Machine Makers Extract Intel with Conversational AI **16**

Injection Molder Makes Use of its RaaS Advantage **20**

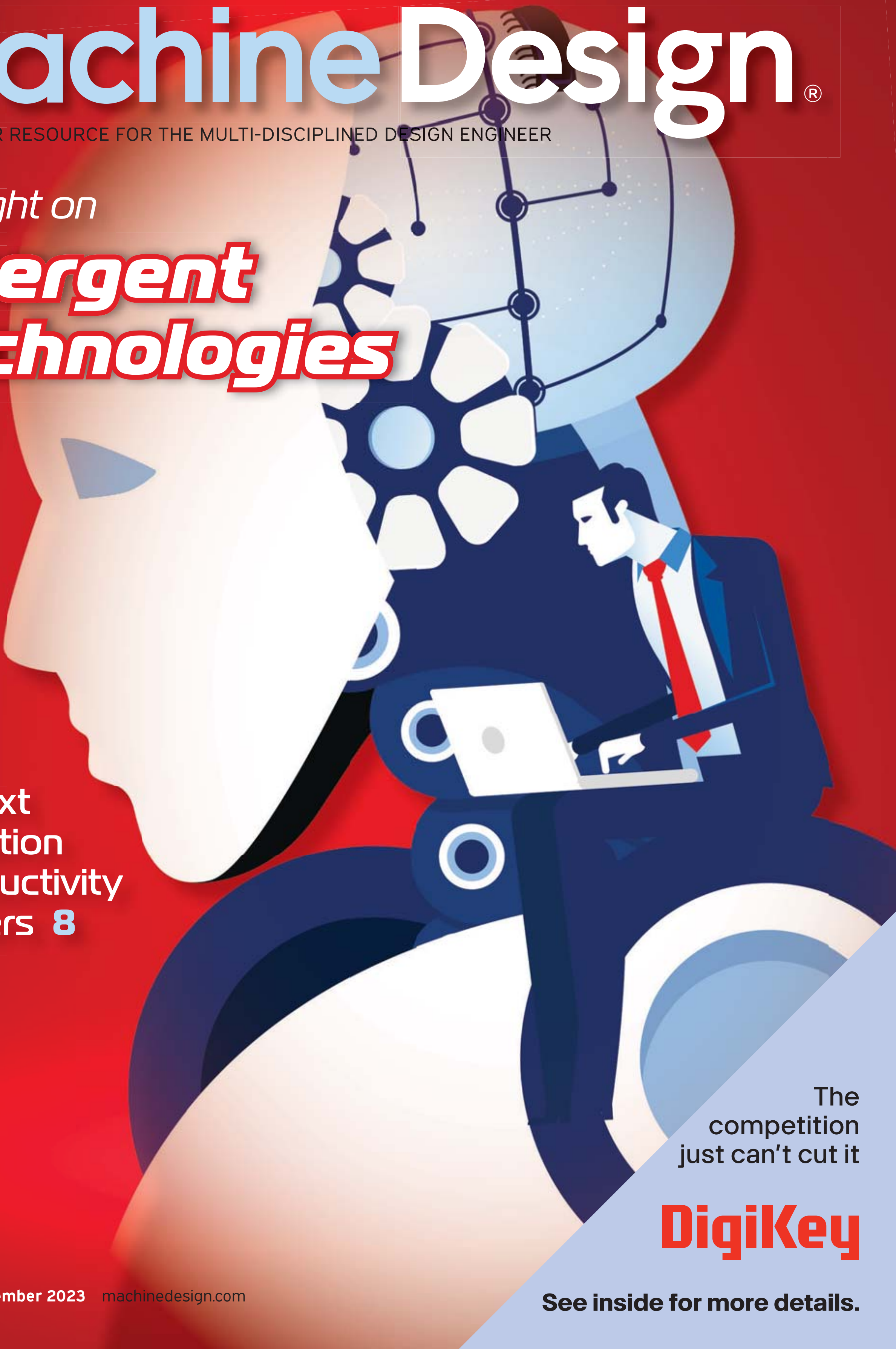
Welding Innovation Aids Medical Device Development **28**

Machine Design®

THE PREMIER RESOURCE FOR THE MULTI-DISCIPLINED DESIGN ENGINEER

Spotlight on

Emergent Technologies



The **Next Generation** of **Productivity Boosters** **8**

November/December 2023 machinedesign.com

Control Motion AND Cost

with perfectly matched servo motors, drives, and cable sets

Servo Systems
starting at:
$899.00

SureServo®2 Servo Systems

Complete systems (motor, drive, & cable set)

The fully digital SureServo2 family of brushless servo systems offers a rich set of features to cover a broad range of applications. Choose from 26 standard permanent magnet servo motors that operate in combination with one of 16 standard servo drives.

- Precise control of position, velocity and torque
- Flexible power input options:
  - 120/230 VAC single-phase input: 100W - 2kW
  - 230 VAC three-phase input: 100W - 15kW
  - **NEW!** 460 VAC three-phase input: 400W - 15kW
- Use with PLCs or any other host controller
- Drives feature on-board indexer and multiple auto-tuning modes
- Option modules for EtherNet/IP and Modbus TCP provide networking capability
- Free setup software AND field upgradeable firmware
- 45-day money-back guarantee
- Two-year warranty

Servo system selector:
www.go2adc.com/servoselect

Add a precision planetary gearbox to increase available torque or for inertia balancing:

- Inline, right-angle, or hub style
- Best-in-class backlash
- Six gear ratios: 5:1, 10:1, 15:1, 25:1, 36:1, and 50:1
- Hardware included for mounting to SureServo2 motors
- Maintenance free with 5-year warranty

Servo gearbox selector:
www.go2adc.com/gearselect

Research, price, buy at: www.automationdirect.com/servos

Order Today, Ships Fast!

TOP RATED BY CUSTOMERS

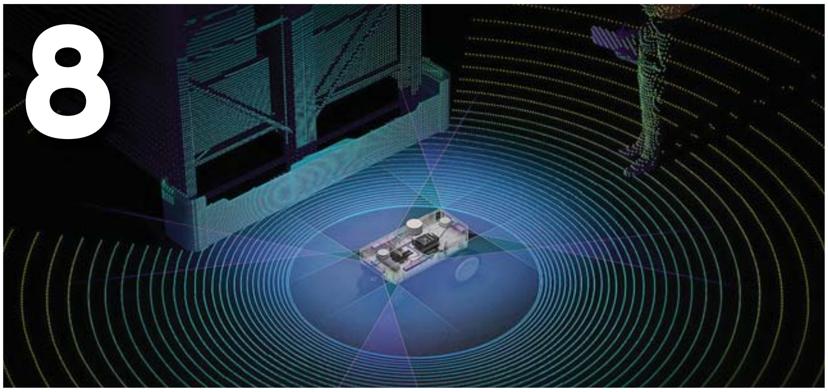
AUTOMATIONDIRECT.com
1-800-633-0405
the #1 value in automation


Altech®
NEW
Dual Rated
AC/DC
Motor Disconnect Switches
RT Series
E185115
Door Mounted
Motor Disconnect Switch
• Available in 16, 30, 40 Amps
600V AC / 60V DC
• Switch make/break operation is semi-independent from operator's actuation speed
1 Locking Nut to Mount Handle
KATKO
LoadSafe
LSF Series
Safety certification PENDING
Extended/Direct Handle
Motor Disconnect Switch
• Available in 16, 30, 40 Amps
600V AC / 60V DC
• Switch make/break operation is semi-independent from operator's actuation speed
Door & Panel Mount
Integrated Shaft
1 Locking Nut to Mount Entire Kit/ Handle
LSF Series DIN Rail & Panel Mount
RF Series Convenient Rear Facing Terminals
Built-In Panel Mount Tabs
Altech Corp.®
Your Source for Automation & Control Components
AltechCorp.com | 908.806.9400
ACCESSORIES
• Handle
• Shaft
• Auxiliary Contact

INSIDE

MachineDesign

NOVEMBER/DECEMBER 2023
Volume 95, Issue 6



COVER SERIES

COLUMNS

DIGITAL EXTRAS

NEWS & NOTES

Machine Design (USPS Permit 323-980), (ISSN 0024-9114 print, ISSN 1944-9577 online) is published 6 times per year (January/February, March/April, May/June, July/August, September/October, November/December) by Endeavor Business Media, LLC. 1233 Janesville Ave., Fort Atkinson, WI 53538. Periodicals postage paid at Fort Atkinson, WI, and additional mailing offices. **POSTMASTER:** Send address changes to Machine Design, PO Box 3257, Northbrook, IL 60065-3257. **SUBSCRIPTIONS:** Publisher reserves the right to reject non-qualified subscriptions. Subscription prices: U.S. ($139.00 per year); Canada/Mexico ($159.00 per year); All other countries ($199.00 per year). All subscriptions are payable in U.S. funds. Send subscription inquiries to Machine Design, PO Box 3257, Northbrook, IL 60065-3257. Customer service can be reached toll-free at 877-382-9187 or at machinedesign@omeda.com for magazine subscription assistance or questions.

