts. And 90% of respondents anticipate further growth for automation-related solutions in the coming years, demonstrating the continued need for these technologies.

The need for more automation is due in large part to the labor challenges facing the industries served by fluid power including manufacturing and heavy-duty mobile equipment. By making work easier to complete or even doing work in place of a human—freeing people up to focus on other, more important tasks—automation is helping overcome these labor challenges.



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## How is Automation Impacting Fluid Power Systems?

As fluid power systems play an important role in many machines, it will be necessary to incorporate the technologies required for automation, such as sensors and software, with hydraulics and pneumatics. Doing so enables these components to meet the needs of automated systems, such as more precise and controlled movements.

Many in the fluid power industry are already seeing the impact of automation. Thirty-four percent of survey respondents said more than 50% of their fluid power component and system





designs are now influenced by the move toward automation. About 45% said 10-50% of their designs are influenced by this trend, signifying its growing importance to customers.

Respondents were almost evenly divided on the ways automation is impacting fluid power systems. Just over 36% said the addition of new technologies are impacting their hydraulic and pneumatic system designs, followed closely by 31.67% indicating the need to improve precision and control as a major impact. Another 25% said there is greater integration of sensors in their system designs which is helping to meet the requirements of automation systems.

The use of sensors in particular has risen in fluid power systems over the last several years due to the improved control they can provide for faster, smoother and more accurate operation—key requirements for automation systems.

### **Will there be a Shift Away from Hydraulics and Pneumatics?**

While automation brings with it the integration of other technologies into fluid power systems, there is also the potential for a replacement or augmentation of traditional hydraulic and pneumatic solutions in some applications.



Just over 58% of survey respondents said they see a shift away from traditional hydraulics and pneumatics due to automation. Several respondents noted servo systems—including servo motors and servo control—as a way in which fluid power components will change because of automation.

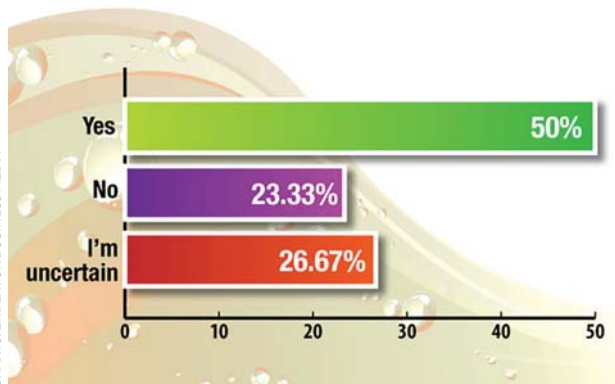
Many respondents also pointed to the increasing use of electronics alongside hydraulics and pneumatics, noting that many of the changes coming to the market will help to enhance the capabilities of traditional components as opposed to completely replacing them.

## Fifty percent of respondents have seen an uptick in requests for solutions which aid automation efforts.

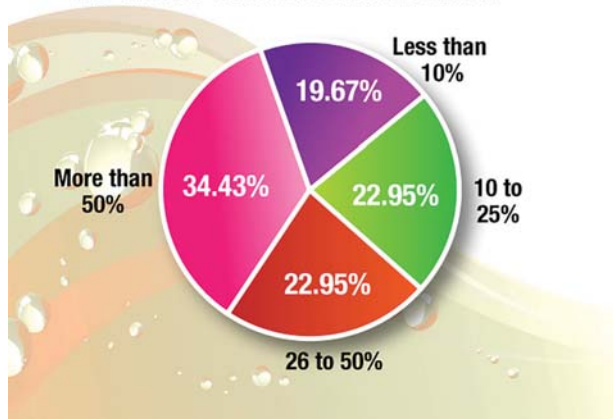
However, there are some technologies which are being used in place of traditional hydraulics and pneumatics, namely electromechanical devices such as electric actuators. Many of these components are able to provide forces similar to fluid power components but with more precision and control.

Hybrid systems combining the best of fluid power and electronic devices are becoming prevalent as well for automated systems. These systems can provide machine OEMs with the benefits of both component types, enabling them to meet various performance requirements which could include not only automating tasks but also ensuring efficient use of energy in their operation.

### Various forms of automation are growing in many of the industries-served by fluid power. Have you or your company seen an uptick in requests from customers for solutions that will aid their automation efforts?



### What percentage of your fluid power component and system designs are now influenced by the move toward automation?



### A Need for More Industry Education

When it comes to implementing automation solutions, the majority of survey respondents, 45%, said the biggest challenge is uncertainty about what technologies to use. This was followed by 25% indicating there is not enough industry information.

The latter was particularly evident from Automate 2023, an event focused on automation and related technologies in the industrial space. A3 - Association for Advancing Automation, which owns the event, reported it was the largest edition yet, driven by the growing demand for automation solutions and education on how to implement them.

Seeing this industry need—which was expressed by the many people the *Power & Motion* team spoke with at the show as well—the association plans to hold the event annually going forward.

Better understanding of the technologies utilized and how to implement them will ensure automation systems provide the desired benefits. In conjunction with this, some survey respondents said a key challenge to automation system development is knowing how to choose between use of fluid power and electronic alternatives. Understanding how to weigh the pros and cons of each type can help designers create systems which are capable of meeting both performance and application requirements. Keeping up with new technology introductions which could benefit automation systems was another noted challenge.

In addition, survey respondents pointed to the need to demonstrate the benefits of implementing automation solutions. These systems can be an expensive initial investment; being able to prove the business case and potential return on investment can help to overcome the potential hesitation with making investments in automation.

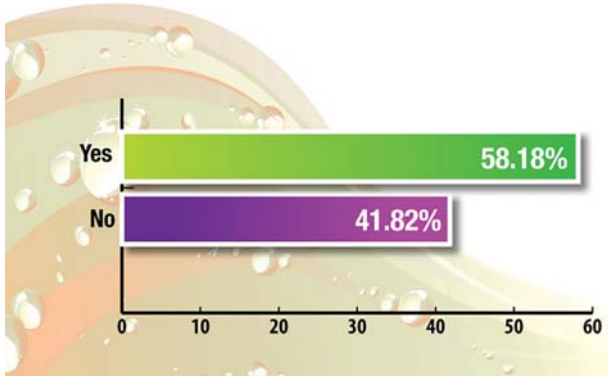


## Opportunities for Fluid Power in Automation

Despite the challenges associated with developing and implementing automation, the majority of survey respondents, 88%, see opportunities for the fluid power industry as these systems grow in use.

Ways in which respondents see automation benefiting fluid power include increasing interest in development of efficient systems. Hydraulics in particular are known to be very inefficient, but improving their efficiency can benefit their use in

### Are you seeing a shift away from traditional hydraulic and pneumatic technologies due to the implementation of automation?



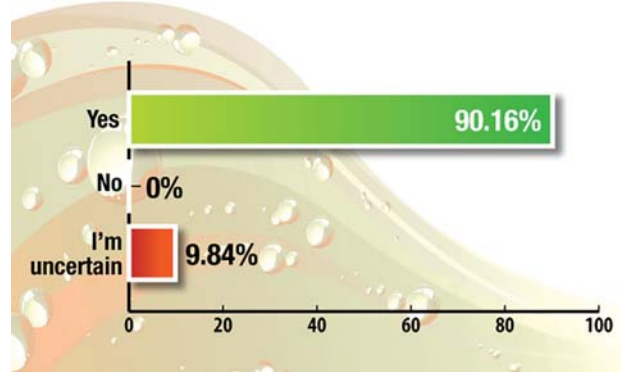
many applications and overall machine efficiency—leading to reduced energy costs, among other benefits.

The increased combination of electronics with hydraulics and pneumatics is another opportunity noted by many survey respondents. Doing so can help to achieve the efficiency, precision and control desired in many applications today, including automation solutions. Improving the performance of fluid power components in this manner ensures they are able to continue providing value to machine OEMs and their customers.

Inclusion of electronics also presents the opportunity to monitor the health and status of components and systems, aiding with implementation of preventative maintenance, one survey respondent pointed out. This can help to keep machines running in a productive manner by preventing unplanned downtime from occurring as users can better monitor machinery and fix issues before they cause a major problem and hinder business operations.

While there are many technologies entering the market to aid with automation, several survey respondents said there will remain a need for hydraulics and pneumatics in many applications. As one respondent noted, there will always be a need for fluid power systems because of the power density they

### Do you anticipate further growth for automation-related solutions in the coming years?



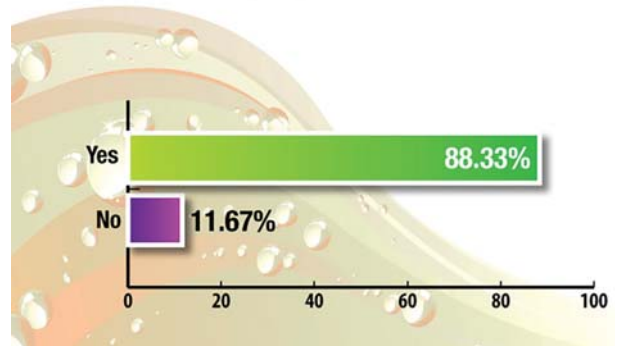
can provide as well as their reliability in harsh environments.

Some survey respondents said the use of servo systems with hydraulics and pneumatics will benefit their use in automation. One respondent said hydraulic systems with servo-driven pumps can provide high levels of power density and efficiency and can even be more energy efficient than using electric alternatives alone. The respondent said this is similar with pneumatic systems as well.

Another respondent noted the advent of servo systems and proportional pneumatics is opening doors to new applications.

There will always be a need to make machines easier and safer to use as well as more productive, which automation

### Do you see opportunities for the fluid power industry as automation progresses?



can help to achieve—whether by automating a single task or enabling unmanned operation of a vehicle. As such, it will be important for the fluid power industry to continue advancing so it can help to achieve these machine requirements and meet the needs of the growing effort to implement automation solutions. **P&M**

# Sensors and Software in Motion Control: Key Benefits to Consider

Improved performance, efficiency and automation capabilities are among the benefits offered by integrating sensors and software into motion control systems.

by Sara Jensen

**I**ntegration of sensors and software into motion control components and systems is on the rise. Their use has grown in recent years due to the many benefits which can be achieved including collection of performance data and improved controllability, among other reasons.

According to Dave Boeldt, product manager for the Bosch Rexroth Corporation, Automation & Electrification division, machine building has become more focused on software than it was in the past. Previously, mechanical functionalities were the priority followed by electrical, and software was a small portion of the machine building process.

“Now everything is starting to be focused on software,” he said. “Software is what gives the machine its connectivity between the shop floor and the IT world.”

