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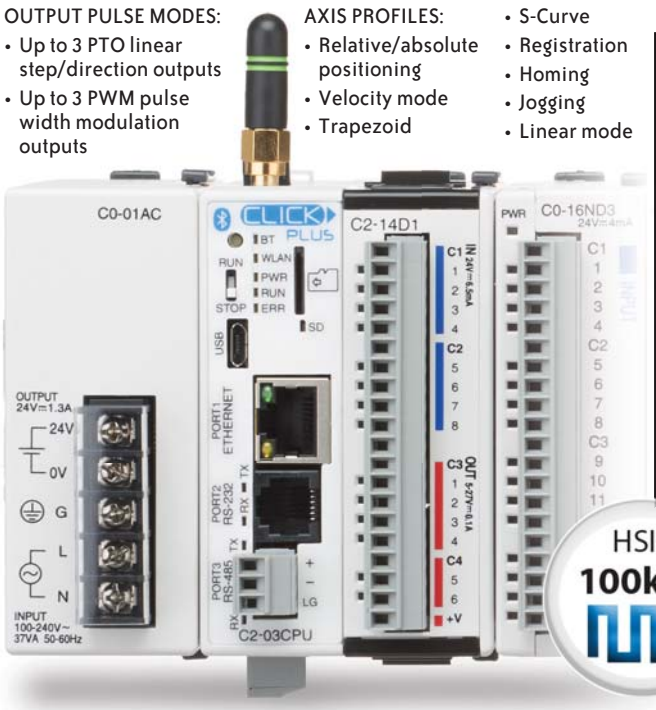

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COVER STORY

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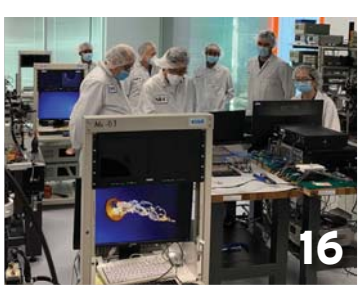

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DIGITAL EXTRAS

NEWS & NOTES

MACHINE DESIGN ISSN 0024-9114 (PRINT) AND 1944-9577 (DIGITAL) is published by Endeavor Business Media, 1233 Janesville Ave., Fort Atkinson, WI 53538. Machine Design is published monthly, except for combined issues in Feb/March and Aug/Sept. Rates: U.S.: $139/year; $199/two years. Canada/Mexico: $159/year; $239/two years; All other countries: $199/year; $299/two years. Cost for back issues are U.S. $10.00 per copy plus tax, Canada $15.00 per issue plus tax, and Int'l $20.00 per issue. OEM Handbook and Supplier Directory, $50.00 plus tax. Prepaid subscription: Endeavor Business Media (MACHINE DESIGN), PO Box 3257, Northbrook, IL 60065-3257. Periodicals postage paid at Fort Atkinson, WI and additional mailing offices.

Canadian GST #R126431964.

DIGITAL SUBSCRIPTION RATES: U.S.: $69/year. Canada/Mexico: $79/year. All other countries: $99/year. Print/Digital combo subscription rates: U.S.: $174/year; $249/two years. Canada/Mexico: $199/year; $299/two years; All other countries: $249/year; $374/two years.

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From the Editor

By Bob Vavra, Senior Content Director

Designing for... Everything?

It's finally time to take the plunge into manufacturing's digital age.

ONE OF THE AREAS *Machine Design*'s content team has explored in 2022 is the relationship between design and operations in a modern manufacturing plant. And as fundamental as that sounds, there are a wide array of ways to take that concept.

There is product design, which must fit within the parameters of process design. Whether we're discussing a car or the fuel to propel it, the product and the process have to be aligned in order to achieve the organizational goals.

Wrightstudio | Dreamstime

But in an increasingly volatile age of economics and environment, there are other design considerations. The product must be designed for efficiency and effectiveness as the end of the manufacturing line, but it also must have a lifecycle that can be managed and optimized. The manufacturing process itself must be efficient to preserve scarce capital and reduce costly downtime.

All of this occurs amid the most seismic shift in manufacturing technology in a generation. The advancement of robotics, artificial intelligence, sensors and analytics have given both the design and operations teams powerful, scalable new tools to better control the throughput of goods. Implementing these changes requires both a capital investment and a change in both the hiring and training of manufacturing personnel in an age when both human and financial resources seemed stretched to their limits.

In short, the challenge goes beyond designing for operations. The process and system design teams must design to optimize everything.

Fortunately, the tools are available. Major suppliers and OEMs are seizing on this surge in technology to turn these tools into dynamic systems that identify operational opportunities and point the way toward a better system, all while maintaining the flow of materials through the process.

Today we can better utilize maintenance staff and better direct line workers by providing the right data in the right context. Our coverage of the Automate Conference in Detroit and the ARC Advisory Group event in Orlando looked at how data is being refined and focused through AI to produce extraordinary insights.

But the start of that focus begins in design. It is here where the future is shaped and formed. It is no longer enough to be wading in the shallow water of digitization. It's time to dive into the deep end of the digital age in manufacturing.

As Craig Resnick, VP of consultancy for ARC Advisory Group told an audience at their recent conference, "There's never been a more important time to accelerate the digital transformation. We don't have a technology issue; we have an implementation issue." ■

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Automate 2022:
Machine Vision Solutions Point to the Future of Automation

Showcasing automation, robotics, vision and motion control, Automate 2022 brought tried-and-true, game-changing solutions to Detroit.

At the Mitsubishi booth, two robots (RV-7FRL and RV-8CRL) simulated their ability to move to various focal points on a workpiece, while the ASSISTA collaborative robot worked around them to inspect various points of interest. *Credit: Mitsubishi*

Technological research firm Gartner uses the word "hyperautomation" to describe a strategic technology trend in which end-to-end automation can be used to transform a business. The term could also apply to the level of disruption displayed at Automate 2022, where exhibitors demonstrated how integrating multiple technologies and platforms are collaborating to scale automation across enterprises.

After a couple of years of lockdowns and trade show cancellations, the biannual event hosted by the Association for Advancing Automation (A3) was a veritable block party for many of the world's leading global suppliers. More than 600 robotics and automation exhibitors congregated at Huntington Place in Detroit (June 6-9, 2022) to share the latest innovations and best practices in machine vision, motion control, artificial intelligence and robotic process automation.

"Coming out of the pandemic, companies in every industry will be looking for automation products and solutions to help them become more successful in an increasingly-automated world," A3 president, Jeff Burnstein, said in a pre-event note to the press.

Alex Shikany, A3's vice president of membership and business intelligence, agreed. The industry has reached historic levels of not only technology adoption but also technology convergence, he pointed out during an industry trends and outlook presentation. With 11,595 robots sold at a value of $646 million, he said, North

American companies purchased "the most robots ever" in a single quarter.

"Every industry, including agriculture, construction, retail and hospitality, is now looking at how they can take advantage of robotics to make their companies more successful," Shikany said.

A3 data showed that while automotive orders remained strong in Q1 of 2022, non-automotive companies are driving the increase in orders overall. During this period, unit sales to automotive OEMs were up 15% while orders from automotive component companies were up 22%.

The data also revealed that non-automotive industries such as metals, warehousing and life sciences—which previously had not deployed automation—currently display "deep levels of automation deployment," Shikany added.

According to A3 data, unit sales to non-automotive industries saw increases in Q1 over the same period of 2021. The data revealed that:

- Metals were up 40%;
- Plastics and Rubber were up 29%;
- Semiconductors and Electronics/Photonics were up 23%;
- Food and Consumer Goods were up 21%;
- Life Sciences/Pharma/Biomed were up 14%; and
- All Other Industries were up 56%.

Robotic adoption has undergone a historical shift, too. In 2011 the automotive industry held 64% market share, while non-auto held 36%. In 2021, the trend had reversed; the non-auto segment of industry held 58% of market share. The trend first saw a reversal in 2020, pointed out Shikany.

"It's just an incredible time that's indicative of all the new applications and industries that are represented at the show," he said. "When you walk through the booths, you see motion control, you see robotics and vision solutions come together. Whether you're coming at it from an investment perspective or deployment perspective, it is all working together."

Line of Sight

A key insight from Shikany's analysis was that machine vision portfolios have been a major factor in the way manufacturers achieve automation milestones.

AT A GLANCE:

- Alex Shikany, vice president, Membership & Business Intelligence, A3, puts a spotlight on the robotics industry's biggest trends and notable statistics.
- The robotics industry is seeing historic levels of adoption and technology convergence plays a big part in its growth.
- Exhibitors at Automate demonstrate how machine vision portfolios integrate technologies that enable complete automation.

The market segment made record gains in 2021. "The annual numbers surpassed $3 billion in North America for the first time on record and indications for the first quarter was strong as well," Shikany said.

The ever-expanding application base for industrial machine vision technology was apparent in exhibitors' cross-sector applications and were also reflected in presentation topics and certification programs tailored to advance attendees' knowledge as Certified Vision Professionals.

From image sensors with higher resolution and faster frame rates, to optics for nonvisible wavelengths and better components for communication protocols, machine builders, integrators and vision developers were on the lookout for form factors that support high reliability, stability and accuracy. What follows is a sampling among a multitude of components and applications on display at this year's show.

Zebra's VS40 shown in a vision application. Quality inspections and track-and-trace cameras can be tailored to business needs. Options include range, illumination, connectivity and power. *Credit: Zebra Technologies*

SensoPart's BlueLight technology can offer greater detection efficiency than conventional red light proximity sensors. *Credit: SensoPart*

A Nod to Fixed Industrial Scanners

Zebra Technologies' fixed industrial scanners and machine vision systems were recognized among the best in machine vision by the judges of the Vision Systems Design 2022 Innovators Awards program. Zebra, which recently acquired Matrox Imaging, brought its first suite of machine vision cameras and fixed industrial scanners to market in 2021.

These systems are powered by the Zebra Aurora software platform, an interface that integrates with factory and warehouse systems. The in-motion vision scan functionality is touted for enabling warehouse workers, AMRs, fixed industrial scanners and machine vision systems to decrease material transport tasks by up to 50%.

Reliable Detection

SensoPart is a specialist in the detection, positioning, identification and recognition of measuring colors and contrast. SensoPart's booth demonstrations were set up to show how photoelectric sensors with BlueLight technology can offer greater detection efficiency than conventional red light proximity sensors, particularly when detecting dark or transparent objects, including black objects with a high gloss surface.