Altech® Superior Circuit Breakers
Large inventory in stock

3 UL approvals, 1-3 Poles, AC and DC models
and the Most trip curves in the industry

UNIQUE DUAL CONNECTION TERMINALS

Many Features:
- Flexible & replaceable terminal barriers
- Clear and visible Part No.
- DIN Clip
- Hinged Terminal door

DLS9 UL489
UL(AC), DL(DC) Series
- Available in AC and DC models
- 0.3-63A/ 240V AC, 0.3-32A/ 480Y/277V AC
- 0.3-60A / 125V DC (1 pole); 250V DC (2 pole)
- Thermal Magnetic
- 10kA Short Circuit Interrupting Capacity

LISTED C.B. E329510
IEC 60947-2 Short Circuit Tested

DLS8 UL508
V-EA Series Manual Motor Controller
- Most Trip Curves in the Industry
- 0.3-60A/480Y/277V AC
- 0.3-25A: 1 pole - 42V DC; 2 Pole - 80V DC
- 30-60A: 1 pole - 24V DC; 2 Pole - 60V DC
- Thermal Magnetic
- 10kA Short Circuit Withstand Capacity

UL508 Listed E137938
up to 25A B,C,D curve
up to 25A B,C,D curve

DLS7 UL1077
UR Series Supplementary Protector
- 0.5-60A / 480Y/277V AC
- Thermal Magnetic
- 10kA Short Circuit Withstand Capacity

E137915

Altech Corp.®

Your Source for Automation & Control Components

AltechCorp.com | 908.806.9400

From the Editor

By **Rehana Begg**, Editor-in-Chief

For Better or For Worse, Multimodal AI Cultivates New Frontiers

NOT EVEN A SICK DAY could shelter me from the deluge of ping notifications emanating from the Teams app on my laptop.

Humane, a startup founded by former Apple designers Imran Chaudhri and Bethany Bongiorno, had officially launched their Ai Pin—a wearable device designed to replace your smartphone—and my colleagues (mostly tech editors) were having a kerfuffle.

They went full-bore Star Trek. “It's the wrong shape,” was one comment. “You should be able to use it by just tapping it,” was another.

“I don't know; the fact that it doesn't really have a display and you have to talk to the device could help curb some of my worst smartphone habits,” was yet another.

Much like the Star Trek communicator badge, the Ai Pin can be worn on your lapel. Users interact with it using an intuitive touchpad and by speaking naturally. The Ai Pin is equipped with a built-in speaker and camera, along with a few neat functions. The founders demonstrate online how one can use the AI Pin as a foreign language interpreter, stay on target with nutrition goals by using the device's computer vision to identify food, or interact via a laser ink display projected onto your palm.

But should it replace the smartphone? Technology will inevitably be rolled back or replaced with innovations that have greater appeal. In 2015, Google dabbled with a similar prototype. Their circular device came with a built-in microphone and Bluetooth, which merely allowed it to connect to a smartphone and enable users to conduct searches without reaching for their cellphones. It flopped.

The Ai Pin, however, advances to a whole new category of emergent tech. With collaboration from Microsoft, OpenAI, Qualcomm Technologies, Inc. and T-Mobile, the device was designed to bring the power of AI to commercial users. Not all of the kinks appear to be ironed out yet, but the technology conceivably launches us into the next iteration of mobile tech.

The same holds true for some of the more rugged algorithmic-driven tools showcased in this issue. Consider for instance how iNAGO's context-aware and automated dialogue management system is going beyond the usual parameters of speech recognition. (Read “Making Conversation,” on p. 16.)

In attempting to simplify the purpose and scope of the technology, iNAGO's founder Ron Di Carlantonio channels yet another blast from our sci-fi past when he conjures up memories of KITT, the sentient, talking, bulletproof car popularized in the television series “Knight Rider.” iNAGO's conversational AI platform enhances the communication experience by analyzing the context and then determining what the correct response should be.

We are nowhere near a true understanding of generative AI's power, nor the limits of its capabilities. Manufacturers are just beginning to discover they can work with AI specialists to develop custom models to power their machinery.

What we do know is that it is transformative. Given the proliferation of AI-enabled products, it is reasonable to expect advanced machine-learning models will unlock new applications and bolster performance parameters in unimagined ways.

Even if your organization is not yet ready to adopt the latest and greatest iteration, it pays to keep an eye on the best use cases and to be ready to support your teams with the tools they'll need to be their most productive and to significantly improve their experience.

What do you think? Reach me at rbegg@endeavorb2b.com.

The competition just can’t cut it

But we can.

We can custom-cut wire and cable of any length, any gauge, any weight, with no splice and no minimum. Simply select the package type “Digi-Spool®, continuous Spool.”

And DigiKey is UL certified for custom cutting!

Visit digikey.com/digi-spool

DigiKey

we get technical

MachineDesign

EDITORIAL
Senior Content Director: **Bob Vavra**
bvavra@endeavorb2b.com

Editor-in-Chief: **Rehana Begg**
rbegg@endeavorb2b.com

Managing Editor: **Jeremy Cohen**
jcohen@endeavorb2b.com

Senior Editor: **Marie McBurnett**
mmcburnett@endeavorb2b.com

Technical Editor: **Sharon Spielman**
sspielman@endeavorb2b.com

Technical Editor: **Sara Jensen**
sjensen@endeavorb2b.com

ART DEPARTMENT
Group Design Director: **Anthony Vitolo**
tvitolo@endeavorb2b.com

Art Director: **Jocelyn Hartzog**
jhartzog@endeavorb2b.com

PRODUCTION
Production Manager: **Sam Schulenberg**
sschulenberg@endeavorb2b.com

Ad Services Manager: **Deanna O'Byrne**
dobyrne@endeavorb2b.com

AUDIENCE MARKETING
User Marketing Manager: **Debbie Brady**
dmbrady@endeavorb2b.com

Article Reprints: reprints@endeavorb2b.com

LIST RENTAL
Smartreach Client Services Manager: **Kelli Berry**
kberry@endeavorb2b.com

SUBSCRIPTION SERVICES
OMEDA: machinedesign@omeda.com
847-559-7598 or 877-382-9187

DIGITAL
VP of Digital & Data Innovation:
Ryan Malec rmalec@endeavorb2b.com

SALES & MARKETING
Patrick Carmody
pcarmody@endeavorb2b.com
AK, AR, AZ, CA, CO, HI, IA, ID, IL, IN, KS, KY, LA, MI, MN, MS, MO, MT, ND, NE, NM, NV, Western OH, OK, OR, SD, TN, TX, UT, WA, WI, WY, Western Canada

Brandy Bissell
bbissell@endeavorb2b.com
DE, MD, NC, NJ, NY, Eastern OH, PA, SC, VA, WV

Liz Stott
lstott@endeavorb2b.com
AL, CT, FL, GA, MA, ME, NH, RI, VT, Eastern Canada

Stuart Bowen
sbowen@endeavorb2b.com
Belgium, France, Luxemburg, Netherlands, Portugal, Scandinavia, Spain, United Kingdom

Diego Casiraghi
diego@casiraghi-adv.com
Italy

Helen Lai or Charles Liu
helen@twoway-com.com or liu@twoway-com.com
Pan-Asia

DESIGN & ENGINEERING GROUP
Electronic Design, Machine Design, Microwaves & RF, Power & Motion, SourceESB, Source Today, 3DX

EVP, Design & Engineering Group: **Tracy Smith**
tsmith@endeavorb2b.com

Group Content Director: **Michelle Kopier**
mkopier@endeavorb2b.com

ENDEAVOR BUSINESS MEDIA

Endeavor Business Media, LLC
30 Burton Hills Blvd, Ste. 185, Nashville, TN 37215
www.endeavorbusinessmedia.com

CEO: **Chris Ferrell**
President: **June Griffin**
CFO: **Mark Zadell**
COO: **Patrick Rains**
CRO: **Reggie Lawrence**
Chief Digital Officer: **Jacquie Niemiec**
Chief Administrative and Legal Officer: **Tracy Kane**

MachineDesign.com

Engineers Bring Pride, Experience to Their Craft—and it Pays

Machine Design's Salary Survey finds compensation grows as the job market remains tight and technology plays a prominent role.

https://machinedesign.com/21277772

Bringing Sustainability from the Boardroom to Ground Level

Smarter use of sensing technologies can drive energy efficiency and enable electrification. Examples include heat pumps, battery chemistries and industrial sensing.

https://machinedesign.com/21267845

Moving a New Machine to Electric Drive

Frequently asked questions about battery options in electrification projects.

https://machinedesign.com/21267789

Featured Video

Facing Discrete Manufacturing Challenges

Stephen Greene of Stratus talks with *Machine Design* to discuss the manufacturing complexities with supply chain, sustainability and workforce shortages.

https://machinedesign.com/21275892

@MachineDesign

MachineDesignMagazine

Machine-Design-Magazine

Read Anytime, Anywhere!