Joern Strasser, business manager for Speed Sensors at Rheintacho, has witnessed a rapid increase in the number of

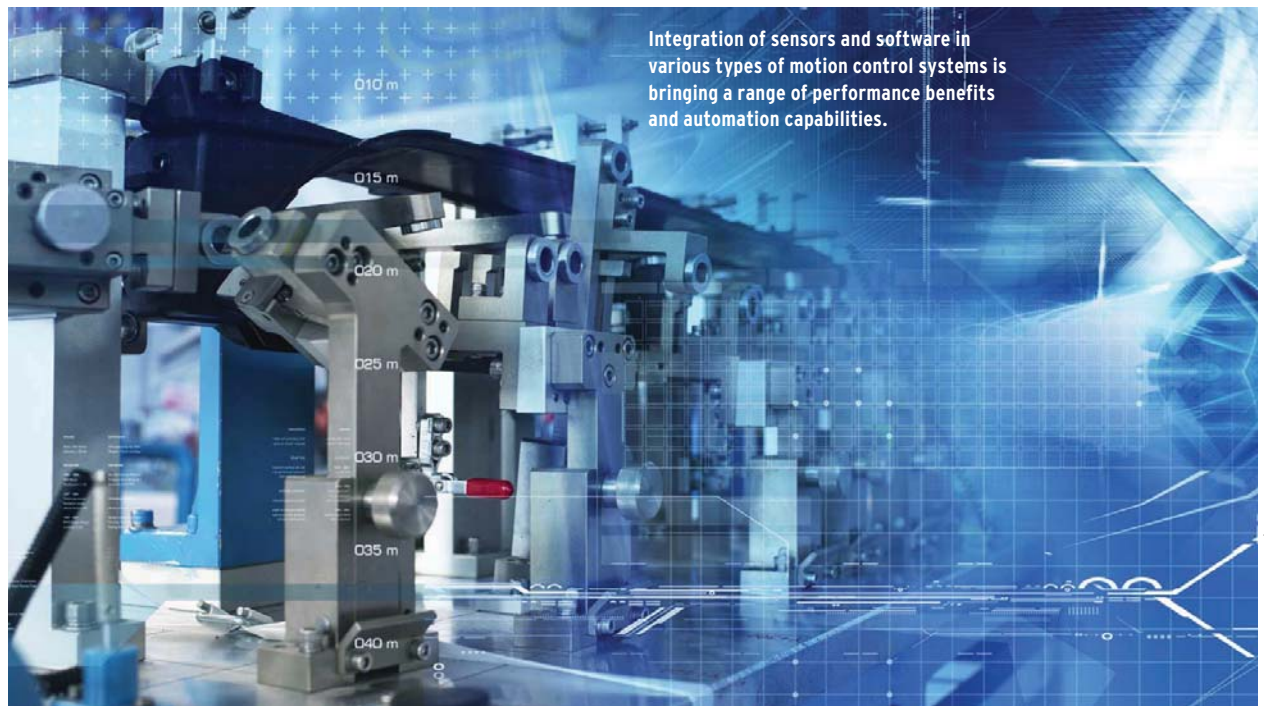


A variety of sensor types are enabling monitoring of almost every aspect of motion in today's machines.

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sensors utilized in customer applications, particularly hydraulics, since joining the company about 10 years ago.

“There are a lot of reasons [for this growth],” he said, “but the main one is there are more tasks required in the mobile hydraulics world.” These include predictive maintenance capabilities, increased safety and efficiency, and the move toward autonomous driving.



Integration of sensors and software in various types of motion control systems is bringing a range of performance benefits and automation capabilities.

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## Sensors Bring Performance Advantages to Motion Control Systems

Oliver Lythgoe, chief marketing officer at FÉTIS Group, agrees the number of sensors used in hydraulics and other motion control devices is increasing. He said the reason for this is simple. “Everybody who operates machines, sells machines or rents machines wants them to be easier and safer to operate.”

This requires smoother and more accurate operation, which can be achieved by moving towards a more electronic world through the incorporation of sensors.

Lythgoe noted FÉTIS is seeing increased demand from customers for inclusion of sensors in the company’s hydraulic cylinders. Many are looking for a combination of pressure and position sensors which he said enables new forms of control for faster, more accurate cylinder movements.

Strasser said the more a system gets controlled, the bigger the advantage because the next technological step for many manufacturers in the mobile equipment space is autonomous driving. Autonomous vehicles require a lot of measurements and data collection to ensure accurate and safe operation. “You need to have knowledge about what is going on in the machine and this can be managed by the usage of sensors,” he said.

Today, almost every motion on a machine can be monitored, said August Meyers, branch manager for Mobile Automation at SIKO Products Inc. Sensors of various types enable monitoring of rotation, speed, position and other aspects, enabling machine users to ensure components and systems are performing as desired.

Monitoring performance benefits machine productivity as well as safety, which Meyers sees as the number one factor driving increased use of sensors. This includes “protecting operators as they’re using a machine, protecting the machine itself from being used in unsafe conditions, and then protecting the environment around the machine so that the machine can’t actually get into a situation where it damages things around it,” he explained.

Greater concern is being placed on efficiency than it was in the past, as well, due in part to sustainability efforts. The more efficient a component or system is, the less energy it requires and thus the less fuel consumed, and emissions produced. As electrification and other diesel alternatives gain market share, the need for efficient systems will be even greater to maximize energy use.

The improved control sensors provide can help to improve efficiency. Lythgoe explained that in hydraulic pumps, for instance, the pressurization and pumping of hydraulic fluid can be better controlled through the incorporation of sensors, enabling efficiency gains to be achieved.

## How Software is Benefitting Manufacturers

The role of software in motion control systems is varied as it can be used to program the functionality of components and machines, provide connectivity between systems and aid with data collection and analysis.



The pairing of electronics with hydraulics and other motion devices is bringing new levels of control and efficiency.

Strasser noted software is becoming more important for the compilation, calculation and processing of data including that collected by sensors especially as manufacturers work toward development of autonomous driving capabilities.

The advent of Industry 4.0 in the manufacturing sector has also increased software’s role in the collection and analysis of data, aiding performance monitoring and maintenance needs. Bosch Rexroth’s Boeldt said the move to Industry 4.0 brought the ability to get more out of machines by allowing collection of data related to performance of various components.

For instance, motors and drives equipped with sensors “can tell you how much torque the application is using and based off that torque, you can see [in the software] where a motor might be working harder and you can [look at] what is causing this to happen,” he said.

Boeldt said the industry was struggling to promote the concept of data collection and developing predictive maintenance models until COVID-19, which changed the way people worked. Remote connectivity became increasingly more important, requiring greater visibility into production systems and how applications were running.

“This led to the digital transformation,” he said, in which use of the Internet of Things (IoT) and connectivity to sensors is enabling collection of information and diagnostics to identify areas in which equipment efficiency and productivity is being maintained at a maximum level. And if there are areas which are lacking, those can be determined and corrected as necessary.

According to Boeldt, software is removing the limits out there in the industry by enabling things to be seen in real time and decreasing any latencies that may exist. It is also helping manufacturers quickly and easily add new functionalities to their machines and switch between production applications, enabling better flexibility and scalability.

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The move to Industry 4.0 has brought about the ability to get more out of machines by allowing collection of data related to the performance of motion control components.

## Best Practices for Integrating Sensors and Software

While there are many benefits provided by sensors and software, understanding how to properly integrate them with motion control systems will help to ensure these benefits are achieved.

Knowing the application in which the system will be used is key. Mobile hydraulics, for instance, are often utilized in harsh environments, requiring use of robust, reliable, field proven technology. “When you think of hydraulics, it is like bull riding in a minefield,” said Strasser. “You have the harshest conditions you can think of; you have dust, dirt, vibrations, unpredictable weather conditions and sometimes the system comes in contact with different kinds of fluids,” all of which he said is very aggressive on sensors and other components.

When integrating sensors into hydraulic components and systems, Strasser noted the importance of considering how the sensor will be mounted—whether externally or internally—as well as the space claim available.

Lythgoe agrees that taking the environmental conditions into account is important when integrating sensors into hydraulic systems. All components need to have a strong design to withstand not only the environment but also shock loading, vibrations and potential misuse by machine operators.

The second important factor he said to consider is how the data collected by sensors will be used. “What’s the decision you are going to make with that data? What is the value of that decision to each person in the value chain?”

He said there are also questions surrounding criticality which need to be taken into account. “What happens when a sensor fails? Or when it loses accuracy? How’s it going to fail? How will information be interpreted? How will it be detected? What’s the Plan B? Criticality and safety are fundamental,” said Lythgoe.

Meyers also emphasized safety being a key factor to consider when integrating sensors. He also noted the importance of determining the type of signal output that will be used. “That is contingent upon the type of control systems being used,” he

explained. “Are you using EtherCAT, PROFINET, PROFIBUS or IO-Link?” The chosen control system also factors into the other necessary design considerations as well as replaceability, availability, and compatibility across multiple sensor lines he added.

Understanding the application and its requirements is important to the integration of software as well. According to Boeldt, the greater focus on software in today’s machine designs has led to data and monitoring of that data being top considerations to take into account as well as how the data will be collected and analyzed.

Security has also become a major design factor. Boeldt said there are various methods Bosch Rexroth uses to build security features into its software platform to ensure no outside entities can execute machine functions.

“Having a robust cybersecurity plan is really something that’s challenging and also needs to be maintained,” said Boeldt. “It needs to constantly be updated so that it can adapt to [new cybersecurity issues as they] come out.”

The use of sensors and software in motion control will continue to grow in the coming years to provide the improved performance and data collection capabilities for which machine owners are looking.



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Understanding the application in which a motion control system will be used is vital to proper integration of sensors and software. Hydraulics, for instance, are commonly used in harsh environments which requires durably designed components.

Further automation of systems and machines in a variety of industries will be a strong driver for this continued growth. “There is no going back,” concluded Meyers. “We are in an automation phase...we are going to see more and more automation...[and] the technologies are advancing every day.” **P&M**

### Watch and Learn More!

Information in this article comes from our Engineering Academy session “The Benefits of Integrating Sensors and Software into Motion Control Systems.” Register now at [designengineeracademy.com](https://designengineeracademy.com) to watch the full panel discussion as well as other webinar sessions which are part of “The Value of Sensors & Software in Motion Control” event. These can be watched on-demand when most convenient for your schedule.



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# The Importance of Hydrolytic Stability in Hydraulic Fluids

The presence of water can negatively impact hydraulic system performance, necessitating use of lubricants with some level of hydrolytic stability.