With detection rates of 2 mm to 1,200 mm and with a protection degree of up to IP69K, the solution can be used in the automotive, plastics, packaging and pharmaceuticals industries. The hardware is complemented by VISOR software, allowing applications to be up and running and continuously monitored.

Collaboration is Key

Mitsubishi Electric Automation's "better together" theme and in-booth experience included not only a glimpse of its robots and automation, but also ways in which solutions can be integrated. During a booth visit, Patrick Varley, product marketing manager for Mechatronics at Mitsubishi Electric Automation, highlighted the collaborative effort between Realtime Robotics RapidPlan robot programming and

motion control software and Mitsubishi Electric's industrial robots in a demo cell.

Two robots (RV-7FRL and RV-8CRL) simulated their ability to move to various focal points on a workpiece, while the ASSISTA collaborative robot worked around them to inspect various points of interest. Varley pointed out that in real-world settings, the time spent programming and re-programming industrial robots can take up too much of an engineer's time.

"Realtime Robotics' technology has the ability to speed deployment, operations and production for manufacturers, helping to improve their cost structures and time-to-market," said Varley.

Eye of Production

A long-time supporter of Automate, MVTec Software made its presence known by displaying the company's comprehensive machine vision software product portfolio in a larger booth. In addition to rolling out two new software versions—HALCON 22.05 and MERLIC 5.1—the software company emphasized how its service offerings in application evaluations, training documentation and technical support can be efficiently integrated into customers' applications.

In one demo, experts demonstrated how common bar and data codes can be read using MVTec's software, regardless of orientation and even when the element width was less than one pixel or when the code was partially obscured.

Quality Inspections

Teledyne Technologies showcased its range of its digital imaging products, instrumentation and engineered systems. One of its business units, Teledyne DALSA, demonstrated the Z-Trak 2, configured for 360-deg. in-line inspection and measurement. The 3D image sensor technology can deliver scan speeds of up to 45,000 profiles/sec. and can be used in discrete applications, as well as for continuous extrusion, or outdoor applications such as roads and highways.

The company noted that sensors housed in IP67 enclosures were designed for harsh environments. The instrument is bundled free with Teledyne Imaging's Sherlock 8.1—a point-and-click, rapid application development software package, Sapera Processing RTLs (real-time locating systems) and Sapera LT, a free image acquisition and control software development toolkit.

The Big Picture

What does all of this mean? Automation technology (hardware and software) has in recent years been deployed in record numbers and at historic rates of adoption. For Shikany, the upshot is that alongside the evolving sensing and navigation functionality of robotic systems, the convergence of complex machine vision systems, imaging capabilities and algorithms will continue to play a fundamental role in driving the automation tools that make companies of all sizes more productive. ■

Human Intelligence Still Comes First

In the rush toward AI, experts see it adding to knowledge not replacing it.

Credit: Getty / 1130683181

FOR RON NORRIS at Georgia Pacific, the promise of artificial intelligence only can be realized with practical human intelligence at the start of the process.

"There was no instructional manual for digital transformation. We found that once you did one thing, you had to do something else," said Norris, Georgia Pacific's director of operations innovation at the ARC Advisory Group's North American conference June 6-9 in Orlando. "AI was something we really needed to understand. What we wanted to add was [to] take the knowledge of people who are leaving—the subject matter experts. It's taking advantage of the knowledge of brightest and smartest people we had."

Norris said the challenge of the digital transformation in manufacturing is that while data is available and better organized, the management of all that information requires a way to better identify which are the critical operational challenges.

"What I'm working on, is how do we really work with the connected worker," said Norris. "Right now, we give the worker an iPad and on this iPad are 20 to 25 apps. If something goes wrong, the app gives an alert. If you work in a facility, there's inherent noise. Things are going on everywhere, and now you have these 25 apps going off. How do you prioritize what to do first? That's what I want AI to do—help our workforce. AI will also enhance our learning and development."

Radek Rybicki, senior manager of global operations and data analytics for global food ingredients company Ingredion, told the ARC Forum that there are four key issues worth noting when embarking on an AI project:

- A good AI and machine learning project is one where you can directly measure the benefit in dollars.
- Data engineering and its architecture is very important, especially to get predictions into a control system securely.
- Once something is running, optimizing it can be a diminishing return vs. tackling another problem with a similar framework.
- Try to go after AI problems that can be scaled multiple times in your organization vs. unique opportunities.

The use of AI to understand and predict operational weaknesses comes at a time when process manufacturers such as Georgia Pacific are working to optimize their existing manufacturing platforms. "The assets are what the assets are. If the assets are aging, we have to make a conscious effort to optimize performance, and that can be tricky sometimes," said Norris. "In the past you've had process control, and it works great. With AI, we are able to predict a little closer when something is going to break."

And in a time when remote work is becoming more the norm for office-bound workers, Norris said AI has allowed Georgia Pacific to redeploy its workers. "When we think about redefining the process models, we look at what roles there are in the facility. What has to be proximal to the facility? What roles can be away from the facility?" Norris said. "In the past, we had to have 40% of our employees as insurance, waiting on something to break. We've become a lot more reliably run."

Data is the Foundation

With all the talk of artificial intelligence and digital twins and other technologies driving the digital transformation in manufacturing, the fundamentals of that transformation start with the right information.

"To me, data is the foundation. The data today is largely in silos There's even different versions of the data within the enterprise. Everyone going to have to make a series of trade-offs from conceptual design to operational design," said Harpreet Gulati, SVP of planning and business for AVEVA at a breakfast presented by Schneider Electric June 7 at the ARC Forum.

The opportunity to build a digital-first manufacturing plant doesn't come along every day, said Nathalie Marcotte, SVP and president of process automation at Schneider Electric. "If you go into a new site, you go with digital from the get-go," she said. "If you have any existing operation, how do you implement a digital solution? We're all looking for digital solutions to be more resilient."

"Collaboration is needed across the enterprise," added Gulati.

Noting the variety of pressures on manufacturing over the past three years, Craig Resnick, VP of consultancy for ARC Advisory Group, said the need to look past those challenges to the opportunities beyond was critical. "There's never been a more important time to accelerate the digital transformation," Resnick told the more than 100 attendees at the breakfast. "We don't have a technology issue; we have an implementation issue."

The annual ARC Conference features process automation solutions across all aspects of digitization, including data management, cybersecurity and the IT/OT convergence. Gulati said today's technology is only part of the ultimate solution.

"With the technology of today, we can get about 70% of the way there," he said. "The last 30% will require more innovation. There's a lot of innovation that [is] going to happen. It's going to have to be enabled." ■

Simonkr 531914732 | Getty Images

CUT THE CABLES

Medical devices—ranging from IV pumps and external monitors to implantable devices and hearing aids—can benefit from wireless power to facilitate a better patient experience.

AT A GLANCE:

- A patient's experience shapes her perspective on wireless power solutions for medtech.
- Learn how IoT of medical technology (IoMT) is revolutionizing the patient experience and care.
- Itay Sherman, chief technology officer at Powermat, discusses why portability should be tied to ease of use and how his company leverages the benefits of IoMT to achieve this goal.

by Rehana Begg, Senior Editor

Tori Bentkover is enthusiastic about the progress of wireless charging technologies for medical devices. Not because she is a public relations professional representing a firm that develops the technology, but because she knows firsthand what a difference it can make in a patient's hospital stay.

"For me, physically going to unplug a monitor from the wall was always unnerving," said Bentkover, who suffered for seven years with the debilitating effects of ulcerative colitis, an inflammatory bowel disease, before undergoing surgery to have her colon removed in 2017.

"There's always hesitancy when you have wires coming in and out of you, because you don't want to ruin anything or do anything to hurt your recovery," she said.

Bentkover's hospital experience highlights the routine challenges and limitations patients face. Her ileostomy—a surgery that connects the lowest part of your small intestine to the outside of your body—was performed in three stages. The first part involved removing the colon and

Monkey Business Images | Dreamstime

rectum. "The best part of is waking up and actually feeling better because the inflamed organ is no longer in your body," said Bentkover.

Yet, while she was healing internally, she wore an external ostomy bag. "It's not glamorous," said Bentkover. "During the second part of the procedure, they form what's called the J-pouch from your small intestine and that becomes your new colon. And then you continue the process of healing a little bit. The third surgery is when they connect everything and put it all back inside."

Even before the surgery, there were times when Bentkover ended up in hospital due to iron deficiency and dehydration. During these visits she would invariably be hooked up to IV pumps and monitors that affected her mobility and infringed on her independence.

Improving the Patient Experience

Reflecting on intermittent hospital stays, Bentkover said that not having to unplug cables and wrap them around equipment and physically get to the bathroom when there was a sense of urgency would have been helpful. "As I learn about how companies like Powermat and hospitals are planning for their futures through wireless power, I think it can go a long way in improving the patient experience," said Bentkover.

Antenna Group, the public relations firm Bentkover works for, represents Powermat Technologies, a wireless power solutions developer of inductive charging technology.

Over the past few years, Powermat has been expanding wireless power capabilities into IoT, robotics and automotive segments, and has joined the growing fold of manufacturers that emphasize human-centric design for connected medical devices.

MarketandMarkets reports growth in the medical devices market is driven by the need for cost-containment in healthcare delivery, but is also attributed to rising focus on active patient engagement and patient-centric care delivery. Globally, the IoT medical devices market is forecasted to reach $92.4 billion by 2026 from $26.5 billion in 2021, according to the B2B research group.

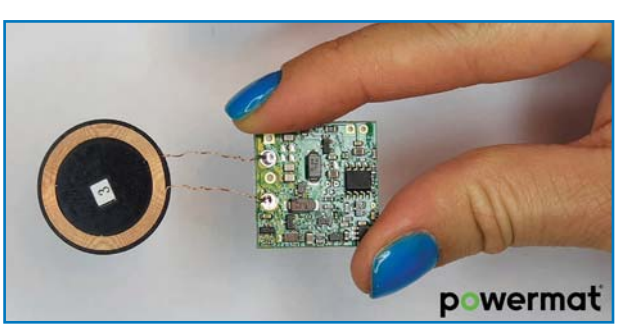
Power to the Battery

Powermat's chief technology officer, Itay Sherman, echoed this trend when he explained that in the IoT of medical technology (IoMT) segment, the benefits of portability are tied to ease of use for the end-user. Powermat's MCU-less system architecture developed for medical devices does not contain controllers, but work efficiently and safely with the use of a passive receiver.