View the digital edition of *Machine Design* at:

www.machinedesign.com/magazine

INDUSTRIAL AUTOMATION EXCHANGE BY

CSIA Exchange
Find a system integrator here: *https://www.csiaexchange.com*

Alleged Insulin Pen Data Breach Sounds Alarm on Data Protection for Patients

MEDTRONIC DIABETES has been hit with a class action lawsuit.

The lawsuit, filed in August 30, 2023 in a California federal court, alleges that Medtronic engaged in "transmission and disclosure" of personally identifiable and health information to Google and other third parties. The breach stems from the use of the Medtronic Diabetes' InPen system.

At Issue According to the lawsuit, *A. H.. v. Medtronic Minimed, Inc., 2:23-cv-07154, (C.D. Cal.)*, the plaintiff alleges that the insulin delivery services provider illegally distributed personally identifiable information and protected health information.

In the complaint, the complainant alleged the InPen's "tracking tools" collects personal data in relation to their healthcare, which Medtronic Diabetes (Medtronic Minimed, Inc. and Minimed Distribution Corp.) "secretly mines, transmits, and intercepts for its own benefit," without obtaining consent and authorization from the plaintiff.

Medtronic Diabetes noted in a letter dated April 14, 2023, that users of InPen Diabetes Management iOS and Android mobile applications may have been exposed to a data privacy incident affected users' personal and health information.

The letter further noted that Medtronic Diabetes used the services of Google Analytics and Crashlytics to understand how users interact with the InPen App. The company stated that gathering information was an effort to "identify technical issues, assess the performance of the application and understand user needs and preferences to provide needed care to our customers." Medtronic Diabetes noted they had learned recently that Google Analytics and Crashlytics transmitted certain user information to Google once a user logged into their account, and Firebase Authentication transmitted certain user information to Google in connection with a user's registration on the InPen App.

Medtronics Diabetes determined on Feb. 13, 2023 that tracking and authentication technologies—including Google Analytics and Crashlytics—used on the InPen App, disclose certain details about a user's actions within the InPen App. *Medtronic*

According to the letter, collected information included the InPen App user name and password, phone number, email address, date of birth, IP address, information about specific medical conditions and treatment and related health information (such as insulin use), and identifiers tied to a user's mobile device, such as mobile advertising IDs (MAIDs), Identifiers for Advertisers (IDFAs), Android Advertising IDs for Android devices (AAIDs), and Identifier for Vendors for iOS devices (IDFVs).

The company has stated that anyone who registered for or used an InPen account since September 2020 may have been affected.

As of this writing, a Service of Summons and Complaint Returned Executed was logged on Sept. 20, 2023.

Why it Matters

The Medtronic data breach highlights the need for the medical devices industry to mitigate the risk of unauthorized disclosures of user protected health information in the future. A class action lawsuit could provide incentive for MedTech companies to improve and reinforce their data privacy practices.

Insulin Pens Help Manage Diabetes

An insulin pen is used to inject insulin through the skin and into the fatty tissue for the treatment of diabetes. The biggest challenges for insulin pen users are associated with knowing the correct dose to inject, when to inject and keeping tabs on shelf-life, temperature and storage conditions, notes the American Diabetes Association.

Bluetooth-enabled insulin pens with built-in data-tracking have come a long way in supporting patients since the first FDA-cleared reusable smart insulin pen was launched in 2017. Current insulin pens are designed to be simple to use and make taking insulin more convenient because they combine the medication and syringe in one handy unit.

A smart insulin pen sends real-time data to the app via Bluetooth connection. The device can calculate each dose based on the patient's current blood sugar level, carbohydrate amounts, active insulin and settings prescribed by your doctor. It can notify you when your insulin has expired, send diabetes data to your health team and also do the math when figuring out how to dose for a meal or correct a high blood sugar reading, notes the American Diabetes Association.

Market Matters

The Insulin Pumps and Continuous Glucose Monitors market size was valued at $10.56 billion in 2022, according to GlobalData analysis. Larger medical and pharmaceutical companies that have joined the competition in emerging smart pen markets include Medtronic Plc, DexCom Inc, Abbott Laboratories, Ypsomed Holding AG, Tandem Diabetes Care Inc and Insulet Corp. Medtronic held the largest share of the Insulin Pumps and Continuous Glucose Monitors market in 2022, noted GlobalData. ■

EMERGENT TECHNOLOGIES That Improve Productivity and Flexibility

A positive-sum automation strategy demands that next-generation robotics, hardware and automation software improve both productivity and flexibility.

by Rehana Begg, Editor-in-Chief

Credit: mnbb 1336773711 / iStock / Getty Images Plus

DESIGN LIMITATIONS, WORKFORCE CHALLENGES, high integration costs, slow productivity growth…These are the nemeses for companies grappling with industrial automation.

Ben Armstrong and Julie Shah, researchers and coleaders of MIT Work of the Future, an initiative that supports multidisciplinary research on the ways technology is changing work, offer forthcoming advice: Avoid zero-sum automation.

The "zero-sum" reference is commonly associated with game theory to describe a situation where a rational actor will seek the greatest gain for himself at the expense of other players in the game. In other words, what a company gains from automation in productivity it tends to lose in process flexibility, noted Armstrong and Shah.

A better approach, they argue, is "positive-sum automation," which they describe as the motivation to use technology design and strategy to improve both productivity and flexibility.

The researchers offer a three-pronged approach to reducing complexity and advancing widespread adoption of automation that centers on design, integration and measurement:

1. **Design:** Automation tools should incorporate low-code programming interfaces so that employees need minimal technical skills to repair or adjust them in real time.
2. **Integration**: A bottom-up approach to automation is preferred, because line employees—who have the closest perspective on a process—also have the best vantage for recommending and developing how it is automated.
3. **Measurement:** Although productivity emerges as the No. 1 reason for automation, the researchers found the actual reasons behind automation to be more nuanced. That means that measuring success should take these nuances into consideration, and companies should develop appropriate metrics for measuring the success of their automation projects, ranging from cite/machine level to system and people.

The emergent technology examples that follow below are neither strictly intended to meet nor fail Armstrong and Shah's expectations, yet their potential to significantly impact a wide range of applications suggest an ultimate quest to overcome bottlenecks to improving productivity and flexibility.

Remote Robotics Support Turns Downtime into Uptime

Consider the robotics industry as an example. More than 500,000 new industrial robots were installed worldwide in 2021 alone. According to the International Federation of Robotics, demand is driven by a host of factors, ranging from labor shortages and reshoring initiatives to rising e-commerce demand. Add the fact that robot downtime can cost a plant more than $1 million per hour and the need for more inventive workarounds become obvious, said Fredrik Ryden, CEO of Seattle-based Olis Robotics, which specializes in remote monitoring, control and error recovery technology for industrial robots.

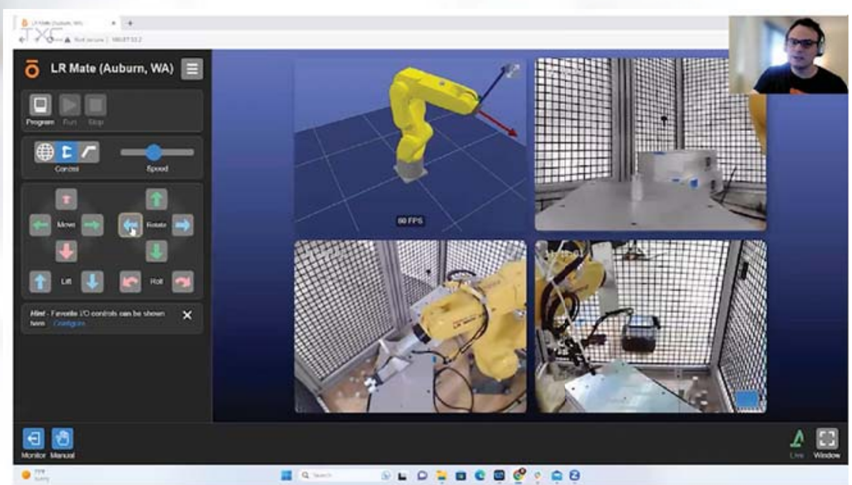
"When every minute counts, you need to leverage remote tools to react as quickly as possible, no matter where you are," he said.

During a video interview with *Machine Design*, Ryden demonstrated how remote support can be part of an overall solution to labor challenges and turnover issues, particularly in situations where plants may not have trained staff. "Downtime is a big issue, but the problem is that a lot of these companies can't even buy automation and robotics in the first place because they don't feel that they have the skills for them," he said.