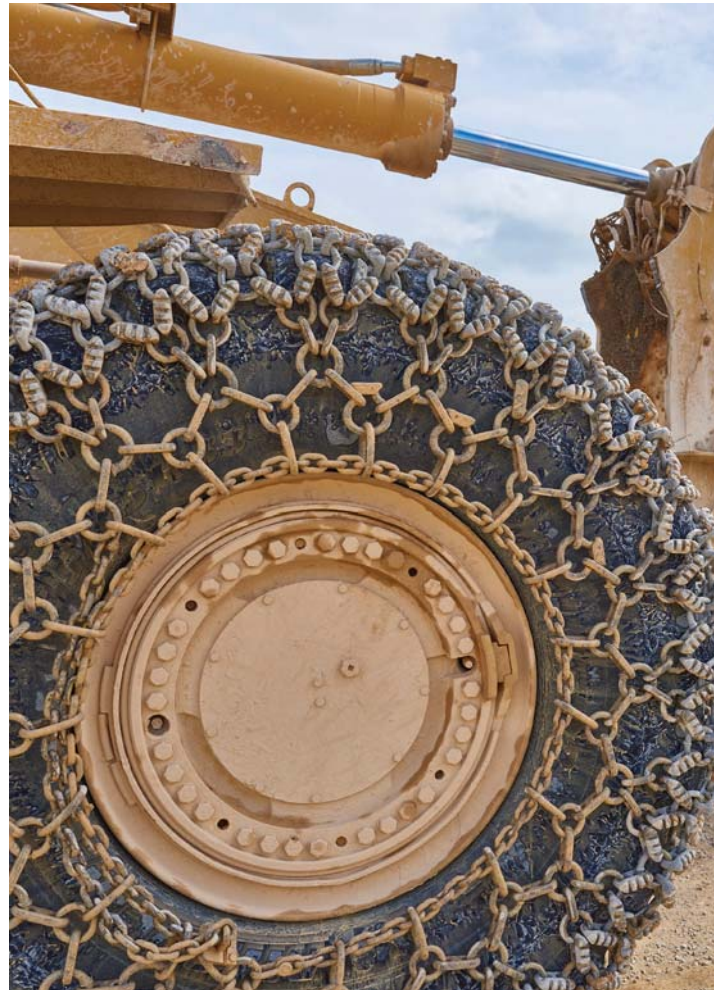
by Sara Jensen

**S**electing the right hydraulic fluid for an application is critical for several reasons, including its ability to withstand the presence of water. Hydrolytic stability is a hydraulic fluid's capacity to withstand or resist chemical decomposition when exposed to water.

Water is the most common contaminant in hydraulic fluid said Stephen Gotheridge, technology development manager, Industrial Oils at Lubrizol in an interview with *Power & Motion*. "Hydraulic fluids are very susceptible to contamination and water is everywhere [which is why] hydrolytic resistance, or stability, is one of the most important characteristics of a hydraulic fluid."

## Why Resistance to Water Matters

Hydraulic fluids must demonstrate a wide range of properties, hydrolytic stability being just one of those, said Gotheridge. And any detrimental change to the fluid, such as exposure to water, will change its properties, leading to performance issues for the hydraulics system and the machine into which



Understanding environmental conditions is important to selecting a hydraulic fluid with the appropriate level of hydrolytic stability.

ALL IMAGES: THE LUBRIZOL CORPORATION

it is integrated. "Any hydrolysis of the components within the fluid is basically going to change all those properties that have been designed into the system," he said.

There are various side effects which can occur due to hydrolytic interaction. These can lead to filters, valves and sensors becoming blocked, impeding hydraulic flow and overall system performance.

In addition, the presence of water in a hydraulic fluid can cause formation of solid particles which he said is well known to be terrible for the performance of lubricants. There are several formations which can occur, including those corrosive to the steel and copper alloys used in hydraulic pumps, circuits and servo valves.

"There are many enemies that can be formed by hydrolysis of the hydraulic fluid," said Gotheridge.



## How to Ensure Hydrolytic Stability

To maintain the hydrolytic stability of a hydraulic fluid, Gotheridge said everyone working with the fluid plays a part—from a formulator like Lubrizol to the person operating a piece of equipment.

Water is a common contaminant in hydraulic fluids and can lead to performance issues in hydraulic systems and machines.



One of the first aspects to take into consideration is environmental factors. If the hydraulic fluid is used in a wet environment, it is important to ensure proper sealing technology is utilized as well as storage of the fluid.

Ensuring proper storage of hydraulic fluid is important to preventing the presence of water. Though a new hydraulic fluid may arrive to a customer free of water, if there is any humidity or other issues with the storage conditions then water could get into the fluid. “You’ve got to ensure that when you put the new hydraulic fluid into the system, that it does not have a higher water content than desired,” said Gotheridge. “Taking a water sample and analyzing that on a new oil is critical.”

There are also important steps to follow when changing the fluid including fully draining the old fluid or doing so as much

as practically possible said Gotheridge. This is important to do because there could be contaminated hydraulic fluid in the system; removing as much of it as possible will ensure the newly added fluid will not be contaminated as well.

In addition, it is important to regularly maintain seals and breathers on the oil reservoir as they are important components to preventing exposure to water.

Monitoring lubricants in service can help to assure hydrolytic stability is maintained as well. Gotheridge said this is done by regularly taking water samples out of the hydraulic fluid and sending them to a laboratory for analysis to ensure there are not large amounts of water in the fluid. He noted this type of condition monitoring is common within hydraulics and most industrial applications. “It’s a very practical in-use operation to make sure you don’t promote hydrolytic susceptibility.”

For fluid formulators like Lubrizol, there are various mechanisms which can be used to ensure hydrolytic stability. Among those is making fluids that can demulse, or shed, water. “We deliberately add components called demulsifiers to the formulation to separate water—whether it be free water, disperse water or tight emulsion water within the actual oil phase,” said Gotheridge.

One of the challenges for formulators is ensuring hydrolytic stability while also considering the other chemistries which need to be included to provide desired performance properties such as anti-wear and anti-corrosion. If the right chemistries are not selected, they could inhibit the fluid’s hydrolytic stability. “It may be that we have to exclude some really good chemistries—some of the best anti-wears may be hydrolytically unstable—because we know it’s going to predominate in the hydrolytic mechanism,” said Gotheridge.

“It’s a very carefully balanced formulation—it’s got the right chemistry for a balanced portfolio of performance [and] it’s not hydrolytically unstable; it can shed water should the system be contaminated,” he said.

## Choosing the Right Hydraulic Fluid

Ensuring hydrolytic stability is an important aspect for those developing hydraulic systems and the machines in which they’ll be utilized as well. They too need to consider the type of environment in which the system will be used and if there is the ability to drain water from a hydraulic system should there be any which enters it.

“It’s a decision whether to use a demulsifying fluid or an emulsifying fluid,” said Gotheridge. While some OEMs stipulate the use of an emulsifying chemistry, he said the majority of the market specifies use of a demulsifying fluid. “The bulk of the hydraulic fluid market is demulsifying,” because of the need to shed water, he noted:

- demulsifying = separate water from oil molecules
- emulsifying = creation of stable arrangement between water and oil molecules

“There is no in-between in terms of performance because otherwise you end up with globules of water floating

around the system, which any lubricant specialist knows is disastrous,” he added.

While the hydraulic circuit design can help with hydrolytic stability—such as through the inclusion of water drain ports and giving the lubricant time to relax in the oil reservoir so it

### Performance vs. Environmental Friendliness

There is a trend in the industry toward increased use of environmentally acceptable hydraulic fluids. This is leading to a move from mineral derived oils to those created using triglyceride, a glycol or a miscellaneous group of synthetic hydrocarbons. Doing so achieves desired properties such as biodegradability, enhanced aquatic toxicity and in some cases biobased carbon use said Stephen Gotheridge, technology development manager, Industrial Oils at Lubrizol.

While the chemistries used for these hydraulic fluids makes them very readily biodegradable, it can also make them susceptible to hydrolysis (decomposition caused by exposure to water). “There is sort of a paradox if you move to an environmentally friendly fluid then there is a performance compromise because what’s being put in there to make it biodegradable also makes it hydrolytically unstable,” he said.

can demulse naturally—the formulation of the hydraulic fluid is critical. As such, it is important for designers to select the appropriate fluid for a given application.

One of the main hurdles associated with hydrolytic stability is educating the industry about it and what options are available in the market. “A lot of people know the different brand names, but they don’t know how they interrelate and perform in terms of exposure to water,” said Gotheridge. “It’s sort of a hidden must have.”

He noted it is possible to have very hydrolytically unstable fluids in the market and make basic performance claims. Currently, OEMs are the ones stipulating certain levels of hydrolytic performance for their equipment using tests such as ASTM D2619, ASTM D4310 and ASTM D943. These tests look at different aspects of contamination from water such as corrosion, sludge and lifetime oxidation.

In general, there is no industry standard for hydrolytic stability. It’s the responsibility of OEMs to specify their requirements and design teams to choose the right fluid for an application.

Gotheridge concluded by emphasizing the need for designers and users of hydraulic equipment to consider hydraulic fluid as a critical component to overall performance. “This fluid has to go around the entire system,” he said. “Please consider it as a critical design item when selecting fluids with regard to hydrolytic stability.” **P&M**



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# Optimizing Linear Motion Solutions Using Hybrid Automation Systems

Achieve greater efficiency, flexibility and more for complex equipment and processes by combining electric and pneumatic actuators.

by Linda Schwartzen

**T**here are many technical and commercial factors that original equipment manufacturers (OEMs) must evaluate when designing motion control solutions for industrial machinery. Many types of industrial machinery use motion control to carry out their functions, and some of the most popular technologies that OEMs depend on for linear motion control are pneumatics and electrical linear actuators. Motion control may be initiated manually by operators or automatically by advanced control platforms.


When designing automation systems, OEMs have historically had to choose between motion control technologies. Pneumatic and electric motion each has its strengths: Pneumatic motion is seen as robust and easy to use and maintain, and electric motion is perceived as smart, quick and precise. OEMs have had to select the technology based on which would provide the most benefit to an application, but, in some applications, key needs were sacrificed in favor of others.

Processes and application priorities have evolved over time. Sustainability is today's top priority in almost every industry, while processes have become more complex and require more precise, efficient motion. Functions are consolidated into smaller spaces with fewer components.

Something else important has changed, too. OEMs no longer have to choose only one technology. There are hybrid automation systems that combine the strengths of pneumatic and electric technologies to provide the greatest benefit for complex motion control applications.

## Trends Driving Hybrid Automation Systems

Some OEMs may wonder why there's a need for electric linear motion in addition to pneumatic. By recognizing several trends driving the evolution and use of hybrid automation systems, we can better understand how cross-technology solutions emerged. Sustainability, digital transformation, machine design and competitive pressures are all influencing its popularity.



Emerson's PACMotion controller, servo drives and servo motors are designed to work together, combining an integrated motion and machine logic solution with the performance, flexibility and scalability required for advanced machine automation.