Sherman pointed out that standard wireless power solutions, such as mobile handsets, include a controller in the transmitter, as well as a controller on the receiver side. "The aim of these two controllers is to communicate with each other in order to control the power transfer between the two devices," he explained.

In more advanced solutions, the controller may provide wireless power but also control the battery charge. "But when it comes to creating solutions that are most suitable for power-sensitive, size-sensitive concepts, a designer would want to simplify the receiver side of the equation," said Sherman. "We transferred all of the smarts that exist on the receiver side to the controller of the transmitter and this allowed the creation of a receiver that is very simple. It doesn't have an MCU in it."

The device consists of mostly passive components, Sherman said, but still provides all of the benefits that come with a complete system. As an example, Powermat's PMT 100 Wireless Power Solution was designed for small form factor IoT devices



The Powermat PMT 100 receiver is designed for small form factor devices IoT devices and enables seamless charging. *Credit: Powermat Technologies*

for wireless power and with charging in mind, and it is touted for reducing overall wireless power implementation costs by up to 50%. Power transfer is controlled with smart algorithms in the transmitter side, while battery charging is done on the receiver end.

The solution is driven by SmartInductive technology, which Sherman described as "hybrid" because it draws from both inductive and resonance charging effects. Broadly defined, an inductive effect describes the transmission of electrical charges between atoms in a molecule, while a resonance effect describes the transmission of electron pairs between atoms in a molecule.

The trademarked technology is enabled by the advanced transmitter algorithm that controls both power and safety parameters in devices that require up to 300 W of power. By using wireless power for portable and personal medical devices, designers can reduce the size of the battery and embed it into small sensor devices.

An additional advantage is the ease with which one can sanitize devices. "The fact that you can now create a complete steel device, with no input or output ports, makes it way easier to sanitize devices, but also provides much easier charging capability for the devices," said Sherman. "You just rest the device on its charging pad or connector."

Enabling IoMT

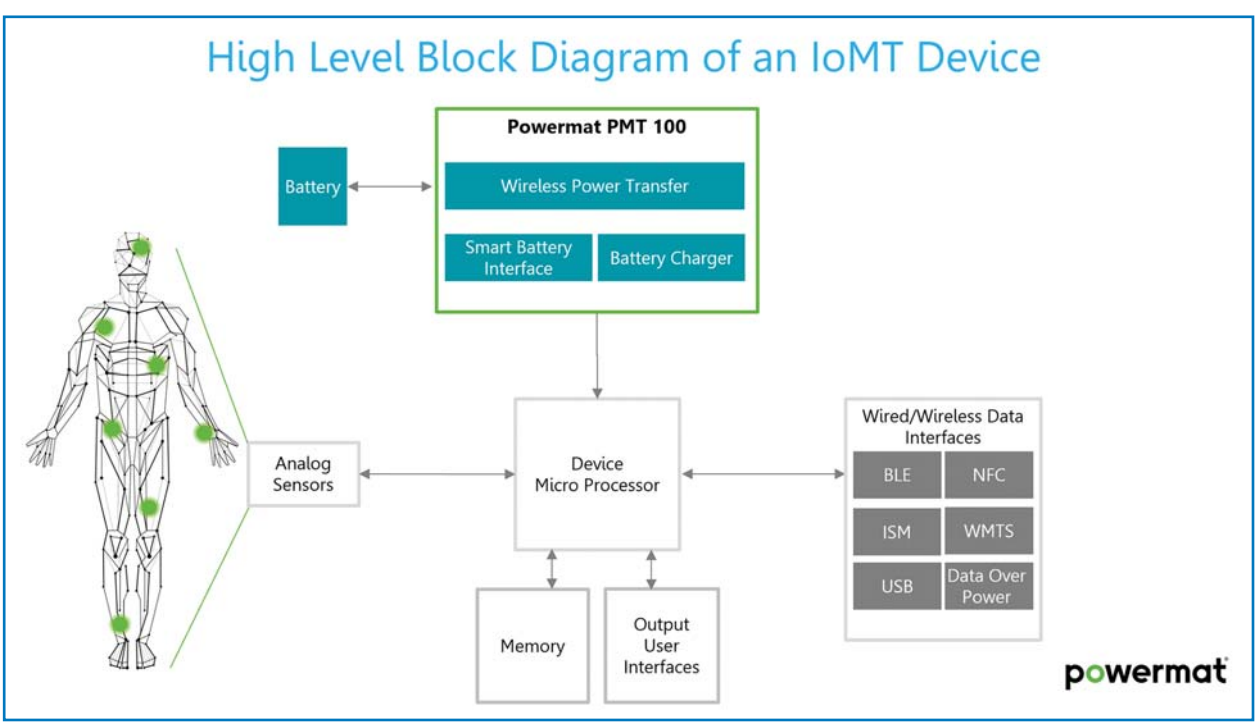
Building capabilities for scalability comes with challenges, and creating a cost-efficient solution ranks high on the list. "Sometimes it's very easy to pick the best-in-class device and you'll get a very robust solution, but it is (a) big and (b) costly," said Sherman. "We are doing a lot of things in algorithms in software in order to lower costs. Sometimes it could mean not using accurate components.

"We don't need, for example, to pick coils that are very fine-tuned to specific inductors," he added. "We can tolerate major differences in production of these coils. And we compensate by using the algorithms that are running on the controller. Essentially, software is for free, so we do a little bit more work on the software and thereby optimize the overall cost of the solution."

If connectivity and interoperability technologies are the enablers in the IoMT ecosystem, then Powermat has made contributions to the design of medical carts, diagnostic instruments and handheld medical devices, as well as wearables and implanted devices such as pacemakers and defibrillators.

Beyond medical design, Powermat has facilitated seamless wireless connectivity that power various products for Duracell, General Motors, Starbucks and AT&T. Cross-industry collaboration and diverting efforts into other segments have helped bridge gaps in creating solutions that provide clinical, operational and, above all, patient value, said Sherman.

Today, Tori Bentkover is grateful for having regained her quality of life. "The hospital setting can be unnerving and dehumanizing, and there are so many studies that show the relationship between hospitals and patient experience and how that helps the recovery and healing process," she mused. ■



Powermat's wireless charging designed for IoMT devices eliminates the need for cables and electric cavities. *Credit: Powermat Technologies*

FMCW LiDAR Gives the Gift of Sight

Human-like perception ranks high on a list of sought-after applications in the race for autonomous driving. SiLC has a laser focus FMCW LiDAR to enable this and other applications.

by Rehana Begg, Senior Editor

AT A GLANCE:

- The development of robust sensory systems at a commercial scale has a long way to go before self-driving, fully automated vehicles can be declared safe for commercial consumption.
- FMCW LiDAR on a chip may provide the sensory capabilities that will propel autonomous vehicles to commercial success, noted Mehdi Asghari, CEO, SiLC Technologies.
- SiLC's 4D FMCW LiDAR integrates photonic components, such as lasers, waveguides and amplifiers onto a single silicon chip; its relevance extends across verticals.

It's been a while since we spotted those clunky spinning cylinders perched atop autonomous vehicles cruising highways.

First seen on Google's prototype vehicles in 2010, those unwieldy mechanical devices were designed for function rather than form and would become heavily reliant on in-built sensors that collected information from mapping information systems, on-board video cameras, radar and laser range finders that could decipher objects as far as two football-field lengths.

Aware back then that it was just the precursor to the miniaturization of self-driving sensor technology, Google noted in a blog post that "our software and sensors do all the work."

Self-driving innovation has exploded since then, but safety above all else remains the cornerstone of design when it comes to autonomous vehicles. Autonomous navigation is made possible by the complex process of gathering sensor information—integrating data from a sensor network, including camera, radar, ultrasound and LiDAR—along with image recognition software for analyzing the data and making intelligent decisions based on the operating environment.

SiLC's Eyeonic Vision Sensor integrates laser, optical circuitry and detectors into a single, silicon photonics chip (the orange-reddish chip in the center). *All images credit: SiLC Technologies*

LiDAR Takes the Lead

The push to add precision to detect what's in our environment has a long trajectory. Initial recordings of sonar (sound navigation and ranging) can be traced all the way back to 1490, when Leonardo da Vinci used a tube inserted

into the water to detect vessels by placing an ear to the tube.

Radar (radio detection and ranging), which is used in advanced driver assistance systems, harks back to the late 1880s when German physicist Heinrich Hertz noticed that electric waves emitted from a transmitter and reflected by a metal surface can be used to detect distant metallic objects.

LiDAR (light detection and ranging) came to the fore after the invention of the laser in the 1960s; it was first used in aerospace applications in the 1970s before being used more extensively in consumer and commercial applications in the 1980s.

Driverless Agenda

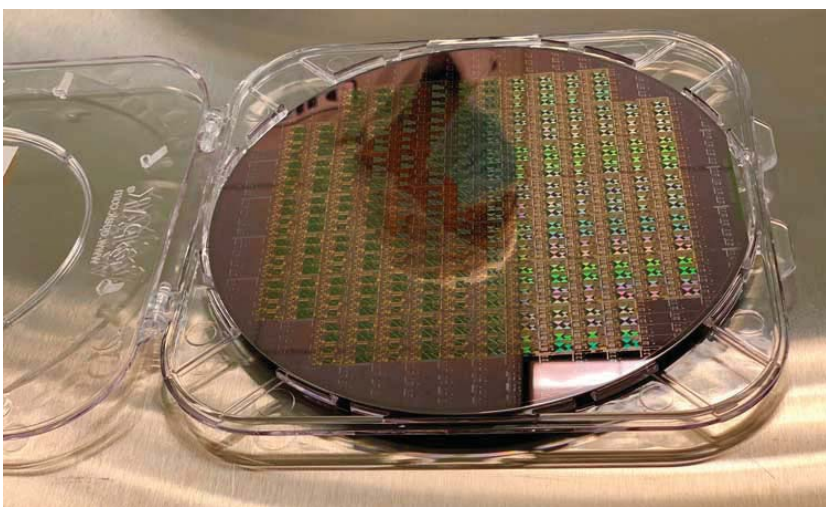
Far from being the silver bullet that points the way for autonomous vehicles, the development of robust sensory systems on a commercial scale has a long way to go before self-driving can be declared fully automated (level 5) for commercial consumption. For one, piecing together the decision-making process requires real-time imaging and accuracy that rival the complexity of a human's perception capability.