That makes the opportunity to buy a remotely supported robot cell a very appealing proposition. When a plant experiences a downtime event, such as an outage in a robotic cell, the impact can be costly. An ability to provide rapid diagnostics in this situation allows the engineer or technician to make an accurate assessment of what caused the event and what the next move ought to be.

These principles were modeled after solutions designed to work collaboratively with humans and to extend capabilities for optimal results. The automation loop they envision considers the KPIs for human teams to be the most relevant.

In keeping with Armstrong and Shah's perspective of successful automation, it is true that we've come a long way from the lights-out, factory-of-the-future experiment envisioned in the 1980s and 1990s. Today, the spike in digital transformation increasingly demands inventive solutions in robotics, hardware and automation software (computing intelligence that power machines).



In a live demonstration, Fredrik Ryden, CEO of Seattle-based Olis Robotics, shows how he can remotely access a working industrial robot and make adjustments. *Machine Design*

Partnering primarily with robot integrators that serve high volumes and big end-users, Olis Robotics' latest offering, Olis Connect, can be controlled directly in a web browser. The plug-and-play module is delivered on an edge-hosted PC, and is intended for brand new and legacy industrial robot arms and robotic cells. Virtual setup can be complete within 30 min.

Typically, remote access can be via corporate VPN or an industrial router. During the interview, Ryden keyed in the IP address and was immediately connected to a robotic cell located 45 min. from his office. He had full control of the demo program set up at a FANUC facility in Auburn, Wash.

Once installed, and secure remote access has been configured, users can monitor and manage their automation remotely. Should a problem arise, alerts are sent to the user's device without connecting to the cloud. Users can perform error recovery actions as needed, such as releasing the grip of the robot's end-effector or repositioning a part.

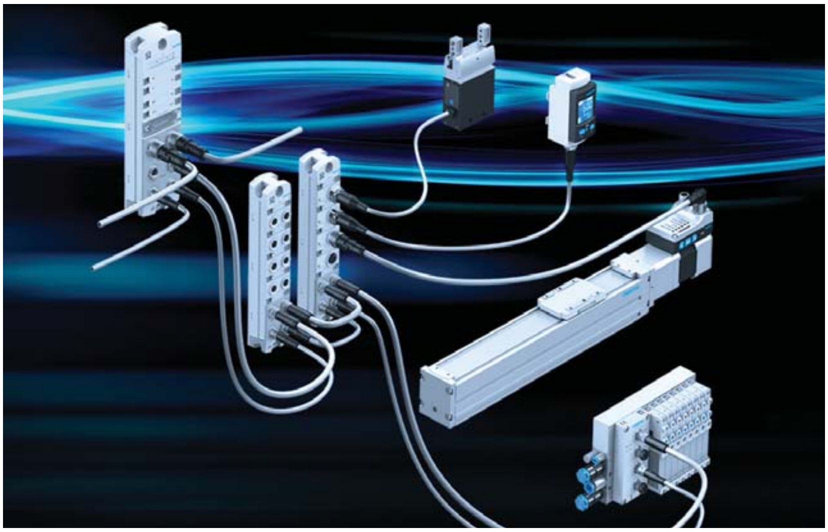
The objective is not to habitually take over or intervene in the work of the robot. "We're experts in remote controlling robots, and our job is to make sure that users remote control robots as little as possible," Ryden explained. "When they do, the solution needs to be secure from a cybersecurity standpoint and needs to be safe from a robot safety standpoint."

He teased the robot in a way that checked whether the safety systems were engaged. "If I were to violate a safety system by going outside of the zone where this robot is allowed to operate, the robot would shut off and I wouldn't actually be able to restart it," Ryden said.

The system works across robot brands. According to Ryden, Olis Robotics currently provides support for robots from Universal Robots and FANUC, addressing about 20% of the operational stock of more than 3.5 million industrial robots deployed worldwide.

Decision-makers need tangible information before making a call on how to best manage the overall situation, argued Ryden: "What they need are facts…They need to know how bad the downtime event actually is so they can determine whether they need to send the whole shift home, or tell their trucks to turn around."

There are many benefits to giving experts, including the technician who installed the cell, remote access and an ability to view the cell. The plant benefits not only from their ability to assess what is went wrong, but also how long it might take to have the system up and running, said Ryden. They may even have insights into the lead time on parts needed. "If we can have facts faster, we can react faster," he emphasized.



A notable feature of Festo's automation platform is its flexible topology. All the distributed and decentralized I/O are under a single IP address. *Festo U.S.*

Automation Platforms Offer Centralized Communication and Integration

Among machine builders and end-users in manufacturing, the use of remote I/O modules is a commonly adopted approach to connecting sensors and actuators to PLCs. During Festo's media educational tour back in August, Eric Rice, product market manager, Electric Automation, said the company's portfolio of automation components was designed for easy integration and robust functionality for the equipment and machinery on the plant floor.

Festo's distributed I/O solution CPX-AP-A, along with its established CPX-AP-I decentralized I/O, has been in development for over a decade, Rice said.

These backplane communications run between Festo devices. "The way we do that is to physically tie all of our sensors, actuators, pneumatic cylinders, etc. to remote I/O modules and pneumatic valve terminals, and connect those devices to the PLC over an industrial Ethernet connection," Rice explained. Commonly used Ethernet connections include EtherCAT, EtherNet/IP, Profane and Modbus.

The costs associated with integrated devices into the code and the assignment of IP addresses can be prohibitive. But by introducing a gateway or bus interface, Festo has reduced the number of devices that connect to the industrial Ethernet network without sacrificing functionality. Whether physically attached on-terminal or connected via cable, all components—such as PLCs, valves, motors, drives and I/O—can be incorporated within a smart terminal under a single IP address.

While the volume of data passed back and forth and the performance of the network remains unchanged, Festo is able to decrease the customer's cost by, as Rice put it, "putting this through a single integration point instead of multiple... The CPX-AP-I and the CPX-AP-A are the two fundamental product lines that make this happen."

Reducing the number of controls the engineer needs for integrating devices also eliminates the need for additional IP addresses, and therefore reduces costs. Rice said that Festo also provides IO link support for easy integration of third-party devices.

Rice explained that these advancements make it easy to use sensors and actuators from other vendors. The solution supports all major Ethernet networks, which simplifies implementations for specialty machine builders or OEMs who sell their machines to a variety of different end-users.

Next-Level Perception Tools Cross the AI Threshold

No discussion about emergent tech in 2023 is complete without a mention of generative AI.

Simply defined, generative AI describes algorithms that use neural networks to identify patterns and structures within existing data to generate new content. Inputs include text, image, audio, video and code. Generative AI technology is expected to add $10.5 billion in revenue for manufacturing operations worldwide by 2033, according to ABI Research.

"Imagine the advancements that we'll see for autonomous machines, robotics—where the camera is one of the most important sensors, of course—and we can adapt it to other sensors, including Lidar, radar and so on."

As advancements in generative AI take hold, decisions will need to be made regarding whether specific workloads should be located on-premises, at the edge or in the cloud. Over the past 12 months alone, generative AI has transformed text and natural language processing and has brought unprecedented advancements to operational technology across industries, particularly spanning defect detection, real-time asset tracking, autonomous planning and navigation, as well as human-robot interactions.

Generative AI offers zero-shot learning (the ability for the AI model to recognize things it hasn't seen before in training) with a natural language interface to simplify the development, deployment and management of AI at the edge, explained Deepu Talla, NVIDIA's vice president and general manager of Embedded & Edge Computing.

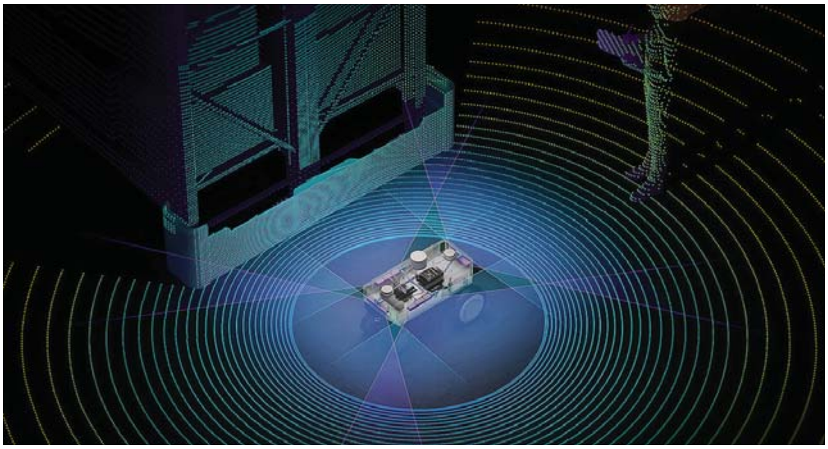
Accelerated computing capabilities that enable the development of next-generation robotics solutions is top priority for NVIDIA. In October, the company announced major expansions to the NVIDIA Jetson platform, giving developers access to tools and tutorials for deploying open-source LLMs, diffusion models to generate impressive interactive images, vision language models (VLMs) and vision transformers (ViTs) that combine vision AI and natural language processing to provide comprehensive understanding of the scene.