ALL IMAGES: EMERSON



## Sustainability

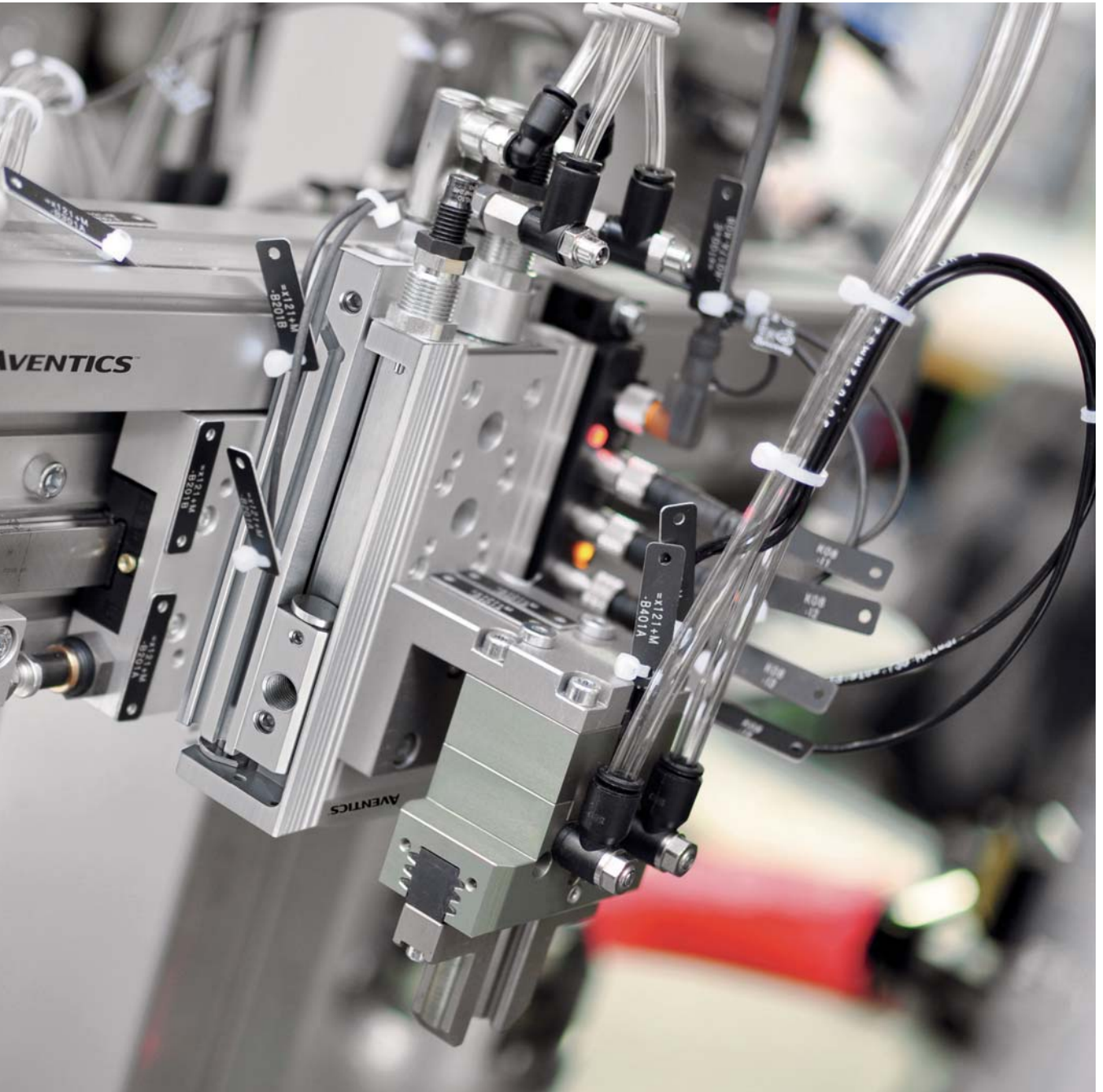
There's an increased focus on energy consumption, carbon emissions and cost savings in every industry. A sense of personal responsibility, customer demand, government regulations and stakeholder pressures are fueling this focus, and many corporations are making commitments and long-term goals based on ambitious net-zero initiatives.

Motion control systems that use less energy and can be powered by renewable resources are key to energy-efficient equipment and are part of a sustainable corporate strategy.

## Digital Transformation

Today's manufacturers interact with digital automation and detailed user interfaces in their daily lives and expect the same digital capability from industrial systems. As companies digitally transform their operations, they're seeing real, reliable benefits.

Embedded sensors in devices continuously track temperature, position, load and wear in real time. Monitoring, automatic configuration and diagnostics and collected process data presented in dashboards give operators the insight they



need to make confident, informed decisions. Connected motion control systems enable operators to analyze production performance, energy use and reliability.

Access to these insights via dashboards empowers manufacturers to better control and continually improve their operations and, ultimately, their production.

### Market Competition

Between labor shortages and supply chain issues, it's never been more challenging for companies to maintain a competitive edge. Additionally, the digital transformation of industrial manufacturing and advanced technologies driving it have made it possible for companies who invest in them to significantly optimize their operations.

There's a greater need than ever to remain agile when responding to changing market needs and reliably meet customer demand to stay on the leading edge of the market. Manufacturers must minimize machine downtime and maximize production, and incorporating connected hybrid automation solutions can help improve machine reliability and uptime.

To optimize energy use, enhance operations and stay ahead in their industries, companies are looking for a complete motion control package. Leading technology suppliers understand this and have developed a range of advanced, integrated solutions that combine servo drives, motors and electric actuators, as well as pneumatics.

OEMs have a significant opportunity to incorporate hybrid automation systems in machine designs that better align with and address their customers' greatest needs and concerns.

### Automation and Contemporary Machine Design

One way that companies are overcoming challenges and increasing production is by integrating smaller, more sophisticated machines into their production lines. Smaller footprints allow more machines to fit in the same production space, and advanced motion control technology can make it possible to automate higher-precision tasks from assembly to final product inspection.

Manufacturers are also seeking motion control technology with: better accuracy to prevent waste; shorter cycle times to increase output; and greater position flexibility to allow operators to change machine programs at the push of a button. Using machines with these features can result in higher production in less time, improve sustainability and reduce costs.

### How to Select Pneumatic, Electric or Hybrid Motion Control

There are many motion control offerings available, and it may be confusing to know how to choose among them. When do OEMs use electric, when do they use pneumatic and when do they use both?

There are many factors and concerns to consider when selecting motion solutions:



Optimizing operations relies heavily on real-time data to present insights from pneumatic, electric or hybrid motion control solutions. These insights allow operators to monitor equipment condition and make informed decisions.

- Do they meet the performance, flexibility and accuracy requirements of the application?
- What are initial operating and continued maintenance costs?
- How do they affect the energy efficiency of the machine?
- How will motion products integrate with other devices?
- Can they collect data and analyze device health?
- Will they make it easier and faster to design a machine?
- What's the learning curve for new technology?

Pneumatic and electric motion control each have distinct advantages, depending on an application's needs, and an application may benefit from either or both. For some applications, it's quite clear which is the best fit. For a simple mechanism to push boxes off a conveyor, a pneumatic cylinder makes the most sense. However, if these boxes should be sorted to different lines or positions on the conveyor, an electrical actuator with multi-positions is required.

In more complex applications, the choice may be unclear. This is one sign that applications may receive the greatest benefit from using both. Electromechanical cylinders can use compressed air via a pneumatic connector for sealing air in filling applications. In assembly systems, an electric linear multi-axis system can use a pneumatic gripper. And an electric linear axis operating in a vertical direction can use a pneumatic cylinder for weight compensation.



Cross-technology automation allows OEMs to harness the complementary strengths of both pneumatic and electric motion control technology in the same application and pass the benefits on to their customers.

Let's look at the strengths of each technology to better understand how they can work together:

### **Pneumatic Motion Control**

Pneumatic motion is achieved by using a compressed gas to physically act on a mechanism to produce the required motion. Pneumatic solutions are proven to provide robust operation for hardware, design and installation, and there are usually fewer components to change or replace when upgrading a pneumatic system compared to a servo system.

The most familiar example of pneumatic motion control is a cylinder with an internal piston, which produces linear motion. This may be why pneumatics is often considered a discrete motion technology, only good for fully extending or retracting a mechanism.

However, continuous innovation driven by motion control technology suppliers has expanded what is possible. For example, continuous rotational motion can be achieved using quarter-turn actuators.

Sensors and flow controls are also available to monitor and optimize operation, while differential pressure control makes it possible for equipment to achieve continuous pneumatic positioning. Using relatively small electropneumatic on/off solenoid valves or modulating positioning valves, controlled pressure is applied against a constant back pressure.

Operators can control position manually using buttons and switches or automatically using a programmable logic controller (PLC) or loop controller.

### **Electrical Motion Control**

Electrical actuators combined with servo motors are known for high speed, pinpoint accuracy and efficiency and achieve motion by converting electricity into rotational or linear motion. These closed-loop systems typically include more complex components, such as a motion controller, servo drive, motor and feedback sensor and design practices than pneumatic motion solutions.

Each servo motor is associated with one drive that follows commanded signals that provide the desired function and can deliver accurate positioning, precise angular velocities and variable acceleration profiles. With such a range, servo systems can provide positional motion control for various applications, from a robot arm to continuously rotating conveyors.

Since servo drives and controllers are microprocessor devices, they have a high, innate level of on-board functionality and can directly offer local and remote diagnostic and data logging features for dashboards.

The connection of PLCs and other controllers to servo motion systems can help OEMs accomplish even more

advanced motion control and synchronization. Specialized functions include highly accurate positioning with sub-micron repeatability, electronic camming and electronic gearing and can benefit the most complex applications, such as machining, robotics and manufacturing equipment.

For example, a packaging line can upgrade from mechanical cam discs to a servo motion system with electric cam discs. Whereas changing the format using mechanical discs is complex, time consuming and subject to error, machine conversion using electric cam discs happens at the touch of a button. This saves time, improves accuracy, minimizes scrap and reduces costs.

### **Hybrid Motion Control**

An electropneumatic hybrid automation system can help manufacturers apply the appropriate technologies for each specific function. When sustainability, position flexibility, precision, stability, quiet operation, connectivity and monitoring matter most, electrical motion has great advantages. When applications have space limitations, demand robust operation or require quick design, installation and commissioning, pneumatic motion control is the best choice.

The production lines in most manufacturing facilities include various types of OEM equipment, with product moving between machines along transport and accumulation conveyors. These lines offer many opportunities to integrate both pneumatic and electric linear motion.