Among available options to gather the staggering amount of data needed to make accurate navigation decisions, LiDAR stands out as a sensory system of note for companies working on autonomous vehicles, argued Mehdi Asghari, CEO, SiLC Technologies.

California-based SiLC announced in May that the company had signed a deal with Shenzhen-based AutoX, an AV company that provides robotaxi service on some of China's public roads. AutoX will use SiLC's LiDAR-based vision solution alongside other sensors in the car tech company's proprietary hardware stack.

SiLC's FMCW LiDAR transceiver, known as the Eyeonic Vision Sensor, is a silicon photonic chip that integrates LiDAR functionality into a single, tiny chip the size of a fingernail. "FMCW (frequency-modulated continuous-wave) LiDAR is basically a technology that enables you to directly measure depth and velocity of objects by measuring the Doppler frequency shift of the light that reflects from them," said Asghari.

"Compare it to the sound effect of an ambulance going by," he explained. "You hear the frequency of the sound is a little bit higher in frequency when it comes towards you and a bit lower when it goes away from you. The pitch basically changes.



SiLC uses a vapor fabrication process and manufacturing techniques for making smartphone chips.

An ultra-low linewidth laser, a semiconductor optical amplifier, Germanium detectors and meters of optical circuits are integrated onto a silicon photonics chip.

"That also happens to be the case for light waves. When objects come toward you and when light reflects off them, it has a certain frequency. When objects go away from you, the light frequency shifts. You can use that to measure the frequency, velocity and motion of objects. You can apply the same [technique] to measure distance."

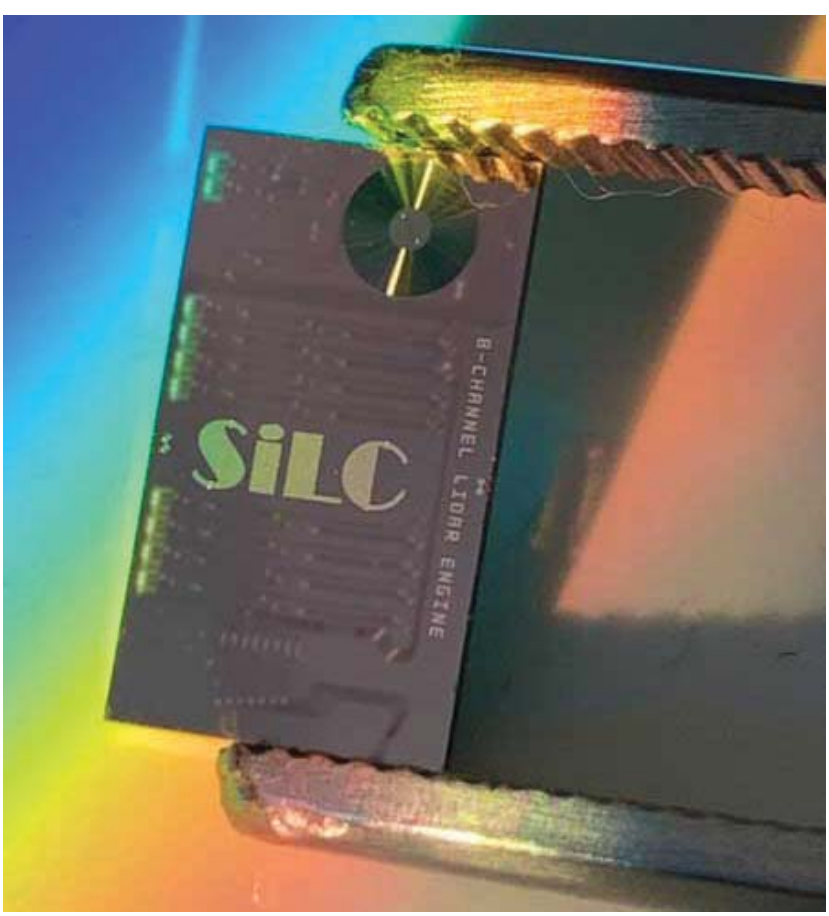
LiDAR on a Chip

The 4D chip-scale FMCW LiDAR integrates photonic components, such as lasers, waveguides and amplifiers, onto a single silicon chip. The vision system can achieve micrometer-level precision and can see objects up to 500 m (1.640 ft.) away under the right circumstances.

In addition, Asghari explained that Eyeonic uses coherent optics to provide polarization intensity data. "Light travels in two polarizations—transverse electric and transverse magnetic—and contains content that some of some of our customers may care to know about," he said. "We provide that information to them and we are the only company that can resolve these two polarization components."

Although FMCW vision capability using Doppler shifts can provide unique sensory information, Asghari maintains that hurdles remain for many who attempt to design technology around it. That's because developing a "true" vision system that is independent of lighting; does not interfere with other sensors; can measure velocity and depth; and can provide superior vision while cutting back on the cost of computing power quite often can end up with hundreds of thousands of dollars' worth of hardware, pointed out Asghari.

"Companies that are trying to make this now are trying to source as cost-effective components as they can afford, and they end up with a shoebox size at best that simply doesn't scale," he said. "It's not going to fit inside your smartphone. It's not going to fit inside your AR/VR glasses. It's not going into smart devices that you use at home."



The Eyeonic Vision Sensor is a silicon photonic chip the size of a thumbnail.

Last year, SiLC raised $17 million in a venture funding round to support the launch of its LiDAR imaging chip. The company designs its vision systems on a vapor fab process, which is used for making smartphone chips. "We have an amazing level of complexity in these chips that can perform the complex stacks we need them to do, and we can make them for extremely cost-effective prices that enable them to become ubiquitous," said Asghari.

SiLC joins an exclusive club that already has traction in the automotive space; Luminar Technologies, Ouster, Velodyne, Aeva and Innoviz are among those firms. As a startup, SiLC is carving out an integrated solution and business model designed at once to reduce size, cost and power consumption.

"Our business model is one of a component subsystem supplier," said Ralf J. Muenster, vice president, Business Development and Marketing at SiLC. "Similar to the Xilinx and Texas Instruments collaboration, people want to buy these components, put them in their system, make the system their own and put their software around it."

Being part of a photonics manufacturing ecosystem means the business model remains resource intensive, admitted Muenster, who spent 12 years as director for the CTO office of Texas Instruments before joining SiLC. "We need to work closely with customers to design in our components, and in many cases actually teach them how to do it. We have full reference designs, we've written the full software, and so that takes time."

Even so, there is a long runway for LiDAR sensor firms that are poised to succeed. "The next cycle is going to be the Age of Autonomy, where we can get rid of mundane tasks like driving a car for hours on Highway 5 down to Los Angeles.

SiLC technologists use a proprietary silicon-based semiconductor fabrication process to manufacture chips along with IC-style assembly processes.

That's no fun," said Muenster. "With the current inflation concerns and supply chain issues, should we have humans that either drive lorries or flip burgers or do other things that we just don't have the human resources for?

"And I think this is going to drive innovation in the next 20 to 40 years…It's just starting in manufacturing. You see 3D sensing growth going to 1 billion units by 2027, 2D sensors already growing to 10 billion units a year. And we think 4D sensing will be on the same trajectory."

No Shortage of Applications

The uptake of 4D LiDAR vision sensing technology for solving manufacturing problems is sprouting everywhere in the robotics, industrial automation and mobility space (ADAS, AVs, robotic delivery, robotic trucks, drones, etc.). "There's a huge pull from companies that are extremely fast growing and have very large market caps and try to solve manufacturing challenges," said Muenster. "They have a conveyor belt at Amazon, where they're trying to detect all kinds of different materials and the current sensors are just not good enough.

"Or, [manufacturers] want to go down to 25 micron precision and figure out how to measure that," he continued. "Yet others want interference-free operation down to millimeter level, which existing time of flight solutions can't give you. Basically, in factory environments they have limited [sight] and limited range to centimeter level precision. There are a lot of applications in manufacturing that require just millimeter level precision—and that's something that comes out of the sensor."

Muenster's ready list of relevant FMCW LiDAR sensing examples include healthcare (monitoring motion without invading privacy), lifestyle (casino security cameras can detect unruly behavior) and sport (analyzing movement to get an edge on the competition).

For both Muenster and Asghari, automotive provides a "golden opportunity" in the long term, but the "big prize" is the consumer market. As an example, Muenster pointed to Apple's LiDAR sensing facility on its iPhone 12 and 13 range of devices, which is a time-of-flight LiDAR that has a range of about five meters and an accuracy of one centimeter.

"If you try to scan your house or anything with it, it's fairly inaccurate," Muenster said. "What you really want is millimeter-level precision, and we can provide a wider range. Ultimately, there's no doubt in my mind that this technology will also go into mobile phones and smart glasses."

Should Asghari's claim hold true, SiLC can for the moment bet on being the only company that "can miniaturize such a complex device in such a tiny form factor, and therefore fit it inside a smart glass or inside the cell phone, or inside the smart laptop or tablet."

Judging by the explosion of use-cases across verticals, however, the startup will in the near future also bet on facing formidable challengers. ■

FOR MORE ON SiLC Technologies' long-range FMCW LiDAR transceivers, be sure to check out *Machine Design's* video interview with Mehdi Asghari at *https://machinedesign.com/21242491.*

by **Rehana Begg,** Senior Editor

3M's Pulse of Public Trust in Science

3M's chief science advocate, Jayshree Seth, shares highlights on the 2022 State of Science Index and discusses why misinformation affects sentiments.

WISE WOMEN IN SCIENCE & ENGINEERING

Consider the facts: The importance of science in America has risen by double digits since its lowest point in 2019. Scientists and engineers are the most credible sources in the U.S.

These two data points were revealed in the 3M 2022 State of Science Index conducted by Ipsos. The study is designed to provide a finger on the pulse of the public image of science across the general populations of 17 countries. The independent research reveals trend lines over time, as to how much people trust, respect and value science and the role it plays in our lives.