Additionally, the launch of NVIDIA Metropolis brings a collection of powerful APIs and microservices for developers to easily develop and deploy applications on the NVIDIA Jetson edge-AI platform. Siemens, for example, is using the application framework for edge AI to connect fleets of robots and IoT devices in the industrial context.

"Imagine the advancements that we'll see for autonomous machines, robotics—where the camera is one of the most important sensors, of course—and we can adapt it to other sensors, including Lidar, radar and so on," Talla said during a press briefing. "Computer vision is right at the tipping point."

During the press call, Talla reinforced the case for generative AI. The time it takes customers to start their design and have all of their AI models and systems into production is time-consuming (potentially taking several years) due to the slow development cycle and the volume of data needed before a neural network does well for a specific task. Neural networks do not generalize very well, he said. In contrast, since generative AI is based on large language models, he describes it as "fairly generalizable."

"That leads to faster development cycles, higher accuracy and also one-shot or even zero-shot learning, in some cases," Talla said. Additionally, using natural language prompts is democratizing solutions, so anybody can communicate with an AI model to a prompt it and get the right output. ■



NVIDIA announced major expansions to two frameworks on the NVIDIA Jetson platform for edge AI and robotics: the NVIDIA Isaac ROS robotics framework has entered general availability and the NVIDIA Metropolis expansion on Jetson. *NVIDIA*

Five Emerging Technology Trends ASME is Following

What's coming down the line that could transform the engineering profession? The American Society of Mechanical Engineers has identified some key technologies—and is looking at ways to help shape their development.

Wrightstudio | Dreamstime

by Jeffrey Winters, Editor-in-Chief, ASME's *Mechanical Engineering* magazine

It isn't just scientists who are developing tomorrow's technology. Engineers, especially mechanical engineers, are tasked with taking clever ideas out of the research labs and making them work. That's why groups such as ASME are following emerging technology trends as closely as anyone.

Every mechanical engineer knows about the contributions to technology made by ASME. The Society's origins date back to the steam era, when poorly constructed boilers led to a series of deadly accidents.

But ASME's army of members and volunteers is constantly identifying new technologies and looking for ways in which it can work to improve them in terms of safety, efficiency, sustainability and benefit for humanity. In decades past, the society has shaped the development of new technologies as varied as high-speed elevators, jet engines and nuclear power.

A commitment to working on the cutting edge of technology means continually monitoring the technology landscape—not only looking for innovations in areas where it already has a strong presence, but also uncovering technologies that are ascending the development curve and need guidance to help them achieve a place in mainstream industry.

As part of that monitoring, ASME's Strategy Office has examined a vast array of emerging technologies to see which ones might have the biggest impact on the engineering profession, and which could most benefit from the Society's focus. Following are five emerging technologies that ASME has identified as worth following.

AT A GLANCE:

- ASME is taking a role in promoting small modular reactors and hydrogen fuel.
- Additive manufacturing may have future applications in pressure technology.
- Engineers also need to pay attention to AI and the mechanical properties of tissues.

1. Small Modular Reactors

Nuclear power is a well-established technology, but there is widespread interest in the industry in developing a new generation of small-scale reactors that could be built in factories and shipped to wherever they are needed. It's a clean energy technology with a lot of promise, since the reactor modules—which are slated to produce between 70 and 200 MW of electricity each—could be added faster and more flexibly than conventional nuclear power stations that usually come in one size: extra-large.

While SMRs are an emerging energy technology, they share enough similarities to conventional nuclear reactors that many of ASME's industry-leading standards and decades of expertise should apply.

"Water-cooled SMR designs share enough technology with conventional light water reactors that they can take advantage of proven technologies to accelerate their moves from demonstration through regulatory approval to commercialization," said John Grimes, a senior manager for emerging technologies in ASME's Strategy Office.

Other SMR designs, which may not be water-cooled, will need early and frequent sharing of design and testing information with the regulatory agencies, Grimes said.

ASME has also created venues, such as this year's Conference for Advanced Reactor Deployment, where engineers and executives working on SMRs can connect with utility, regulatory and financial leaders to discover opportunities in reactor development and the nuclear supply chain.

2. Hydrogen

Hydrogen is the simplest atom, but it's promise as an energy storage and carrier medium is complex. It has the potential to be used as a fuel with very little pollution produced at the point of application, but the traditional (and cheapest) means to produce hydrogen has involved the steam reformation of coal and natural gas, with carbon dioxide as a byproduct.

However, over the past decade there's been a growing effort to find cost-effective ways to produce hydrogen without carbon emissions, either by following pathways that don't involve carbon at all—such as electrolysis using wind, solar or nuclear power—or by capturing the carbon dioxide byproduct and either locking it in geologic storage or using it as a raw material for industrial processes.

"ASME has identified clean hydrogen as an emerging technology to pursue," Grimes said. "We're already active in all areas, whether it's the generation, storage, transportation or end use of clean hydrogen."

ASME has been working with industry leaders in hydrogen technologies such as electrolyzers, pipelines and gas turbines, and the Society offers a variety of products and courses. It has also focused attention on such challenges as embrittlement, which occurs when hydrogen atoms embed themselves within the structure of steel equipment such as pipelines, decreasing its ductility and increasing the chances of fracture.

3. Tissue Properties

While we think of the human body as the province of medicine, not engineering, device and implant manufacturers need to model how their products will work within an envelope of flesh and bone. Understanding the mechanical properties of these tissues is critical, which makes the emerging technology of comprehensive tissue properties database one in which ASME has a longstanding interest.

"The virtual validation and virtual testing of the medical devices will save costs and provide faster solutions to patients," said Israr Kabir, a senior manager of emerging technologies in ASME's Strategy Office. "ASME is working to develop standards for virtual testing models, basically taking a whole suite of different tissues within the human body and building characteristics of these tissues so you know the acceptable limits of mechanical performance."

Grimes said it may sound odd that ASME is involved in this sort of work, but similar work has deep roots within the organization.

"We have a long history with steel properties," he said, pointing to Section II of ASME's landmark Boiler and Pressure Vessel Code. Characterizing the various properties of tissues will similarly create a standard that can help biomedical device and implant manufacturers improve their products.

4. Generative Artificial Intelligence

The past year or two has seen the popular emergence of generative AI in the media, with ChatGPT and Midjourney showing how machine learning models can be used to generate useful text and images. While that's been fun, the real impact of generative AI has yet to be felt in engineering.

It is an emerging technology that bears watching, but engineers must be mindful of AI's current limitations.

One possible outcome, Kabir said, is not a general AI but something built specifically for a particular industrial domain. Such a system would not be intended to replace engineers but would instead extend and expand their ability to generate new designs faster than before.

"It would be about augmenting engineers to do their jobs much faster, but with better efficiency and less waste—sort of the core of engineering in industry," Kabir said.

He brought up the concept of a co-pilot that would assist engineers. Such an AI might be given a design brief and quickly return a variety of options from which to select.

"Every industry is looking at domain-specific models that layer in specific data sets so you can have unique, really focused insights that these general models are not capable of," Kabir said.

Even with those AI-generated insights, the human component of engineering will remain the crucial factor for safety and quality.

5. Additive Manufacturing

Additive manufacturing, or AM, is not new and not even advanced in many cases—hobbyist 3D printers are available that cost less than $200. But the technology is still evolving and finding uses in new, often-critical use cases. Aerospace companies are looking to additive manufacturing as a means to produce low-volume parts on a just-in-time basis, and other industries are beginning to explore the technology.

One arena that is on the ASME radar is using additive manufacturing to build pressure vessels. "There's more and more work being done to use additive manufacturing in either replacing, repairing or producing components for pressure equipment," Grimes said.

One recent demonstration of this concept was the launch of the Terran 1 rocket by Relativity Space. The rocket was almost entirely made up of 3D-printed components, including the engines.

"Maybe that's the future of manufacturing pressure vessels for space," Grimes said.

"But it goes back to fundamental, reoccurring engineering constraints," he continued, "such as the cost, how quickly you can get something done, meeting performance requirements. Just like any emerging technology, it only becomes a successful solution if it can meet those constraints." ■

Industrial Robots:
Remote Monitoring and Control Solution Boosts Productivity

A human-centered remote monitoring and control system for industrial robots upgrades remote connectivity and control.

by **Ryan Cox**, VP of Engineering, Olis Robotics

It's a scenario many integrators are all too familiar with: A robot has failed in the middle of production, bringing an entire line to a halt. Every hour of downtime costs the client tens of thousands of dollars. You've been on several calls already, but you need to get onsite and the earliest you can make it is tomorrow morning. The fix itself—updating a waypoint—takes less than 10 min. The production manager is delighted that production is up and running again, but in the time it has taken to get onsite, the facility is down hundreds of thousands of dollars.