For example, a typical beverage packaging production line includes the following functions: stretch blow molding bottles, fill and cap bottles, convey and accumulate, label bottles, inspect fill and label, pack bottles into cases and palletize and shrink-wrap cases. Stretch blow molding, folding boxes and applying glue all benefit from pneumatic motion, while conveying and positioning bottles within filler and labeling equipment benefits from servo motion.

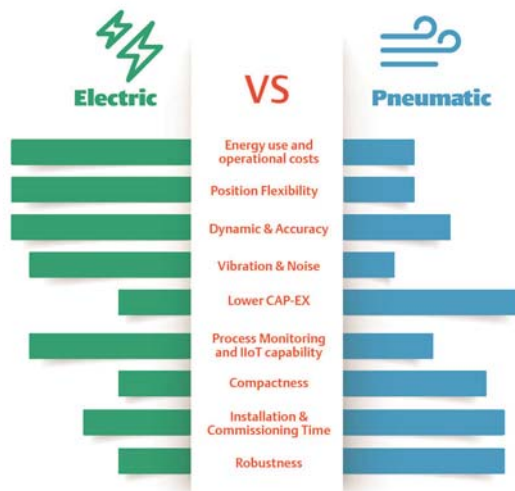
Simple transport conveyors and palletizing systems benefit from both forms of motion: Conveyors can be driven by electric motors, and product stops and gates can operate using pneumatic actuation. Handling bulk cases can be achieved with pneumatics, while interpolation and fine position adjustments may be controlled using servo motion.

### **Advantages of Hybrid Automation Systems**

Leading motion control technology suppliers now offer integrated, full-solution packages that include electrical, pneumatic or hybrid motion control. These comprehensive solutions feature intelligent devices at the field level, motion control, machine control and analytics.

Pneumatic options involve a pneumatic cylinder, valve system, controller, analytics and dashboard via gateway, while electrical include an electrical linear actuator, servo motor and drive, controller and dashboard via gateway. While both

# When Pneumatic, When Electric?



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Electric and pneumatic technologies have distinct advantages that are important to consider when selecting the technology that best achieves the needs and goals of a specific application.

technologies offer dashboards, data is available directly from the servo drive and pneumatic systems require the addition of sensors.

Complete, integrated solutions like this have many benefits for both OEMs and their customers. Since they're already engineered and assembled, hybrid automation systems can streamline procurement, development and commissioning. Otherwise, OEMs must source components separately and match and engineer them themselves. Not only does this take longer and add complexity to the supply chain, it can introduce sizing issues.

Hybrid automation systems also offer flexibility that makes it possible for OEMs to design machines that can produce an array of product types, minimize changeover time and meet changing requirements over the course of time. As many companies face continued pressure to increase throughput while lowering operating costs, this can shorten production runs, increase machine utilization and extend equipment life.

With motion control electronic reconfiguration, operators can change motion profiles on the fly, and some systems offer a future-proofed design and are equipped with features that can be implemented now or in future generations of machines. To offer customers the highest level of flexibility, look for systems with extremely versatile electric actuators that cover a wide range of application requirements.

In addition to remaining competitive, hybrid automation systems can improve manufacturer sustainability. These systems can provide better machine efficiency and reduce scrap, which in turn lowers resource consumption and costs. Energy efficiency can make it possible to better reach sustainability targets, while cost savings can reduce total cost of ownership. For greater repeatability and uniformity, it's important to look for a system with electric linear motion that provides the highest levels of reliability and accuracy.

## Greater Flexibility, Efficiency and Performance

OEMs can determine if a hybrid automation system will benefit an application by evaluating key application factors, including:

- energy consumption,
- operational costs,
- position flexibility,
- accuracy,
- vibration and noise,
- CAP-EX,
- connectivity,
- size,
- installation and
- commissioning time and durability.

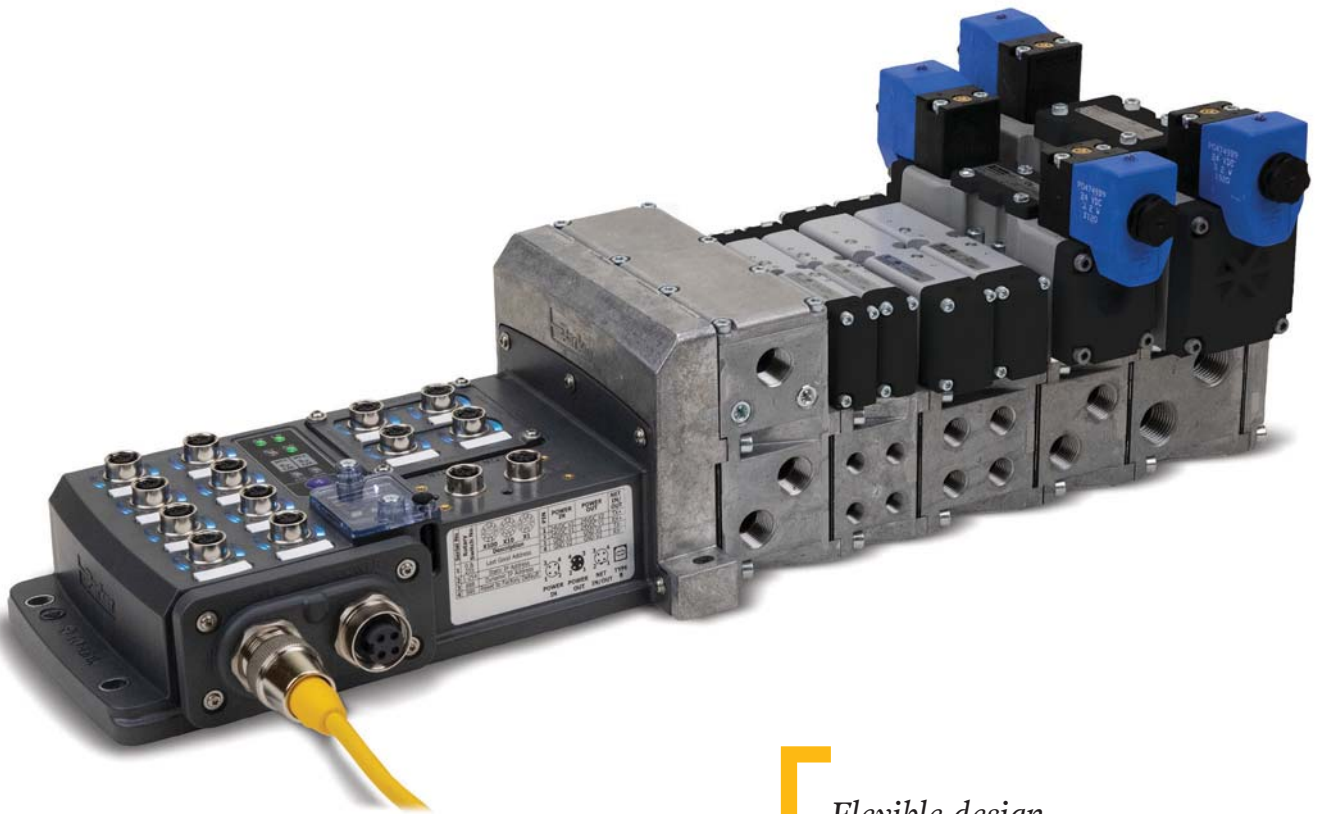
To select the most appropriate solutions that achieve the desired results, it's critical to work with an expert motion control and digital transformation partner with a comprehensive portfolio of technologies and sizing options. A partner like this can help OEMs commission solutions and offer long-term support.

With hybrid automation systems, companies don't have to choose between performance, flexibility, sustainability, connectivity and cost. They can have it all—precise, powerful linear movement, the flexibility to meet changing production requirements, data and insights to maximize production, optimized energy consumption and lower total cost of ownership. **P&M**

*This article was written and contributed by Linda Schwartzen, product marketing manager, AVENTICS™ Actuators, at Emerson. Schwartzen has 14 years of experience in electrical linear motion, sales and product management. She holds a master's degree in mechanical engineering and a bachelor's in mechatronics engineering from South Westphalia University of Applied Sciences.*



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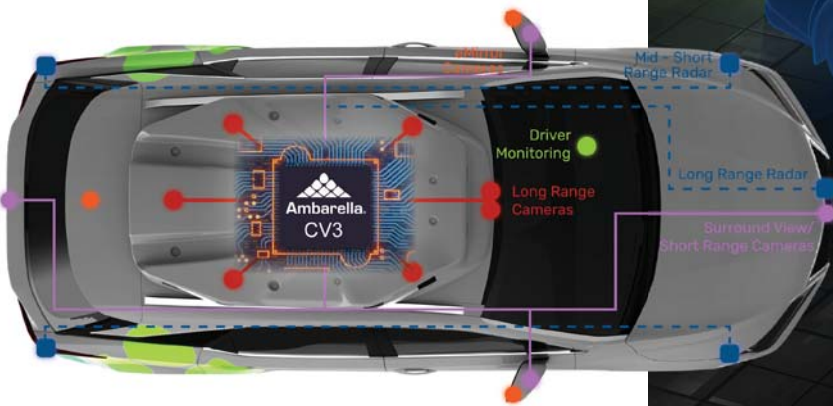
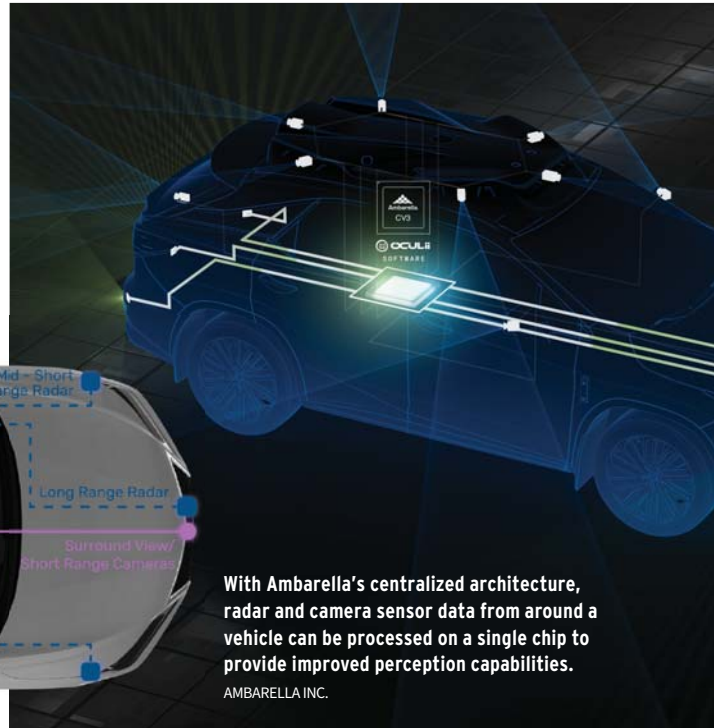


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# Centralized Radar Architecture Improves Perception Capabilities

Ambarella's centralized 4D imaging radar architecture enhances perception to help improve safety of autonomous vehicles.

by Sara Jensen



Edge AI (artificial intelligence) semiconductor company Ambarella Inc. has developed a centralized 4D imaging radar architecture which aims to improve the perception capabilities of autonomous driving systems. The technology enables central processing of raw radar data and low-level sensor fusion from other inputs, such as cameras, lidar and ultrasonics.