"We want to understand the public perception of science," said Jayshree Seth, 3M's chief science advocate and a corporate scientist who works with engineers and scientists to break down complex problems and find solutions. "What does the world feel about science? How does the public see its relevance and how do they view its importance for our future? We have been conducting this global survey for five years now, because we think science matters and we think what people think about science matters."

That makes a good rationale for its coverage in *Machine Design*, too. In the following transcript of a recent screencast, Seth unpacks the highlights of this year's survey.

***Machine Design*: I read the press materials and the report, and I came away with the idea that there is an overwhelmingly positive appreciation for science among Millennials and Gen Z. Can you give us your high-level overview of this year's outlook?**

Jayshree Seth: I can share three highlights that jumped out at me. First, it's really good to see trust in science is high in America and throughout the world. Second, the public is very aware of widespread misinformation on social media and traditional media, and they're very concerned about it. And third, people agree we need more diversity in science and Americans acknowledge that we need to do more for achieving equity in scientific fields. And, as you mentioned, our data indeed shows that the younger generation thinks about science more, appreciates it more. That trust and that interest that the younger generations have, I think is a great sign.

I'm very encouraged by that—as a citizen, as a scientist and as a mom of two Gen Z kids. So, the good news is, trust is high. Living through the pandemic has positively impacted the public perception of science. And it resonates. It's a real testament to what science has delivered in the pandemic and the promise people see science holds to drive impact in the future.

***MD*: I will go through all of those themes that you mentioned categorically, but I want to step back for a moment. Give me a little bit more of a snapshot of the survey methodology and the broad scope of the population that actually participates in the study.**

JS: 3M's State of Science Index is original, independent research and the 2022 survey was conducted from late September to mid-December in 17 countries, and in those countries among nationally representative thousand-gen-population adults, based on their census demographics of that particular country. The countries were picked to represent developed and developing economies, and included countries have specific interest based on 3M presence there. The list of countries are Australia, Brazil, Canada Colombia, China, France, Germany, India, Italy, Japan, Mexico, Poland, Singapore, South Korea, UAE, UK and, of course, the U.S. The survey was actually conducted by a global research firm Ipsos and a combination of online and offline interviews was used.

***MD*: Despite the overall positive tone, the survey shows that misinformation remains widespread and that's the sentiment that we've seen throughout the media. What can you tell us about the impact of misinformation on scientific credibility?**

JS: The survey found that the public certainly believes that misinformation has become a big problem. People do place trust in news stories about science, higher than other topics like sports and health and entertainment. But overall, complete trust is low, so we have to address the problem of misinformation, especially as it relates to science.

As a scientist, misinformation is really concerning because it can threaten scientific credibility.

And the science community is also very concerned and the research around this field is coalescing. But the people recognize that it can have serious consequences. And, it is consequences across the board—in health issues, in public health matters, in addressing climate change, etc. But it's interesting that many Americans (82%) actually said they want to hear more from scientists directly. So that does provide a great opportunity for scientists to communicate more often, on news and on social media platforms in any kind of opportunity that they get to connect with the public.

***MD*: I certainly agree with that. And that's why I love this platform. It creates that direct interface with our audiences. The report also uncovers some interesting data about climate change concerns. Can you elaborate on those concerns, especially among young people and people of color about being displaced from where they live?**

JS: Yes, certainly. Our survey found that nearly seven in 10 Americans are concerned that they or a loved one might one day be displaced from their homes due to extreme weather related to climate change. Globally, actually 80% feared this, while 70% of those surveyed believe extreme weather is the number one direct impact of climate change. For Americans, that number is not far off, at 66%. When you look at the people of color in America, concern around displacement increases significantly (Black Americans 79%; U.S. Hispanics 76%; compared to the 70% overall American).

But it's interesting: Across all demographics, 84% of Americans are confident that science can help to minimize the effects of climate change. Globally, that number is even higher; I think it's 88%. And people agree that we should follow the science to help make the world more sustainable. You can see how, living through the pandemic, that science was able to provide a solution and there's no doubt that it will eventually vanquish this pandemic. It has also provided this relationship for people to understand that science can solve other challenges as well.

***MD:* Another topic is on barriers to STEM education. I'm going to read the statistics and then I'd love for you to comment on what the gap and the impact of each of these findings means to the scientific community. The first one is, "While nearly all Americans believe it is important to increase DE&I (diversity, equity and inclusion) in STEM fields (87%), about two-thirds also agree that underrepresented minority groups do not receive equal access to STEM education (69%)". My questions are: What does this gap in the numbers tell you about the current state, and what can we learn from what seems to be an opportunity to address disparity?**

JS: You're absolutely right. I think it's great to see that more Americans agree it's important to increase diversity in STEM fields. And we also are acknowledging that STEM equity needs significant work. What it means to me is that people seem to understand that a diverse workforce is a robust workforce, that increasing diversity will be correlated with increasing innovation, increasing diversity will also lead to a more positive perception of science when people see the makeup of society reflected in the scientific community.

But we may also need to make the barriers faced by underrepresented minorities more visible, because we need to break them down to facilitate the diversity we need, and foster the inclusion, and further the cause of equity in STEM fields. It is critical to ensuring a robust and diverse pipeline of STEM talent.

This requires in my mind actions from the entire stakeholder spectrum. It's not just access; it is exposure and it is the encouragement of economics in some cases, it is the empowerment people feel, it is the engagement, and then, by achieving of equity. I actually call it the echo system. I'm proud of 3M's effort along the spectrum to help the cause. We're addressing this at every point in this entire system.

***MD*: Here's one more statistic: "Americans differ sharply in their acknowledgment of a racial/ethnic gap in the STEM workforce. While 56% of all Americans believe a racial/ethnic gap exists in the STEM workforce, responses diverge within demographics: 72% of Black Americans and 61% of U.S. Hispanics report seeing a gap versus only 49% of white Americans." How do you interpret these results? If we were to cast a DE&I (diversity, equity and inclusion) lens over the data, would you say that there's a possible blind-spot effect here?**

JS: Well, we know that there's a representation gap. It's very evident. But many people may not be seeing it because the perception doesn't match the reality. We need greater acknowledgement of these gaps, so we can work on closing them. If people aren't even seeing it or acknowledging it as a gap, how are we going to close it?

I just have to look around, and I can see that it isn't where it should be based on the demographics. It's easier to perhaps see lack of representation when you are part of the group that is underrepresented. The bottom line is, we need all the diversity of thought and experiences we can get in order to creatively solve the problems we face. I mean, it will be 9 billion of us just in a few decades. We need to unlock the secrets to a sustainable future and we need to make sure people understand we can't do that if we all think the same, look the same, feel the same—or be from the same background, same community or same college, for that matter. And that is one reason we need diversity; it's a matter of survival.

> *"The bottom line is, we need all the diversity of thought and experiences we can get in order to creatively solve the problems we face."*

So, we have a lot of room for improvement on that STEM equity front. It has a wide-ranging impact—it impacts talent pipelines of companies like 3M and other science-based companies that I'm sure you talk to. People are slowly beginning to appreciate and understand that environments that lack diversity can be closed communities, like ECHO chambers.

And we have to somehow break that down because the same voices will continue to reflect and reverberate. And the problems will be identified with a narrow point of view. We have clearly seen with the pandemic that there is an urgent need for a broader perspective and social context for science and building a more diverse science community in science as a more inclusive space because a narrow view makes science itself vulnerable. And we don't want that.

So, we at 3M understand this, and are aligned with the sustainable development goals. We're committed to inclusive innovation and we want to create a diverse science community and a more positive world with science. We invite people to join us.

***MD*: Healthcare shows up as a key area where Americans are looking to science for solutions. What insights can audiences—such as those who are in the medical devices industry or media outlets such as Machine Design—glean from the data in the survey?**

JS: With the pandemic, it's very clear that the connection between health and science perhaps got stronger. It's not surprising. Our interest in our own health is actually a great way to pull people into science. When it comes to the data from our State of Science Index, the top healthcare advancements people want science to prioritize are cures for chronic diseases and cancer treatments and, interestingly in our 2022 results, the third position people say science should prioritize, is addressing mental and emotional health issues, with even more urgency than vaccines for future pandemics.

We also see across the world access to quality healthcare is considered the number one priority for most countries. I think it's 13 out of 16 countries that ranked "improving access to

quality healthcare" as top action for their country to prioritize. During the pandemic people got a chance to see how this plays out and how there is a disproportionate impact.

In regards to collaboration between corporations and healthcare, that is also a priority. Among top actions people want corporations to prioritize, beyond your core business purposes, is work with the healthcare industry and other entities, so you can improve quality of care and address the root causes of health disparity with underserved and underrepresented communities.

Due to the pandemic—how it disproportionately impacted some communities, how the death and devastation occurred, how lives are ended and upended—that social context is top of mind for people. Science has been given a very human context and societal perspective because of the pandemic. And healthcare is truly personal.

***MD*: What surprises you about the data? The surprising finding for me was that Americans are less enthusiastic about futuristic innovations, such as self-driving vehicles. That is surprising. It was also interesting to read that excitement over artificial intelligence (AI) is not as high in the U.S. as it is globally, and it declines among older generations and white people. Can you make sense of this for me?**

JS: It's always interesting to see the results and then try to rationalize, right? We have had all sorts of discussions. I'll share with you one perspective. Americans have actually had significant exposure now with EVs and they know the benefits and the kinks. It's possible that their view may be more pragmatic. Maybe we can dig into this in our future research and look more into it.

Again, as for AI, there is so much discussion in the U.S. about how bias creeps in because of lack of representation. And that perhaps makes people more wary. Maybe. I mean, the data is what it is. It's the rationalization and the context we can put behind it. That's one way to think about it.

One surprising insight to me was that more people don't recognize the role bias and prejudice towards women and racial minorities plays as a barrier to pursuing a strong STEM education. Only a quarter of Americans believe bias is a barrier. And it's interesting: Last year we asked those who encountered barriers that held them back from STEM what the barriers were; 50% of those in the U.S. said that they felt discouraged and it was because of their gender, race or ethnicity. That figure was much higher in the U.S. than the global average; it was 50% in the U.S. and 27% the global average.

Regardless, I think greater diversity in sciences will lead to greater impact. I'll tell you the way I like to say it is: Our world requires innovation. Innovation needs science. Science demands diversity. And diversity warranty equity.