This scenario is frustrating and time-consuming for integrators. It's also enough to put some companies off deploying automation altogether. This is particularly true for many small-to-medium size (SME) companies where budgets can't justify the ongoing maintenance costs of automation deployments. There has to be a better way to handle robot errors remotely.

Olis Connect allows integrators to monitor, diagnose and remotely control robots from anywhere, ensuring fast and easy recovery while enabling them to grow their business. *Images courtesy Olis Robotics*

The Pandemic Effect

COVID highlighted the effectiveness of remote robot monitoring and control technology—and the limitations of some systems. The trend towards increased adoption of remote robot monitoring and control systems was already happening pre-pandemic, but spurred by social distancing requirements and driven by labor shortages, industry adopted the technology at an unprecedented rate.

As a result, over the past few years the benefits of remote monitoring and control software have become apparent: Companies can restart production faster, gain access to robotics experts more quickly and reduce troubleshooting costs. The global market for remote monitoring and control systems was estimated at U.S. $23 billion in 2020. It's no surprise then, that by 2026, it's expected to reach $31.7 billion at a CAGR of 5.4%.

However, not all remote monitoring and control systems are the same. Some provide monitoring only, which send out alerts but don't get integrators any closer than that to solving the problem. Most provide a layer of analytics capabilities that allow companies to tweak their automation for better performance, using KPIs such as overall equipment effectiveness.

A Fresh Approach

Industry is familiar with setups in which a computer takes remote control of industrial robots. This technology is mature and well understood. However, industry is not so used to humans stepping in and taking remote control of industrial robots—let alone remote error recovery.

The main reasons for this are cultural challenges around robot safety and cybersecurity. But what if those challenges have been solved? The recent emergence of a new human-centered remote monitoring and control system for industrial robots provides a new take on remote connectivity and control.

Consisting of several USB or IP cameras, a compute box and software, the plug-and-play system provides 24/7 low latency video and data access to any robot cell. Once secure remote access has been configured, integrators can monitor and manage automation remotely from anywhere via any browser-capable device. When an error occurs with a robot, the system sends out an alert via that secure connection, completely avoiding the cloud—and a host of cybersecurity risks—in the process.

Olis Connect is controlled directly in a web browser and delivered on an Edge-hosted PC. It runs on both new and legacy automation.

Olis Connect provides users with a unique remote error correction functionality that enables integrators to get robots back up and running remotely, reducing service calls from hours and days to a matter of minutes.

Uniquely, it also allows humans to safely control the robot from any location via a secure browser connection and without violating the robot's existing safety permissions and restrictions. This means that velocity, acceleration and joint limit settings on the robot are always obeyed when remote controlling the arm.

Integrator Dividends

Manufacturers appreciate the reduced error recovery times and improved analytics. But integrators, as the industry segment that will bring this technology to the wider world, are also set to gain massively from the new generation of remote monitoring and control systems.

The biggest challenge facing integrators is time management, according to Blake Krieger, a robotic systems engineer at Minnesota-based automation integration specialists Infinity Robotics LLC and an early adopter of the new technology.

"Demand for automation is rising all the time," said Krieger. "We have plenty of opportunities for new projects, proposals and concepts. However, we also have existing projects on the floor that need to be delivered and supported. The latest remote monitoring and control system multiplies our productivity and frees up time to take on new customers. We installed the technology just a few weeks ago and it has already saved us three on-site service calls."

Integrators are spread thin, especially with global demand for automation on the rise. By slashing the length of time it takes to solve robot errors, the latest remote robot control technology enables integration firms to support additional customers without making any sacrifices in terms of quality.

Multiplying Productivity

The new technology is set to be a "game-changer" for integrators, said Brad Sparkman, president and CEO of Innovative Finishing Solutions (IFS), a leading integrator of FANUC paint robots for the automotive industry, and another early adopter of the technology.

"We fully expect this technology to become standard on both new and legacy industrial robot deployments in a short period of time," said Sparkman. "In our case alone, for example, we have deployed thousands of robots. Given the current labor challenges and rising demand for automation, we expect a majority of those to be retrofitted with the new system within the next couple of years."

For companies like IFS, the latest remote robot control technology enables their automation experts to serve more customers without having to leave the office. It also allows engineers to handle more troubleshooting calls each day.

"It's one thing to receive an alert when a robot has malfunctioned. It's quite another to be able to do something about it, such as remotely jog a gripper to release a part. This new remote robot control solution saves companies many hours of agonizing downtime, giving them reassurance that their automation investment is being maintained effectively," Sparkman said.

Eyes on the Ground

Even when customers are fully trained on a robot or cobot system, they still need a lot of support, said Karl Ericsson, CEO of SE Automation, a leading system integrator based in Stockholm, Sweden and an early adopter of the new technology. "Before the new technology came along, we had to support customers via telephone, WhatsApp and videoconferencing," Ericsson said. "Now, with remote monitoring and error recovery, we can actually 'be' there, see the pendant as well as the whole cell, and get production up and running again. It enables us to do more with less staff."

SE Automation quotes for the system as part of every new automation deployment and has plans to upgrade legacy installations with the technology. Said Ericsson: "It doesn't matter whether you deploy the system on the latest cobot or a 30-year-old painting robot. It doesn't matter whether your production run is high mix/low volume or vice-versa. It doesn't even really matter whether you're at the office or in an airport lounge. The latest remote monitoring and control system gives you the visual and telemetry data integrators need to solve problems faster than ever before." ■

Making Conversation:

Using AI to Extract Intel from Industrial Machinery and Equipment

Using prompt engineering and conversational AI or intelligent assistants, machine makers can exchange information and guidance with industrial machinery.

by **Rehana Begg**, Editor-in-Chief

WHAT IF YOUR MACHINE COULD TALK? This is the question Ron Di Carlantonio has grappled with since he founded iNAGO 1998.

Back in 2000, the Tokyo/Toronto-based computer scientist launched netpeople, a platform that allows companies to create intelligent assistants for their products.

For a simple description of how netpeople functions, Di Carlantonio will prompt you to tap into your childhood memories of KITT, the talking, bulletproof car in "Knight Rider" (either the 1982 or 2008 versions would suffice) that can think, learn, communicate and interact with humans.

Ron Di Carlantonio, founder and CEO, iNAGO, presented the potential of iNAGO's emergent technology at CMTS – Canadian Manufacturing and Technology Show in Toronto.
Machine Design

The platform, explained Di Carlantonio, is an "advanced intuitive conversational assistant" for automotive, consumer electronics and AI-driven manufacturing solutions.

A Talking Car

Needless to say, iNAGO was onboard when the Government of Canada supported a lighthouse project led by the Automotive Parts Manufacturers' Association (APMA) to design, engineer and build a connected and autonomous zero-emissions vehicle (ZEV) concept car and its digital twin that would validate and integrate autonomous technologies. The electric SUV is equipped with a dual-motor powertrain with total output of 550 hp and 472 lb-ft of torque.

But rather than develop it for series production, the vehicle was earmarked to attract OEM contracts. More than 50 suppliers teamed up for the largest industrial collaboration in Canadian history, and following its launch earlier this year, the prototype currently tours auto shows and makes its rounds at manufacturing trade shows.

The brief to collaborating partners in the Canadian ecosystem (including Geotab, Denso, Aisin, ABC Technologies and Vehiqilla) was to create a cockpit for the concept vehicle named Project Arrow. iNAGO would leverage its netpeople assistant platform and the company's conversational AI technology to enable a natural interface to everything in the vehicle.

"We created this open platform for everybody to work on and can create new innovations," Di Carlantonio said. "Project Arrow became a concept of an intelligent cockpit in the vehicle, driven by an intelligent assistant and a slew of other technologies working together."