With these capabilities, greater environmental perception and safer path planning can be achieved for advanced driver assistance systems (ADAS) as well as various levels of autonomous driving for various applications.

## Moving Radar Beyond the Edge

According to Steven Hong, VP and general manager of Radar Technology at Ambarella Inc., what makes the new technology unique is the fact no radar on the market today is processed centrally. “If you look at all the commercial radars that are deployed in [various] industries...typically all of the processing for radar lives inside of the radar sensor itself,” he said in an interview with *Power & Motion*.

Traditional radar sensor modules contain all necessary components—the antennas as well as analog and digital processing—in a single package. However, the module can be on the larger size and requires the use of more antennas to

achieve higher resolutions. “For a high-performance radar, you want to have hundreds if not thousands of antennas,” said Hong.

Doing so provides clearer images and longer range. He said the challenge is that as you add more antennas, more data is generated which can make it harder to move the data to a location where it can be processed.

He explains that today, camera data is typically processed centrally; there is no processing chip for camera data installed directly next to the camera. Instead, the camera data is sent to a more powerful processor elsewhere in the vehicle where it is processed along with other vehicle information. “But for radars, because there is so much data being generated—on the order of multiple terabytes—you can’t move the data anywhere unless you have processed it,” said Hong.

Radar technology is trending toward the generation of more data, forcing processing to remain at the edge, he said. However, this leads to constraints with the module. Increased processing requirements means there is a need to use more antennas and often a larger, thicker radar module which can generate more heat. All of this adds to the cost of the system and can create installation challenges for OEMs as there is often only so much space and heat dissipation capabilities possible, depending on the application.



Hong said this is why radar has lagged in performance compared to camera and lidar “because there is a ceiling on how much you can dissipate heat and how much cost and performance you can have in that envelope.”

To overcome these challenges, Ambarella developed its new radar architecture which enables high-resolution data collection to be achieved without the need to use several antennas.

### Software is a Key Enabler

Hong said the company was able to reduce the number of antennas necessary without compromising performance due to its software. In traditional radar designs, the use of multiple antennas enables effective measure of what is happening in the environment around a vehicle. “If you want a full picture, you need all the different measurements in order to complete that picture,” he explained.

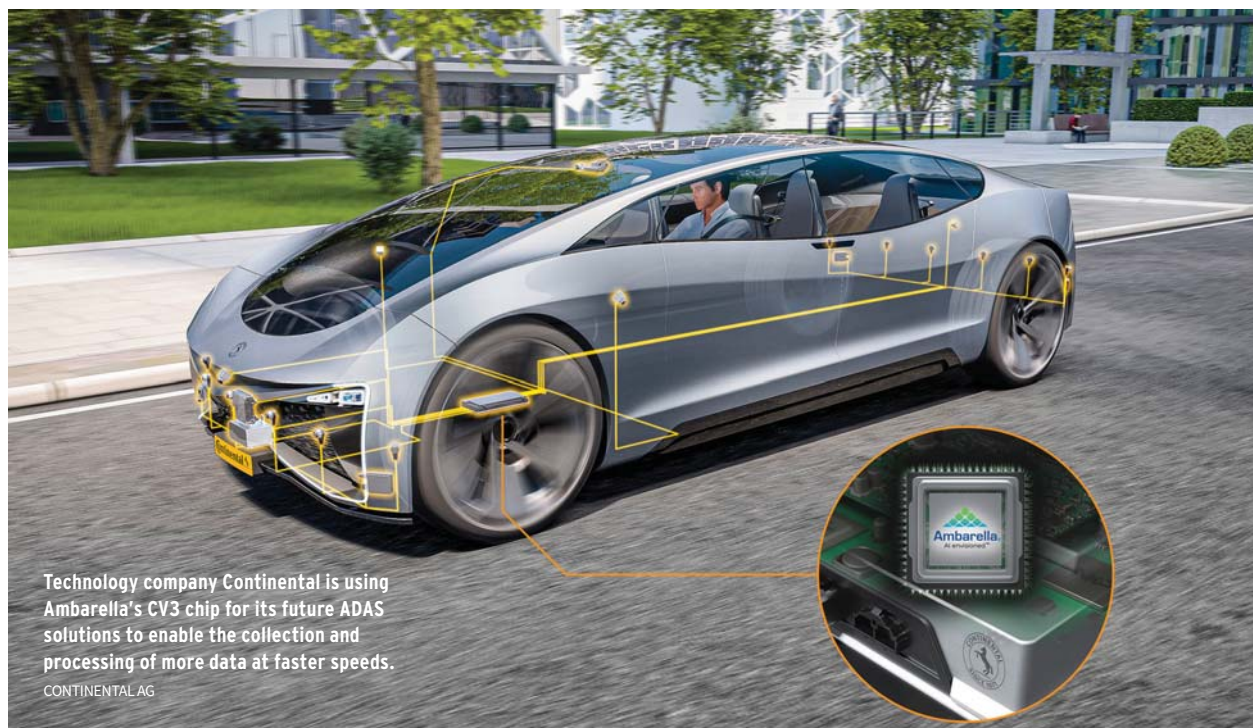
Unlike traditional radar, Ambarella utilizes an intelligent waveform which adaptively learns from the environment using AI software algorithms. “We send out different information at different times,” said Hong. “This allows us with very few antennas to still capture the whole scene.”

As Ambarella explained in its press release announcing the launch of its new radar architecture, by applying AI software to dynamically adapt the radar waveforms generated with existing monolithic microwave integrated circuit (MMIC) devices, and using AI sparsification to create virtual antennas, its Oculii technology reduces the antenna array for each processor-less MMIC radar head in this new architecture to six transmit × eight receive.

The software algorithms are optimized to run on Ambarella’s CV3 AI domain controller SoC (system on a chip) family. As such, higher resolutions and performance can be achieved—high angular resolution of 0.5 deg., ultra-dense point cloud up to 10s of thousands of points per frame and detection range up to 500+ m.

The CV3 is designed to process both radar and camera data, which is a unique capability in the industry said Hong. As such, low-level sensor fusion is possible. Most systems today process radar and camera data on separate chips and use a third chip to combine information from both. This can unfortunately cause necessary information to be filtered out. But with sensor fusion, this loss of information is minimized.

Radar and camera operate in different wavelengths at different frequencies, said Hong. Radar for instance can see much further and naturally sense speed. Being able to combine data from both on a single processing chip enables much richer information to be collected than if done separately. “We believe this is something that is really going to open up the performance of these perception systems in autonomous vehicles and robots,” he said.



Technology company Continental is using Ambarella’s CV3 chip for its future ADAS solutions to enable the collection and processing of more data at faster speeds.

CONTINENTAL AG

## Benefits to a Centralized Architecture

By reducing the number of antennas and processing data on a single chip, “we are able to really allow radar to take advantage of the same things that camera has taken advantage of for many years, centralizing the data,” said Hong.

“Centralizing the processing allows us to shift the compute around the different parts of the vehicle and different sensors depending on what we need,” he explained. For instance, if a vehicle is driving down the highway it will want to see as far in front of it as possible to prevent collisions with objects in the road. But then if the vehicle is in a parking lot, seeing what is directly in front of or around it will be more important than seeing long distances.

The advantage of a centralized architecture over an edge-based one is the sensing system can more easily shift between the types of environments and processing necessary to ensure safe vehicle operation. And this can

### Competing Edge-Processed Radar

Constant, repeated radar waveforms without regard for environmental conditions
MMIC + edge radar processor in module
Radar detection processing in radar module
Multiple terabits per second, per module of radar data (too large to transport and process centrally)
1+ to 2 degree resolution
High power consumption, due to 1000s of antenna MIMO channels used by each radar module
No dynamic processing allocation (specified for worst-case scenarios)

### Ambarella's Centralized Radar Processing

Oculii™ AI software algorithms dynamically adapt radar waveforms to surrounding environment
MMIC only in “radar head”
Radar detection processing in central processor
6x bandwidth reduction for radar data transport
0.5 degrees of joint azimuth and elevation angular resolution
Low power consumption, due to order of magnitude fewer antenna MIMO channels (6 transmit x 8 receive antennas in each processor-less MMIC radar head)
Dynamic allocation of CV3's processing resources, based on real-time conditions, between sensor types and among sensors of same type

This table provides a comparison between traditional edge processing architecture for radar and Ambarella's centralized architecture. AMBARELLA INC.

be achieved without making it overly complicated or expensive.

Processing data in a centralized location also enables the radar sensor itself to be smaller, thinner and consume less power because processing is no longer taking place within the module. This reduces the amount of installation space

needed for the radar and allows for more flexibility in where it is installed.

With the centralized architecture and Ambarella's technology, Hong said more detailed information can be achieved. He noted that radar data is typically blurry and it may be difficult to really know what is being detected. But with Ambarella's new architecture there is improved clarity and resolution which he said has been unparalleled before with radar and on par with current lidar technology.

Hong said in the long run the company's technology could help radar be a better option than lidar because Ambarella's computing capabilities allow higher resolutions and longer range with each generation of its technology. Another advantage is the lower cost of production offered by radar compared to lidar.

He noted Ambarella also uses existing hardware which has been deployed in vehicles around the world for several years, ensuring its reliability and robustness in various applications. While passenger vehicles are one of the largest segments today for perception and radar technology, Hong said the company is targeting a range of applications with its new centralized radar architecture. These include heavy-duty trucks and off-road machinery as well as autonomous mobile robots (AMR) and automated guided vehicles (AGV).

“We believe this is the right combination of sensors as well as compute that will bring safety and autonomy to all vehicles,” he concluded. **P&M**



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#### A Technical Comparison: Pneumatic Cylinders and Electric Rod Actuators

Here's a look at the performance criteria of electric and pneumatic sources of automated linear motion.

[FULL ARTICLE](#)



#### This Week in Power & Motion: HAWE Rebrands Electrification Subsidiary

HAWE's brand which develops electric components will now be included under the HAWE Hydraulik brand name, and more news you may have missed.



#### Danfoss Editron Powers Doosan Electric Excavators

Danfoss Editron has provided the electric powertrain as well as control system to aid electrification of two excavators.

# Danfoss Looks to Overcome Labor Challenges with Autonomous Solutions

Development of autonomous systems will help OEM customers create more efficient and productive machines to alleviate the shortage of skilled workers in agriculture and other off-highway applications.

by Sara Jensen

Danfoss is developing automated solutions which can work indoors and outdoors to meet a variety of application requirements.