I'm a passionate advocate for breaking down these biases and barriers and boundaries to help women and girls and minorities not just enter, but excel and persist in the field. A big part of this is role models. One of the things 3M did last year was a premier docu-series called, "Not the Science Type." It features four diverse women scientists. I'm honored to be one of the scientists featured in it. With this docu-series we just want to inform and influence and inspire by showing that we can all be the science type, regardless of gender and race and age and ethnicity.

***MD*: Thank you for sharing that. Let's end with your key takeaway of the survey.**

JS: The pandemic has really given science a lifeline of support. It was an interesting time. The entire world was facing the same existential crisis and confronting the same fears, and most of us waited for our gift of science in the vaccine. Science, which was seemingly invisible, underappreciated and taken for granted, was suddenly thrust in the public discourse. Scientists were centerstage. So, no surprise, it became the time to stem skepticism.

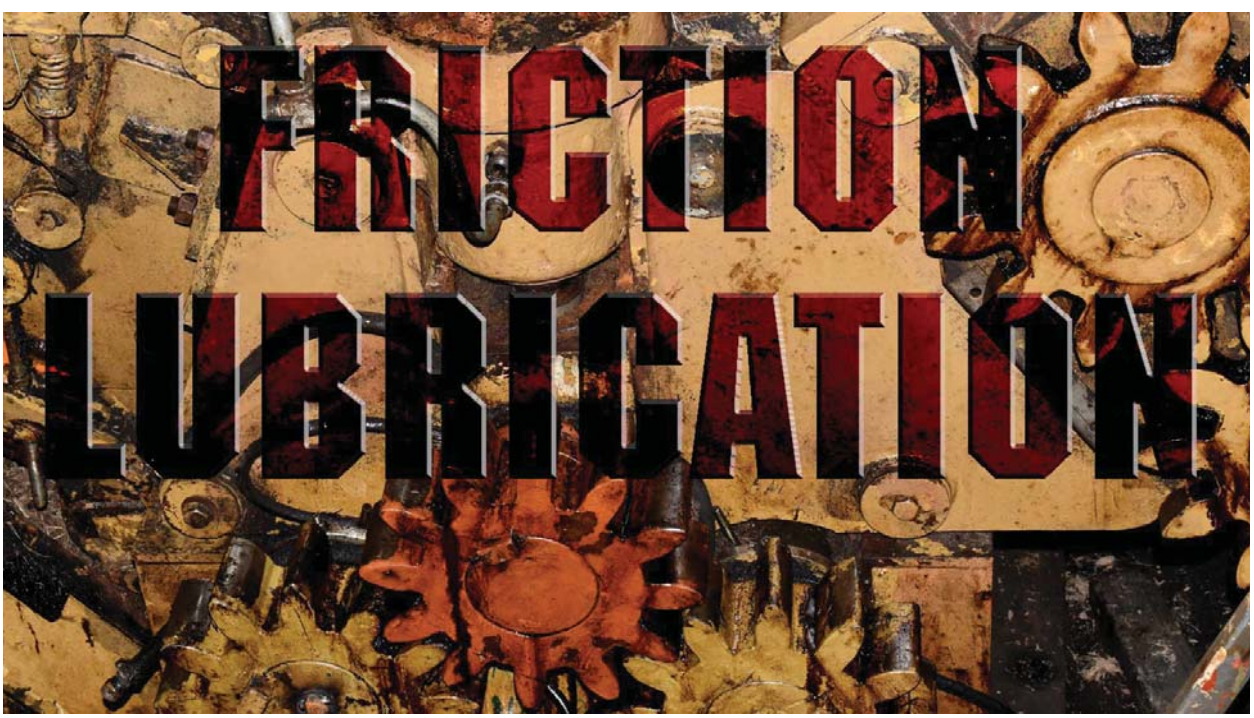
Since the pandemic trust remains high. People associate science with hope for the future, hope for the planet and for the next generation. STEM and the younger generations have a deeper connection with science—and that gives me hope. ■

FOR THE VIDEO INTERVIEW with Jayshree Seth, visit *https://machinedesign.com/21243380.*

Tribology by Design:
A Revolution in Tribology

Tribology by design (T/D) will help engineers more effectively build enduring products by including friction, wear and lubrication in the design process.

by Vern Wedeven, Wedeven Associates, Inc.



Christophe Tausch | Dreamstime

Friction and wear pose incredible challenges to 21st Century mechanical and electromechanical systems, particularly in the fields of nanotechnology, aerospace and biotechnology. By one estimate, 6% of the gross national product is lost or wasted due to damaging friction and wear. Yet, despite tribology's obvious importance, most engineers don't have effective ways of including it in their design processes.

The reason so many engineers lack good methods of including tribology in design is at least partly due to its complexity. In some applications, bearings and gears have contact points that must carry enormous loads at low and high speeds, and the stresses are unbelievably high. Motions are also extreme and contact areas are small—the size of a pinhead, in some cases. There's also heat generated, which brings chemistry and hydrodynamics into the equation. All of this happens on a micro-scale and is controlling performance. Factor in new and sometimes unfamiliar tribology interface materials and manufacturing requirements and things get even more complicated.

How do you design for life and durability under such extraordinary circumstances?

The Moonshot Challenge

The sad reality is that all too often, engineers don't. As a result, some projects don't go as well as hoped. There are delays, mistakes and missteps because of the complex tribology challenges that come into play.

Take, for instance, the Apollo 17 mission. NASA officials agreed that lunar dust was one of the greatest hurdles to nominal operation on the moon because of the mechanical problems

it causes. In a previous mission, lunar grit clogged radiators and even wore a hole in the knee of an astronaut's spacesuit. NASA is now planning an experiment for next year, the Regolith Adherence Characterization mission. Its goal is to determine how and why dust sticks to materials during lunar landing and other operations. The findings will help determine how to design equipment that repels dust and how to make spacesuits that don't break under the wear-and-tear of contact with the moon's sandpaper-like grit.

This is a good example of the problems that can arise in the world of tribology and how it can take a long time to solve those problems. If we could solve tribology problems faster, we could not only promote faster innovations but also greatly reduce the costs and risks of mistakes and unforeseen events.

Tribological failure can also be dangerous or even deadly, as demonstrated when a wind-turbine gearbox caught fire in Scotland in 2011 or when Alaska Airlines flight 261 crashed in 2000 due to excessive wear on a jackscrew in the flight control system. And in the early years of the space shuttle, NASA engineers had to replace the ship's main engine turbopump bearings after every flight.

It took more than a decade to solve this risky and expensive problem, which involved harmonizing tribology materials with complex design and manufacturing.

Tribology by Design: A Formula for Success

Whether you work in aerospace, automotive or aviation, where advanced tribology started, there is now an approach to reduce the risk by helping engineers better understand tribology challenges and more competently design for them. It's called Tribology-by-Design (T/D).

T/D combines a theory, a set of test and analysis tools, and a methodology. It was developed to get powerful tribology mechanisms into engineering design to let engineers design and develop component contact interfaces that can carry loads and transmit power under extreme conditions.

This year T/D is being taught to engineers around the globe as part of the Massachusetts Institute of Technology's Professional Education course, "Tribology: Friction, Wear and Lubrication." I will be an instructor for a session that explores how T/D connects and differs from axiomatic design (AxD), a widely adopted design methodology developed by the course's lead instructor, Dr. Nam Pyo Suh, Cross Professor Emeritus at MIT.

AxD uses matrix methods to systematically analyze the transformation of customer needs into functional requirements, design parameters and process variables. It's used to design the best possible solution for planned features and functions.

T/D methodology is complimentary. It differs in that it targets the operating conditions or duty cycle of a critical component within its operating system, and predicts and solves tribology problems to save time on testing and redesign. The theory characterizes critical tribology interfaces in terms of motion, stress and temperature, and how these parameters activate the tribology interface materials and mechanisms during operation (MST-Tm).The T/D process extracts and delivers the targeted MST-Tm to a virtual TRL 4 (Technology Readiness Level 4), where innovative tribology R&D can be done using T/D test and analysis tools.

The three T/D tools represent component analysis, single contact models (SCM) and single contact simulation testing. These tools provide, respectively, a component digital twin, an interface digital twin and an interface simulation twin.

A Missing Link: Motion

Design and life theories for bearings and gears are based on stress and contact-fatigue stress-cycle criteria, along with a "material life factor." In contrast, T/D theory is based on motion-driven mechanisms for lubrication and performance which is more consistent with physical reality. "Tribology" by definition is the science and technology associated with contacting bodies in relative motion. It is all about motion.

> *"Tribology" by definition is the science and technology associated with contacting bodies in relative motion. It is all about motion.*

Consider a violin. A bow resting on a string does nothing but add motion to the bow, and you get a frictional mechanism or a motion-driven mechanism to make harmony. We need motion to engineer the interface materials and achieve functional harmony.

Tribology is enormous, and it is everywhere. Increasing demands for more performance and energy savings continue to drive innovation in mechanical systems. Introducing new materials, designs and test methods will play an important role in future progress.

But relevant tribology design parameters are urgently needed to support new bearing and gear materials, lubricants and designs for transportation, energy and industrial components. Using T/D theory, test and analysis tools, and methods to discover and apply new technologies will open the door to a much more rapid response to tribology challenges, faster innovation, reduced costs and mitigating risk.

Engineers have much to benefit from bringing T/D into design. It will let them keep pace by providing a systematic way to cover all the bases. ■

VERN WEDEVEN is the founder and president of Wedeven Associates, Inc. He has written more than 90 technical publications and is a co-instructor of the MIT Professional Education course.

The Best Bearing Lubrication System May be None at All

Using lubed-for-life plastic bearings lets designers eliminate the need for complex, maintenance-heavy lubrication systems.

by **Matt Mowry,** igus Inc.

Machine and equipment manufacturers are feeling more pressure than ever to cut costs without sacrificing machine performance, a balance that can be difficult to achieve. OEMs often overlook a simple way to get a long-term improvement in profitability for themselves and their customers: eliminating bearing lubricants. By getting rid of lubrication subsystems, OEMs reduce production costs while making their equipment more marketable and less expensive to operate. At the same time, the costs and hassles of properly disposing of used oil can be eliminated, plus the initial expenditure for ancillary processes and components such as grease lines, fittings and manifolds can be lowered or eliminated.