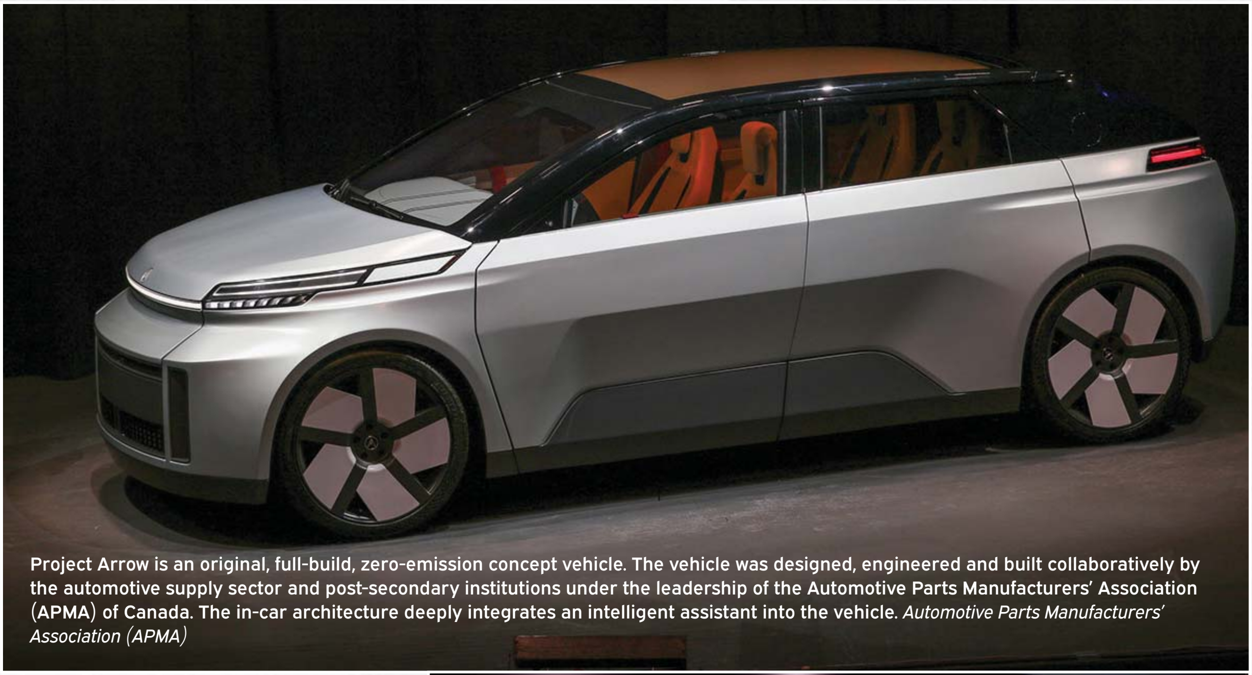
The general use of AI-based solutions in the automotive industry stretches across the lifecycle of a vehicle, from design and manufacturing to sales and aftermarket care. AI-powered chatbots, in particular, deliver instant, personalized virtual driver assistance, are on call 27/7 and can evolve with the preferences of tech-savvy drivers.

Di Carlantonio now sees an opportunity to extend the use of the intelligent assistant platform to the smart factory by making industrial equipment—CNC machines, presses, conveyors, industrial robots—talk.

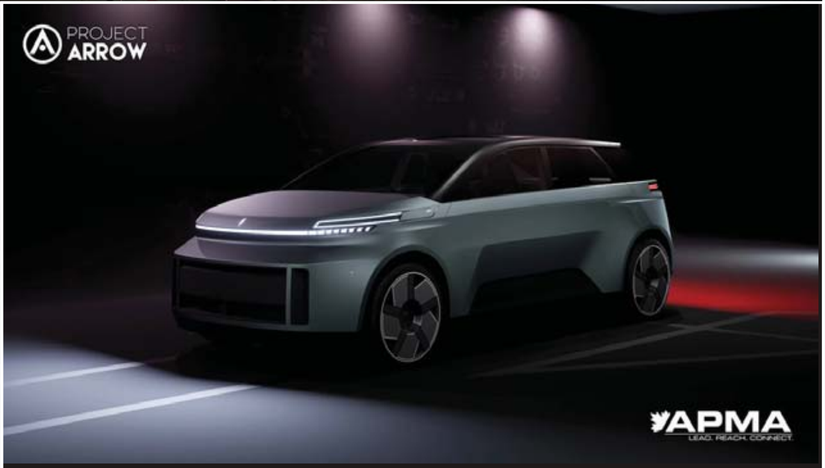
Intelligent Assistants

Before OpenAI's large-language model-based chatbot ChatGPT became a sensation in 2022, there were several incumbent voice-activated command systems. ELIZA, a natural language processing program written in the 1960s, was the first chatbot. Others followed, "including the chatbots on your bank site that don't answer anything," said Di Carlantonio.

Building on what came before, iNAGO's mission is to bring an intelligent, conversational assistant to market—one that captures contextual data and information that enables the use of smart components, navigation systems and troubleshooting services.



Project Arrow is an original, full-build, zero-emission concept vehicle. The vehicle was designed, engineered and built collaboratively by the automotive supply sector and post-secondary institutions under the leadership of the Automotive Parts Manufacturers' Association (APMA) of Canada. The in-car architecture deeply integrates an intelligent assistant into the vehicle. *Automotive Parts Manufacturers' Association (APMA)*



The Project Arrow, a Canadian-made zero-emission concept car, is the collaboration of more than 50 automotive supplier partners. The car is an answer to the challenge of the Canadian government to be at Net Zero by 2050. *2023 Canadian International AutoShow*

iNAGO's part in the communication stream is to make sense of the data in the context of what is being said. When humans process communication, we have to understand what the audio is. "In other words, I can hear you through my ear and that becomes text," explained Di Carlantonio. "That text gathers a meaning. We understand what the meaning of that text is, and then we go looking in our brain for some knowledge, and we pull that out. And then we decide how to answer.

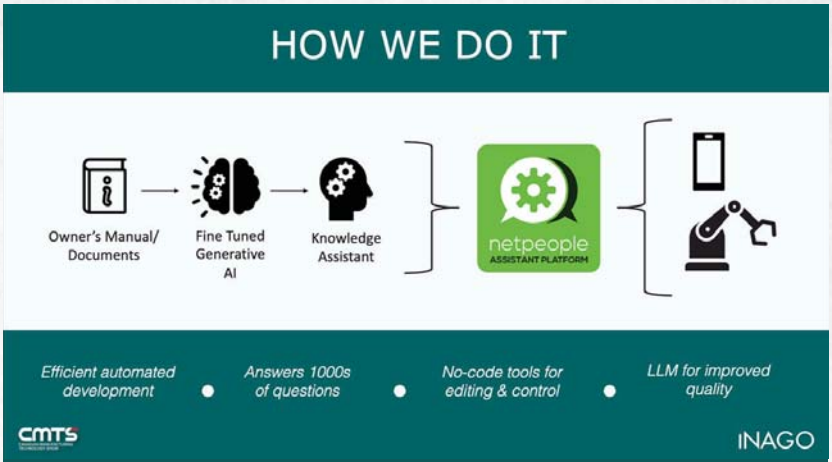
iNAGO does not develop speech recognition (the ears), Di Carlantonio clarified. That part is often done by companies like Google, Nuance, Cerence and others. Instead, the patent-pending solution comes into play after the speech has been recognized. It analyzes the text, makes sense of it and then determines what the correct response is. "We then provide tools to allow anybody—non-programmers—to be able to create that knowledge and create an experience," he added.

Context-Aware Natural Language Understanding

To appreciate iNAGO's unique capability to comprehend the context of a prompt, consider the task of asking Alexa or Google a question. Unless the question is formulated in one statement, the response is generally limited and one is unable to ask a follow-up question or add more information. To do so, explained Di Carlantonio, one needs to understand the context of the conversation. In computer science parlance, the neural networks and architecture aim to solve sequence-to-sequence tasks while handling long-range dependencies with ease. Few have had success at doing this; ChatGPT, however, is showing measured success at completing the task.

To say the technology is "context aware," explained DiCarlantonio, is to assert it understands all of the things being talked about (the conversational context) within the setting or environment. "If you were in a car, and you're going 150 Km an hour, and the person next to you says, 'what are you doing?', it has a very specific meaning because of the context, not just because of the words," he explained. "What we've tried to do is develop technologies that will understand the context and help better bridge that gap when conversing with a human."

A robotic arm picking and placing a product or a lathe cutting a part has a very specific function, and getting the context right in adding a conversational prompt to respond in a specific manner has significant implications. "Let's just say it's one level more serious than a chatbot on a bank site," said Di Carlantonio. "If the chatbot on a bank site doesn't get it right, you go to a call center. If a robot doesn't get it right, you could cut somebody's arm off. So, the safety element is critical and communication has to be accurate, and has the obligation to be both valuable and safe. The level of communication is much, much higher, and much more complex."



The netpeople platform developed by iNAGO uses generative AI to create machine learning models that turn information, such as the owner's manual, into knowledge that can be accessed in the command and control of machines. *iNAGO*

AI Opportunities in Manufacturing

Relative to other industries, manufacturing has focused on hardware and has a long way to go to keep pace with state-of-the-art software technology implementations, said Di Carlantonio.

Over the past couple of years iNAGO has worked on ways to install its solution in machines. The experience has revealed a number of opportunities, he noted. Firstly, in spite of the ruggedized design of displays on industrial machines, they present limitations on who can program the machine or understand the data on the display, he said. No-code/low-code capabilities have opened up an ability to update solutions that are better aligned with the changing needs of the workforce.

"Today, you have one person—the expert—who programs it. You're basically tied to what he can do or she can do, and you're limited," Di Carlantonio pointed out. "What if everybody on the plant floor could tell the machine what to do, and what if a designer could communicate with the machine to tell it the part it wants to make, and it could be conversational?"