DANFOSS POWER SOLUTIONS

**A**utomation is one of the many areas in which Danfoss Power Solutions is focusing its technology development efforts. The company's PLUS+1 Autonomy solution brings together hardware and software to provide the various levels of automation OEM customers require.

Peter Bleday, head of autonomy at Danfoss Power Solutions, outlined the five levels of autonomy, all of which Danfoss is developing technology for:

1. Reduce the load on the operator.
2. Some functions are automated or combined.
3. Vehicle performs key functions, operator is there for some safety.
4. Vehicle performs most functions, operator can take over if needed.
5. Vehicle performs all functions, operator is not needed.

The third level is where Danfoss is currently focusing much of its development efforts; it is the level at which the vehicle starts to make decisions for the operator said Bleday.

This capability is becoming increasingly important in many off-highway mobile equipment applications, such as construction and agriculture, as a means of helping overcome the skilled labor shortage. Use of automation can also help to improve efficiency and productivity by ensuring work is completed consistently and accurately.

*Power & Motion* had the opportunity to speak with Bleday about Danfoss' automation technology developments as well as trends the company is seeing in this area.

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

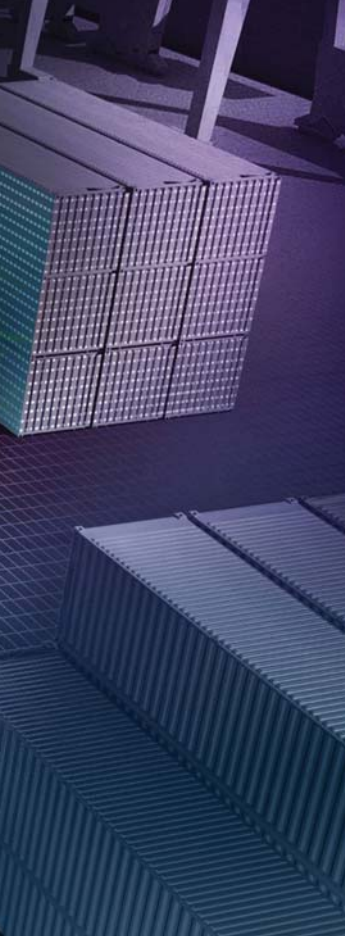
**Power & Motion (P&M): What prompted Danfoss to get into the field of autonomy and what is the benefit of doing so?**

**Peter Bleday (PB):** In early 2017, [we were] just starting to see the need for autonomy from the OEMs' perspective, and we actually started with a prototype and a small R&D team. That team was the DAVIS team, the Danfoss Autonomous Vehicle Integration System [which] was built for a prototype at Agritechnica in 2017. And from there, for the next two-and-a-half years the R&D team stayed together and kept kind of developing. In early 2020, we sat down and said, "Okay, what is driving the market? Is autonomy going to be a major thing? And if so, how should Danfoss provide products to OEMs and distributors?"

Because when you say autonomy, it's such a wonderfully big topic. So, we sat down and really said, "Okay, this is how we're going to go about it and we can provide a lot of software capability." I think the Lego building blocks is my favorite [analogy]...we can provide either the Legos to you and you can build it yourself, or we can build it for you and go about it that way.

A lot of what we've seen, especially in our markets, like agriculture, there's a huge lack of skilled labor. I was out in California [in] October of 2021, and typically they have about 200 people to harvest these large strawberry fields. We were talking to a farmer out there and he had 45-50 [people] that had actually shown up; he wasn't going to be able to harvest





his whole field before the crop went bad. We've seen that [challenge] pushed up to the OEMs because then it's "How can I build a vehicle that does this? Or can be more productive?" The OEMs, a lot of them, especially the smaller ones, they can't do that [autonomy] themselves. And so that's what's really driven us to say we can build the whole solution here.

**P&M: Does Danfoss see agriculture as a key application area or market that really needs autonomy?**

**PB:** There's really three reasons why agriculture [is a focus] and I'll start with the reasons why not mining and material handling. A lot of those are very vertically integrated. In all honesty, Rio Tinto owns the mine and they own everything about the mine.

For them, they work with a Caterpillar to come in to maybe do the vehicles but they're doing the whole site and it's very vertical and a big project. Same thing with warehouses with Amazon Robotics and companies like that.

But in agriculture, there is no big Rio Tinto-style end-user that can really integrate a field like that or a whole site. Also, when you look at food supply from a [global] perspective, Canada before the pandemic left over \$3 billion worth of crops in the field in 2019. And that was just due to the lack of labor [which] goes to the lack of food supply. So for us, agriculture is absolutely a priority; airport ground support as well has been a priority. You've seen all the cancellations and issues there are and so those two industries are where a lot of our mid-sized OEMs are; OEMs that don't have a team of 500 people like a John Deere does to do this by themselves where we can leverage what we have to help them the most.

**P&M: Danfoss does indoor and outdoor capable systems. Are there many differences in how you develop the systems for machines that would work in those environments?**

**PB:** The biggest difference is how the machine localizes and figures out where it is. Outdoors [there is GPS]...we actually use a lot more sensors fused together to figure out position more accurately. But at the end of the day GPS is pretty widely available worldwide. Indoors there is no GPS, and it is very relative to your environment. If you're in [a building] you only need to know what it looks like, you don't need to know what a building down the street looks like. It's a different kind of problem, and one that's a little bit harder to solve and harder

to solve at a scale where we can work with an OEM who's going to deploy their vehicles to 20 or 50 different buildings. The indoor navigation piece is something we wanted to take on right away. Luckily, we do have a lead customer we're working with on that.

For indoor there's a software solution that we're working on that somebody can use to localize themselves. But if there is a Wi-Fi or ultra-wideband network, we can now integrate into those. There's a lot of different technologies...our goal isn't to be the provider of all [the components]; our goal is to really help integrate the system together.

**P&M: Could you talk a little bit about those industry partnerships Danfoss has with some of the sensor manufacturers and how the company goes about doing those? What is that partnership like?**

**PB:** One thing we realized is that the breadth of applications that our distributors see, let alone what we see across all of them, is so wide that no one single sensor is like the Holy Grail of sensors. There's different needs in different places...people ask about dust or airports...we use different sensors [for all of those situations]. And one of the things we realized early on was, we're not going to make the killer app version of that sensor, so why don't we just go find the companies that really do it well and do it ruggedized and build it out. And so, our partnerships are all a little bit different in how they are but one of the key factors is we don't just buy that product and resell it. What we do is, literally in some cases, carry the business cards of our partners with us and when we talk to one of our customers, we'll say based on your application, this is going to be the right sensor for you. Here's the person you need to call to get that sensor because they have their own field support teams. They have their own way to support it, and that's the way that OEM or distributor is going to get their best support is going to be through that partnership as opposed to calling us and us having to call somebody else.

**P&M: And how or where does autonomy and hydraulics systems possibly play together?**

**PB:** What I would say is autonomy is not a part, it's very much a system-level problem. When you look at things like our EHi steering valves which are electrohydraulic, steer-by-wire technology, we have to have steer-by-wire on the autonomy side. We play with the full system and suite of products. We're able to use our E-Steering, we're able to use our hydraulics...and because all of those are electronic and software controlled, now we can add the autonomy to it. With a lot of the hydraulics products being digitally controlled, that's what does the physical work at the end of the day so that interface is key. **P&M**

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Read the full interview at [powermotiontech.com/21252580](http://powermotiontech.com/21252580).

Wilden AODD pumps equipped with its Pro-Flo SHIFT Air Distribution System have the potential to help reduce energy costs and use.

ALL IMAGES: WILDEN



# How AODD Pumps with Effective Air Distribution Systems can Reduce Energy Costs

Air-operated double-diaphragm pumps equipped with technology to reduce compressed air use can help manufacturers curb their energy costs and environmental footprint.

by Tom Zuckett

**E**very aspect of human life is impacted by energy. Its importance is so profound that society would cease to function as effectively and optimally as it does today without energy. The world has several resources that contribute to the energy pie, such as natural gas, refined crude oil and coal, among many others.

But energy isn't without its costs, which is why industrial manufacturing operations need to look at their framework to

ensure they are functioning as efficiently as possible. Energy costs continue to climb, but the price is not the only consideration.

Many industrial companies are developing new manufacturing and production methods to help reduce their energy costs and environmental footprint. Sustainable manufacturing is the term used to describe these new methods. While those methods are admirable and effective, they also come with higher upfront implementation costs.



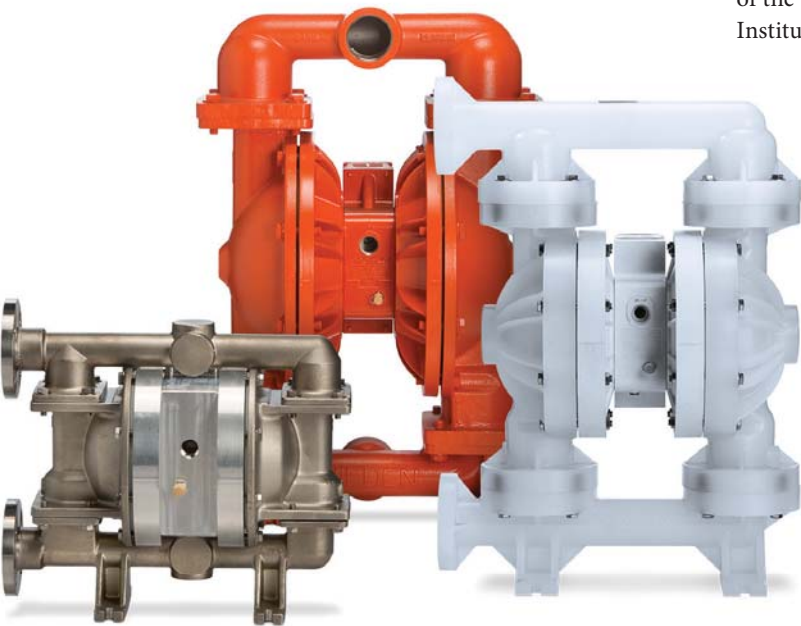
This leaves many operations with a dilemma. Do they opt for sustainable manufacturing to improve the environment in the long term but suffer financially in the short term? Do they forgo sustainability efforts altogether but adversely impact the environment and still pay premium prices on rising energy costs?

According to KPMG's 2020 Survey of Sustainability Reporting, about 80% of the world's leading companies incorporate sustainability programs into their day-to-day operations. For those on both sides of the sustainability spectrum, the challenge will be finding ways to achieve and continuously improve those sustainability measures. The technology used in these operations plays a pivotal role.