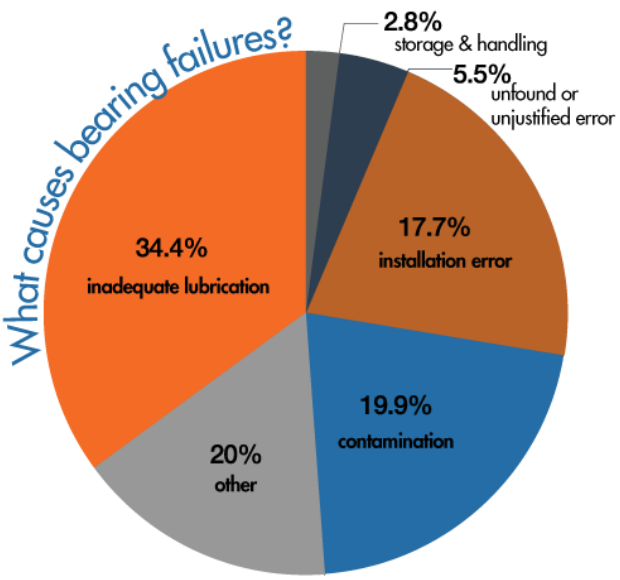
So, what are the problems with bearing lubricants? According to a major ball-bearing company, 54% of bearing failures are lubrication-related. And an MIT study estimated that about $240 billion is lost each year in the U.S. due to downtime and repairs on manufacturing equipment damaged by poor lubrication.

There is a lower-cost, easier-to-maintain component that eliminates the total cost of bearing lubricants: high-performance, dry-running plastic bearings.

The Hidden Costs of Lubrication

Proper lubrication delivery is critical for ball bearings. Most require continued maintenance for relubrication, which typically requires scheduled downtime. This increases maintenance costs and causes a loss of production time.

Although some relubrication processes are automated, most are performed manually using a grease gun. It takes a series of critical steps to ensure proper lubrication, including carefully storing and handling the lubricant, properly cleaning the bearing, and using the right amount of lubricant and the right grease gun, to name just a few. In addition, it is critical to use the same grease for the bearing's entire lifespan.



Improper bearing lubrication or relubrication accounts for up to 50% of machine failures. Eliminating lubrication from machinery lets OEMs minimize maintenance costs and risks for users.

A major oil company studied the time it took to manually lubricate a single grease point. It indicated that manual lubrication takes an average of three minutes per point. The average machine has 20 grease points to maintain, which correlates to a total annual labor cost of $7,300 for one machine.

Another source claims that the average plant employs 2,196 bearings and spends $60,000 on relubrication annually; of that, $57,000 is just for labor.

Lubricated bearings can increase manufacturing complexity and expenses. They often need to be fitted with grease fitting (zerks) and manifolds, oil lines, and sometimes oil reservoirs and pumps. Not only are there costs for buying these components, there are also manufacturing costs for machining and assembling the mating parts.

There are also parts needed to protect bearings from contaminants. The leading cause of bearing failure stems from lubrica-

tion contaminated by moisture and solid particles. If as little as 0.002% water gets mixed into the lubricant, the probability of failure jumps by 48%. And just 6% water can reduce the bearing lifetime by 83%.

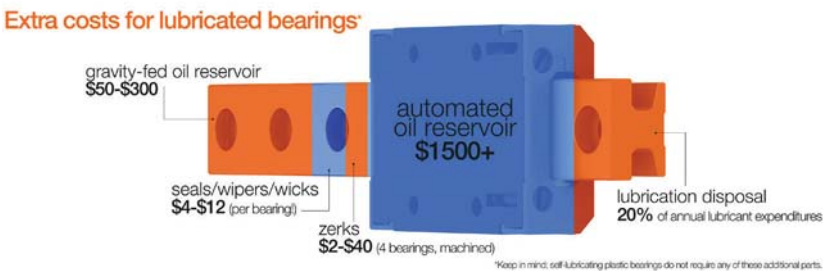
Ball bearings need seals to keep oil in and unwanted water and liquids out, as well as wipers and scrapers to keep out dust and debris. Seals only last so long and do not perform well in dirty and dusty environments. And they also increase friction. In agricultural machinery and lawnmowers, where dust and debris are prevalent during operation, seals and wipers must often be replaced.

Improper bearing lubrication or relubrication also accounts for up to 50% of machine failures. When a bearing fails prematurely, several steps may need to be taken. Replacing the bearings, shafting, and even motor or other parts can be very costly. If the machine needs to be taken offline, expenses can potentially skyrocket. In a six-sigma manufacturing guide, it was estimated that the average cost for downtime is $500 per hour, and in some automotive and other high-volume production factories, downtime costs are considerably higher. In addition, unplanned downtime can ripple through the plant's production schedule.

Getting rid of used lubricants can add up to approximately 20% of the lubricant's annual cost, says Valin. This means if a plant spends $50,000 per year on lubricants, it will spend about $10,000 on disposal. In addition, the price of oil can affect costs as lubricants are normally petroleum-based, so when the price of petroleum goes up, so too does the price of lubricants.

Sidestepping Lubrication Subsystems

One surefire way to eliminate lubrication costs and headaches is to use self-lubricating plastic bearings. They are made of high-performance polymers and, unlike rolling-element bearings, they slide instead of roll. They consist of a base polymer embedded with fiber reinforcements and solid lubricants.



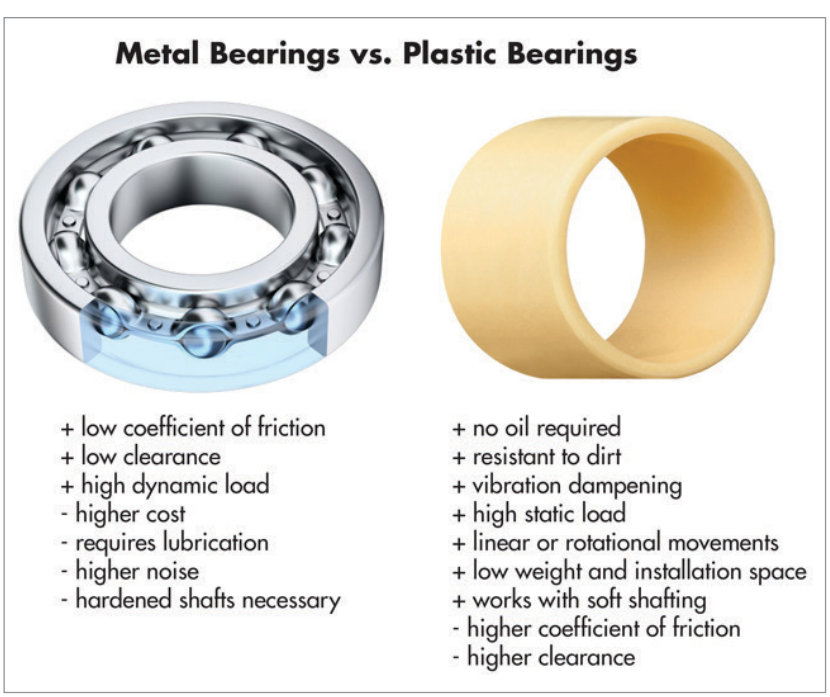
Getting rid of used lubricants can add up to approximately 20% of the lubricant's annual cost, says Valin. This means if a plant spends $50,000 per year on lubricants, it will spend about $10,000 on disposal.

The fiber reinforcements increase load carrying capabilities and wear-resistance. At the same time, the solid lubricants get transferred from the bearing to the shaft to form a low-friction micro-finish which reduces friction. Unlike PTFE-lined bearings, plastic bearings' self-lubricating properties are present over the full thickness of the bearing.

They also do not need external oil or grease and operate completely dry. Their lack of oil and grease makes them good candidates for food and medical processing, packaging and other sanitary applications. It also means they don't attract dirt, eliminating the risk of seizing and the need for seals or wipers leads.

They are ideal for labs and food processing machinery that require a clean, oil-free operation. Plastic bearings also perform well in dirty environments like agricultural workplaces because they don't attract and retain dust and dirt.

They work on softer shafts, even those made of anodized aluminum, which has excellent corrosion resistance and is usu-



ally less expensive and easier to machine than case-hardened materials and stainless steels.

Self-lubricating plastic bearings can reduce maintenance costs and unplanned downtime due to bearing failures. If a self-lubricated bearing needs replacement, the replacement part (a small, inexpensive plastic sleeve) can be purchased for a fraction of the cost of a recirculating ball bearing. And once installed, they don't require maintenance, unlike traditional ball and metal-backed bearings.

Plastic bearing materials resist a range of corrosive media, including water, chemicals, cleaning products, UV rays and more. Specialized materials are also on the market that stand up to harsher media, such as hydrochloric acid, steam/autoclaving and radiation. This lets them be used in wash-down and even underwater applications.

Plastic bearings are good for short-stroke applications, unlike linear ball bearings, which require a long stroke to fully lubricate; short strokes can cause ball bearings to slide instead of roll over the shaft, causing damage.

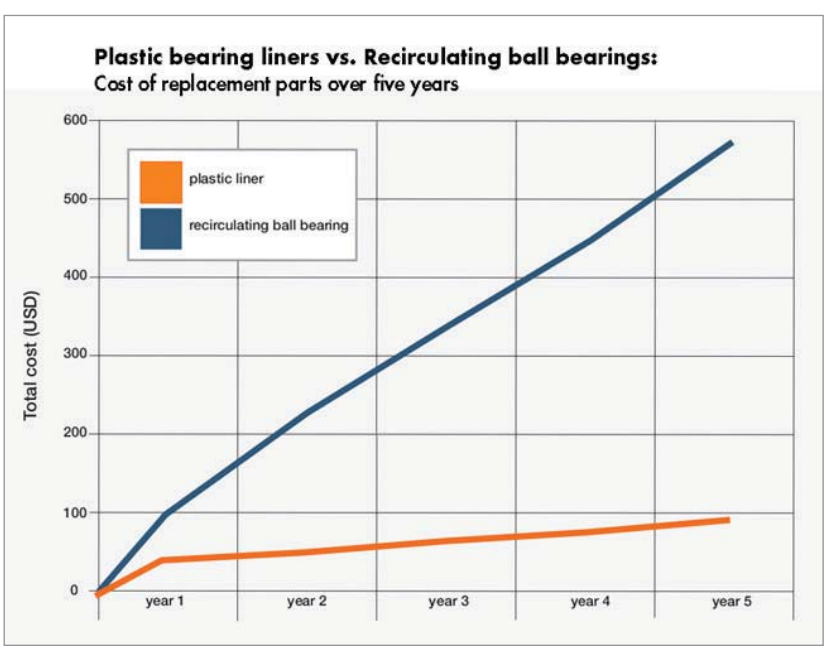
Plastic bearings weigh about 80% less than metal ones. Cutting weight lowers drive requirements and can lower operating costs, reduce fuel consumption and lower the inertia of moving parts.

There are applications plastic bearings cannot handle. These include those with:

- High loads with high speeds: They lead to excessive frictional heat buildup and wear.
- Highly cantilevered loads: Plastic bearings slide, unlike ball bearings that roll, so linear applications with higher coefficients of friction may result in uneven movements for highly cantilevered loads or drive forces.
- Extremely precise applications: Plastic bearings have a higher running clearance than ball bearings, sometimes 0.001 to 0.002 in.
- Extreme temperatures: Plastic bearings are not recommended for applications with long-term temperatures exceeding 484°F.

From the initial purchase through the life of a bearing, plastic bearings eliminate the need for lubricants and the accompanying maintenance and protective components. ■

MATT MOWRY is product manager for drylin linear bearings at igus Inc.

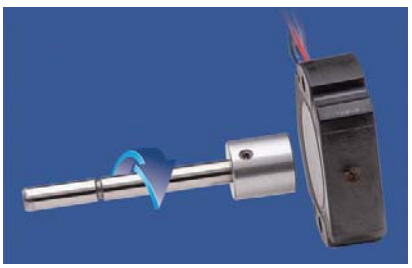


A piece of farm equipment uses wheels to create troughs of consistent depth and width in which to plant seeds. Oil-impregnated bronze bearings with graphite plugs let the wheels roll easily, but they needed to be replaced two to three times a season. On the West Coast, the bearings experiencing high wear and premature failure due to abrasive soil conditions; on the East Coast, high salt content in the air corroded the wheels and they seized. The bronze bearings were replaced with self-lubricating plastic bearings from igus. This increased the equipment's lifespan increased by 500 to 600% and the price of the plastic bearings was 70 to 80% less than bronze bearings.

A packaging machine could fill and seal 160 15-lb packages per minute. It used linear metal bearings, but they scored the shafts and leaked grease. They were replaced with self-lubricating drylin R linear bearings. To date, the linear bushings have surpassed the 10-million-cycle mark on some of the company's packaging machines with little to no noticeable wear.

A team of researchers from the Worcester Polytechnic Institute in Massachusetts have developed a piezoelectric actuated robot that could work when inside an MRI machine. To reduce the use of metal that could interfere with the MRI, the robot used plastic bearings from igus to control the motion and positioning of a biopsy needle. The plastic bearings are made of FDA-compliant polymers designed for applications with contact to food or drugs.

Touchless Angle Sensors Include IO Link



The RFC4800 Series of touchless angle sensors can measure angular position up to 360 deg., revolution counter and speed without wear. The RFC 4800 is now available with IO-Link output interface. Its serial communication protocol needs only three wires to simultaneously transmit measured values and status information. The status bit can signal a controller if a sensor needs to be replaced and the controller can detect the new device and automatically configure it based on stored values minimizing downtime. Parameters such as zero point can be sent and programmed into the sensor over this bus. Mean time to failure is 810 years. Cable and connector versions are available.

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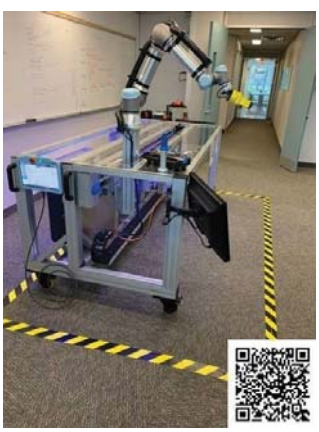

Festo Develops Multi-Axis Solution for UR Robots

Festo has developed its UR+ certified multi-axis solution for Universal Robotics (UR) cobots. The certified UR system adds up to four axes of motion beyond the UR cobot six axes, and embodies Festo world-class precision, reliability and longevity. This solution from Festo lowers customer engineering time and speeds startup as it arrives ready to install. No programming is involved in setup and no additional PLC is required.

Festo

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Autonomous Transport System Offers Safe, Compact Solution

The MP1000R is a flexible and scalable solution which can replace manual forklifts and tuggers in manufacturing spaces, leading to improved efficiency and helping protect workers from potential injury. By using the ROKIT Locator Software, the MP1000R is able to navigate autonomously in highly dynamic environments without additional infrastructure. Its compact size and zero turning radius make it ideal for operating in tight spaces or down to aisle widths of 1,400 mm (55 in.).

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Universal Translator Can Service Multiple IP Protocols

An embedded module has been developed that serves as a universal translator for enabling serial devices (RS-232, 422, 485, SPI, I2C) to communicate via protocols such as EtherNet/IP, Modbus TCP, PROFINET, BACnet/IP and others. OEMs also gain the capability to push data from plant-floor and field devices to analytical and business applications via OPC UA and MQTT. The module offers device makers a quick-to-market, affordable and simple solution for adding a full array of industrial protocols to any new or legacy device a manufacturer uses.

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Vacuum-Tight Connection Effective in Many Conditions

The M series HY is designed for all applications requiring vacuum-tight connections in harsh environments. Its ultra-low leak rate, coupled with a wide operating temperature range, allows for unmatched performance in optical enclosures or high-altitude applications. This new addition to the M series lineup provides customers with the highest density ratchet coupling connectors on the market where vacuum-tight integrations are required. Features include ultra-low leak rates, optimized PCB tails enabling easier PCB routings on high-density configurations, lightweight materials and vacuum-tight sealing over an extended temperature range.

LEMO

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Robotic Depalletizer Uses Machine Vision Software

A robotics depalletizer has been developed to handle complex depalletizing tasks in the logistics, e-commerce, healthcare and consumer packaged goods industries. Using machine vision software, this new solution can quickly assess a wide variety of box types, enabling customers to efficiently process assorted loads with very little engineering effort and short set-up time. The speed and accuracy of the system enables it to work at a peak rate of up to 650 cycles per hour, 24 hours a day.

ABB

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PAC Reduces Need for Programming, is IIoT-Ready

The PACSystems RSTi-EP CPE 200 programmable automation controllers helps OEMs meet customer requirements by minimizing the need for specialized software engineering talent. CPE 200 controllers will deliver large programmable logic controller (PLC) capability in a small, cost-effective, IIoT-ready form factor so machine manufacturers do not need to sacrifice performance for price. The controllers offer open communications through native, pre-licensed support for OPC UA Secure and other common industrial protocols.

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Ad Index

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NIST Debunks Myths about High mm-Frequencies for 5G Networks

New research shows that mm frequencies should prove fine for 5G and even 6G networks.

by Stephen J. Mraz, Senior Editor

Wireless transmissions can take many different routes to the intended receiver. The colored lines are reconstructions of measured paths of millimeter-wave signals between a transmitter (not visible) and receiver (lower middle) in a NIST industrial control room. These paths are all secondary, meaning they are reflected or diffracted signals. *Credit: NIST*

Wireless systems are moving to the mm spectrum at 10-100 GHz, which puts them above the crowded cellular frequencies as well as the early 5G systems that work at around 3 GHz, according to the National Institute of Science and Technology (NIST). System operators seem to prefer the lower bands of the new mm spectrum because they believe more signals are lost at higher frequencies due to smaller wavelengths using less of an antenna's surface. But until now, no one has been able to definitely prove whether this true or not.

To settle this dispute, researchers at the NIST found that transmission performance is consistent across different bands of the millimeter-wave spectrum targeted for high-speed 5G.

NIST researchers developed a way to measure frequency effects using the 26.5-40 GHz band as a target example. After extensive study in the laboratory and in the field, NIST confirmed that the main signal path over a clear line of sight between transmitter and receiver does not vary by frequency.

The team also found that signal losses in secondary paths where transmissions are reflected, bent or diffused into clusters of reflections can vary by frequency, depending on the type of path. Reflective paths, the second strongest and critical for maintaining connectivity, lost only a little signal strength at higher frequencies. The weaker bent and diffuse paths lost a bit more. Until now, the effects of frequency on this so-called multipath were unknown.

"This work may serve to debunk many misconceptions about propagation at higher frequencies in 5G and 6G," NIST electrical engineer Camillo Gentile says. "In short, while performance will be worse at higher frequencies, the drop in performance is incremental. So, we do expect the deployment at 5G and eventually at 6G to be successful."

The NIST method emphasizes innovative measurement procedures and enhanced equipment calibration to make sure only the transmission channel is measured. The researchers used NIST's Synthetic Aperture Measurement Uncertainty for Angle of Incidence channel sounder for its repeatable and accurate testing of 5G mm devices across a wide range of signal frequencies and scenarios. The NIST sounder is unique in that its antenna beams can be steered in any direction for precise estimates of angle-of-arrival.

NIST's main innovations in the new study were to calibrate procedures to remove the effects of equipment from the measurements; extend an existing algorithm to determine from a single measurement how individual paths vary by frequency; and to conduct studies in an industrial control center and a conference room to classify the types of paths involved and determine any frequency effects. ■

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The SLC440 BLE uses the Bluetooth Low Energy system for secure data transmission, up to 5 meters. The data transmitted from the safety light curtains is accessible by the Schmersal **SLC Assist App**, available for Android and iOS smartphones and tablets.

The SLC440 offers many integrated functions including fixed blanking, floating blanking, fixed blanking with movable edge region, double reset, contactor control (EDM), automatic mode, re-start mode, and beam coding.

This unprecedented access to the operational data of the Safety Light Curtain has many advantages:

- The app serves as an installation alignment aid as it displays the signal strength of each beam.
- Real time monitoring of the active operation mode, the status of the OSSD outputs and the status of the protective field provides the information necessary to quickly resolve faults.
- The app can provide documentation on the light curtain, either emailed or saved to the smartphone or tablet.
- Additionally, you can see which functions have been enabled and their parameterized settings.

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