### The Challenge with Current AODD Pump Technology

Depending on the utilized technology, some industrial companies can maintain their outputs while reducing their energy consumption. One example comes from operators that use air-operated double-diaphragm (AODD) pumps. This technology uses air as a power source, but electricity makes that supply—sourced by an air compressor—possible. Even though air serves as the primary power source, it still needs electricity to function.

Still, how it uses electricity can be the difference between excess energy consumption and sustainable manufacturing. The importance of energy efficiency and its impact on the bottom line can be found when looking closer at the price of electricity in recent years.



Reducing the amount of compressed air required by AODD pumps can help manufacturers to reduce their energy costs and environmental footprint.

On a national level, the average price for a kilowatt/hour (kWh) 6 years ago was 7 cents. In the spring of 2021, that price point nearly doubled to 13.3 cents per kWh. In 2022, it rose another cent to an average of 14.5 cents per kWh. Even three states—North Dakota, Montana and Oregon—that saw a drop in their electricity prices between 2021 and 2022 still saw their averages jump 3-4 cents higher from the 2017 mark.

Other states, however, experienced price hikes above 20 cents per kWh in 2022. Those states included Alaska, California, Connecticut, Hawaii, Maine, Massachusetts, New Hampshire and Rhode Island.

Out of context, those price jumps might seem miniscule considering it's a matter of a few pennies in some states. But even a few pennies worth of price increases can add up fast to a company's bottom line. Add in the fact that industrial manufacturing serves as an essential driver of the global economy, and it's apparent how fast those costs add up.

For example, industrial pumping systems are involved in 20% of the world's electricity demand, according to the Hydraulic Institute. Another key fact is one that many pump operators are aware of—90% of the costs associated with owning a pump comes from its energy consumption. Those additional cents per kWh truly have a large impact on the cost of doing business.

### Potential Savings Through Sustainable Manufacturing

While pumps require their share of energy to function, reducing those amounts by 30% to as high as 50% by using equipment or upgrading the pump's control system is possible. Because those energy savings are possible, pumps should be a prime target for operators looking to reduce their carbon footprint and trim their operating costs simultaneously.

That's why sustainable manufacturing is paramount for operators now and well into the future. According to the World Commission on Environment and Development, sustainable manufacturing meets today's energy needs without adversely affecting future generations.



AODD pumps feature a simple, two-diaphragm design which uses a common shaft and two inlet and two outlet ball valves, suiting their use for industrial liquid-handling applications.

This effort, in practice, involves operators finding ways to be more economical in their manufacturing processes and using components and equipment to keep waste to a minimum and have less impact on the environment.

There are several factors that industrial operations must consider when it comes to sustainable manufacturing. Those factors include manufacturing cost, power consumption, operational safety and environmental friendliness. While many variables go into making an operation sustainable, having pumps that operate optimally and efficiently play a prominent role in achieving sustainable manufacturing.

### Reduced Compressed Air Use Offers Possible Solution

Manufacturing facilities rely on pumps for several applications and tasks, such as loading and unloading raw materials and finished products to transferring fluids and waste products. The pump varieties are vast, but our focus is on one that relies heavily on electricity to function and serves as a main selection for utilitarian pumping applications.

As stated earlier, AODD pumps use air to operate but require an electrically powered driver, mainly a compressor or electric motor. This reciprocating, positive-displacement technology works well with industrial liquid-handling applications due

Pumps which operate optimally and in an efficient manner play a prominent role in achieving sustainable manufacturing goals.

to a simple, two-diaphragm design, which uses a common shaft and two inlet and two outlet ball valves. The compressed air drives the diaphragms, which prevents mechanical stress during operation, helping to maintain the pump's longevity.

This technology, though, requires an abundance of compressed air to operate, and that supply comes from another power source fueled by electricity. As we know, electricity prices have increased in recent years, meaning these pumps will be more expensive to operate without any other equipment or technology upgrades.

Fortunately, AODD pumps have technology that can reduce air consumption, which scales back on their electricity use. Air distribution systems serve as an enhancement to AODD



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pumps that optimize air flow within the equipment. Wilden, an AODD pump manufacturer, invented the Pro-Flo SHIFT Air Distribution System (ADS) to reduce the amount of compressed air required to operate an AODD pump.

While air distribution systems assist with air flow optimization, not all technologies boast the same benefits. Traditional air distribution systems have an inefficiency when working with AODD pumps. A time delay occurs when pressurized air switches from one chamber to the other in the AODD pump. This delay creates an overflow situation in the air chamber, forcing operators to vent it out of the pump, which does not provide any benefit to the pumping process.

The Wilden ADS overcomes this inefficiency by restricting air flow into the air chamber at the end of each pump stroke. This allows an efficient amount of air into the pump that keeps the process active. A specialized air control spool regulates the air to prevent overflowing without reducing product yield, providing reduced air consumption while maintaining the pump's desired efficiency and flow rates.

Through the Pro-Flo SHIFT ADS, AODD pumps can operate with up to 60% less compressed air compared with other AODD pump technologies. Even with 60% less air, the AODD pumps can reach higher flow rates (up to 34%) than pumps without the Wilden ADS.

In fact, the Pro-Flo SHIFT ADS can operate reliably and efficiently with up to 60% less compressed air when compared to other AODD pump technologies while still being able to achieve flow rates that are up to 34% higher than competitive AODD pump models. Those performance enhancements can lead to much less energy consumption, saving the operators money and minimizing the environmental impact.

These types of efficiencies helped one facility save up to \$1,000 a year in energy costs by replacing their existing AODD pump with a Wilden model equipped with the Pro-Flo SHIFT ADS. The pump ran nearly eight hours a day for five days a week.

### Conclusion

Industrial companies do not have control of energy price fluctuations, but they can find ways to cut back on their consumption and environmental footprint. AODD pumps with compatible and effective air distribution systems can lessen energy consumption while also optimizing the pump's performance.

These small changes that industrial companies can make pay dividends for their operation and the environment. **P&M**

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*This article was written and contributed by Tom Zuckett, AODD business development manager, Americas for PSG and Wilden.*

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- stroke lengths from 50-2,000 mm
- operating pressures up to 5,076 psi
- absolute linearity of  $\leq 0.04\%$  F.S. (min. 0.3 mm)
- meet or exceed ISO, E1, and CISPR EMC standards.

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### SMAC LPL30 Electric Actuators

SMAC Moving Coil Actuators developed its LPL30 low-profile electric linear actuators to provide the speed, consistency and repeatability desired in many manufacturing applications. It is particularly beneficial for use in dosing and dispensing applications which require these capabilities.

Features of the LPL30 electric actuators include:

- programmable speed and stroke
- force up to 70N
- micron-level positioning
- cycle rates up to 2,400 cycles per minute.

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### IronHorse Motor Control Devices

AutomationDirect has added a line of IronHorse branded devices to its motor control product offering. These motor control devices aid the control of AC and DC motors used in a range of applications, and are UL Listed, CE marked as well as RoHS compliant.

Products in the IronHorse line include:

- manual motor protectors
- contactors
- thermal overload relays
- various accessories.

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## Festo ADN-S Pneumatic Cylinders

Festo has added the ADN-S ultra-compact, space-optimized product to its line of pneumatic cylinders. The company shrank the housing length of its ISO standard ADN double-acting cylinder to be used in space-critical applications.

Key features of the ADN-S include:

- short and slim to fit small spaces
- lightweight design
- piston rod with internal or external thread
- two mounting positions
- magnetic piston for position sensing.

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# Q&A: Understanding How to Test and Repair Servo Motors

Proper servo motor testing and repair as well as the tools available ensures machine downtime is minimized.

by Robert Farrell



Brushless Servo Motors offer power and efficiency in a compact form factor which can benefit various applications.  
MITCHELL ELECTRONICS INC.

Servo motors can be used in a range of applications, and like any component, will wear over time. Understanding how to test and repair them can ensure longevity of the servo motors themselves as well as reduce downtime for the machines into which they are integrated.

Contributor Robert Farrell spoke with Stuart Mitchell, vice president of Mitchell Electronics Inc., about testing and repair of servo motors. Mitchell Electronics develops test products for encoders and servo motors, serving industries in which brushless servo motors often fail or require more regular maintenance and troubleshooting due to heavy use or extreme environmental conditions. This includes manufacturing industries such as automotive, aerospace, food services, consumer packaged goods and robotics.

Mitchell offers his insight into common causes of servo motor malfunctions as well as how best to test and repair motors to help maintain productivity.

**Robert Farrell (RF): What are the advantages of brushless servo motors?**

**Stuart Mitchell (SM):** Brushless servo motors offer substantial power in a relatively small package and are more energy efficient than earlier motors. They are often coupled

with high resolution encoders enabling them to accomplish high precision movements. Brushless servo motors do however introduce the requirement that they must be properly aligned with the encoder to function correctly.

**RF: Why do servo motors stop working?**

**SM:** There are several components that can wear out over time such as bearings or brakes. Motors can also stop working due to a buildup of debris or oil in the housing. The encoder can stop working due to problems with the glass disc or the electronics.

**RF: How do I know if a servo motor is malfunctioning?**

**SM:** Sometimes you will notice that the machine stops, functions intermittently, or has reduced efficiency. Certain servo drives and test products can also report errors.

**RF: What are the advantages of testing or repairing a servo motor?**

**SM:** It helps to simply know which part of the machine may be responsible for a failure, for example the servo motor, the servo drive, or a programming or cabling issue.

Many technicians have learned how to align and verify the encoder which

enables reconditioning of the motor and returning it to service quickly. The biggest cost benefit is reduced downtime because lead times for new servo motors can vary. Repairing a servo motor also has ecological benefits by avoiding scrapping a motor.

**RF: What does your company offer for testing and repairing servo motors?**

**SM:** We don't repair anything, rather we focus on providing unique products, personalized customer support and training that enables our customers to do this job.

Our TI-5000JX product is used to test the encoder that is used in the servo motor. It confirms encoder status such as counting, error codes, and alignment angle. The TI-5000JX can also test and reprogram encoder memory.

Our TI-3000JX is a run test product which acts as a universal servo motor drive providing a diagnostic test before or after a servo motor repair. Manufacturer specific servo motor drives can be excellent for verifying servo motors but can be difficult and time consuming to configure. It is also not always practical to have a spare servo motor drive for every servo motor that you wish to run. The TI-3000JX acts as a generic servo motor drive enabling configuration of an unloaded servo motor run test in a matter of minutes in a standardized way regardless of the servo motor manufacturer, allowing you to check if your servo motor is good, bad or not working reliably. **P&M**

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*This article was written and contributed by Robert Farrell, owner of Farrell Mar-Com, LLC and co-founder of Revolution in Simulation.*

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Read the full article at [powermotiontech.com/21264145](https://www.powermotiontech.com/21264145).



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