Secondly, interpreting the sheer amount of data a machine generates is a burden for the average person. "It's just too complex," he said. AI can instantaneously gather all of that data, and process it to determine improvements and patterns.

Thirdly, despite the confluence of knowledge that humans hold about their machines in plants, the industry faces one reality: "People are older and they're retiring, so no more experts," pointed out Di Carlantonio. "The person leaves and all that knowledge leaves the organization." "So how can we retain that knowledge and make it available to everybody, even if they just started last week? That's an opportunity I think this technology can solve."

Undocumented Gap Between Machine Makers and Machine Operators

iNAGO's work with its R&D partners revealed there is a gap between makers of machines and users at the plant. The designers and machine makers don't know what is happening with a machine at the plant level, and the plant is very busy and doesn't have time to gather information, said Di Carlantonio. This exposes an inefficiency in developing solutions that keep pace with production and operational needs.

"Basically, the plant knows the capabilities, but they have no idea what a user would do with a machine, other than what the machine maker has said it could do," Di Carlantonio clarified.

Di Carlantonio characterized the work of figuring out how to best enable machines to "talk" as being in a "discovery phase" as they try to learn optimal ways to give people the means to interact with machines and allow manufacturers to capture and understand what's going on at the plant level.

"The work we're doing right now is, how do we take that knowledge or information we know about machines and put it in these AI models that allow people to interact with them in a natural way?" he asked.

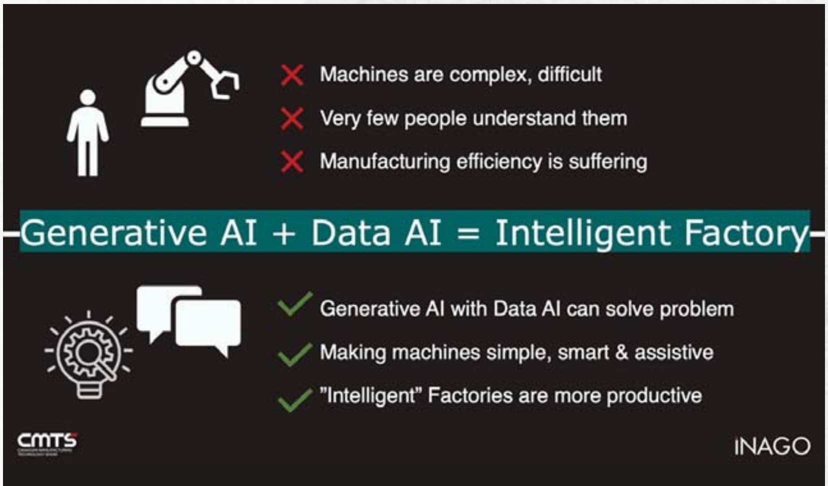
This phase would be augmented by learning the problems users encounter with machines that are not contained in the operating manuals, as well as simplifying the programming so that it becomes more accessible to a larger group of users.

Natural Language Understanding

For iNAGO, the ongoing focus will be to work through the challenges of turning information into an AI solution that users can interact with in a natural way. "That's a challenge we've been trying to solve for six years, so we are very close to that challenge," Di Carlantonio said. "We can take a manual or a specification, and using AI, we can convert it into something that you can just ask questions and get information."

Another challenge is that experts on the plant floor "hold a lot of information in their heads and they don't have it down on paper," he said. "Or, if they do, it's not the easiest to understand a document. So how do we get those people to share in this and be involved, and how can we take their knowledge into the AI solution?"

Finally, the hurdle of figuring out the business model remains. "Who's going to pay?"



iNAGO is creating next-generation conversational digital assistants. The company plans to deploy its intelligent communication and intelligent assistants in smart factories. *iNAGO*

With ChatGPT, Microsoft paid a billion dollars in investment in their first investment to create their tool, reminded Di Carlantonio. "Well, nobody in manufacturing is going to invest a billion dollars to do this kind of thing. We need to gradually bring it in. And we need to figure out the right business model that's a win for everybody."

To this end, Di Carlantonio is working with companies to bring his solution to fruition: "We believe the people who will pay will be at the plant level. So, at the very end [a] customer would pay for a service to improve their productivity and efficiency. And probably companies like us, the tech companies at the end, will be at the very bottom, but we will be providing that technology to allow the current manufacturers to incorporate the solution into their technology, and then, provide it as a service to the end customer. So that is the challenge as we get through every stage and show the ROI." ■

An Injection Molder
Embraces Emergent Technology with Robotics as a Service

ICON Injection Molding has enhanced efficiency, streamlined operations and is achieving sustainable growth since implementing Formic's Robotics-as-a-Service (RaaS) solution.

by Sharon Spielman, Technical Editor

Nicole Kleitsch-Killam, chief administrative officer, ICON Injection Molding. *Courtesy ICON Injection Molding*

Misa Ilkhechi, co-founder and vice president of solutions and partnerships. *Courtesy Formic*

Founded in 2001, family-owned, Phoenix-based ICON Injection Molding caters to a range of industries, making parts for laboratory use, security devices, pool equipment and more. "With a dedication to 'Excellence from Art to Part,' we have grown organically to become a go-to provider of custom plastic injection molding," says Nicole Kleitsch-Killam, chief administrative officer at ICON. "It also means that if a customer wants to order only 1,000 parts this month and 100,000 next month, we have to be able to react."

The impetus for ICON to explore automation arose when the company was faced with a specific project that required operators to repeatedly retrieve 300°F hot plastic parts and place them in a cooling bath. According to Kleitsch-Killam, the project required that operators stand on their feet for the entire workday to complete the task. "This repetitive manual process led to concerns about both worker safety and operational inefficiencies," she says.

"While our operators faced persistent minor injuries such as burns, as well as a high risk of more serious injuries, our overnight and weekend shifts were marred by inconsistent staffing levels that led to disruptions." She says as they grappled with the resulting high worker turnover, inconsistent output, longer lead times and higher prices for end customers, "We knew automation was the answer to both challenges."

Understanding a Robotics-as-a-Service Solution

Kleitsch-Killam says ICON initially reached out to a familiar conventional vendor, but the capital expenditure (CapEx) was too high and only covered the robotic unit—not any of the essential auxiliary equipment.

"Automation seemed out of reach, financially, until our CEO asked Jeff Galindo, our executive operations specialist, to find a solution," she explained. "An industry friend introduced him to Formic, and he was blown away. With no upfront CapEx and a low $10/hour rate, Formic's 'Robotics-as-a-Service' model just seemed too good to be true. We were even more impressed to learn that Formic would manage the maintenance, upkeep and programming of the system."

Under Formic's pay-for-productivity RaaS model, ICON pays for the operation of the robots when they are actively deployed. This hourly payment structure avoids a large CapEx spend and still reaps automation benefits.

Misa Ilkhechi, co-founder and vice president of product and partnerships at Formic, says, "Formic owns, programs, installs and maintains robotic systems from vendors like FANUC, Universal Robots and Yaskawa Motoman at its own cost, assuming the financial risk for customers…Put simply, if any of our systems don't work or fail to hit the agreed-upon productivity metrics, we don't get paid, so we're literally invested in keeping them running well."

As Formic grows, it is creating a library of automation solutions that can do everyday tasks, Ilkhechi explains, "so that even as we customize solutions, we don't have to continuously reinvent the wheel." At the same time, Formic is creating a platform where the company purchases hardware in bulk, which solves supply chain issues and reduces the cost and access to hardware for its customers and for other sub-component and system integrators that sit between Formic and the hardware, he says. “As Formic builds its knowledge and hardware base, it will be able to lower subscription costs and continue to democratize automation for U.S. manufacturers.”

RaaS is Adaptable as Needs Evolve

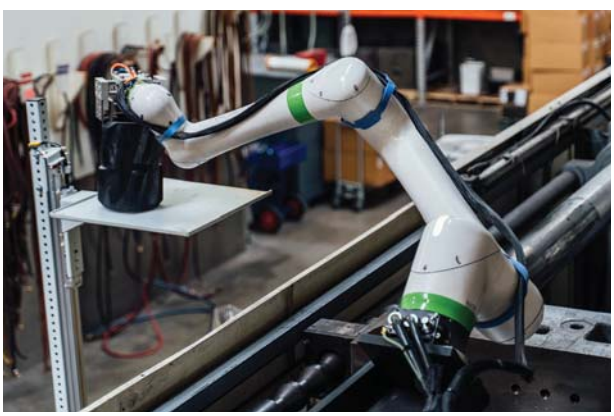
ICON and Formic collaborated to design and deploy a custom automated solution. Taking a technology-agnostic approach, Formic sourced hardware and software components from a range of suppliers, taking performance and suitability for ICON’s needs into consideration. The RaaS offering also adapts as needs evolve.

“Formic’s Tend solution is deployed on our factory floor in Arizona, but Formic owns, operates and maintains it for us and we only pay the hourly rate when it’s running,” Kleitsch-Killam says.

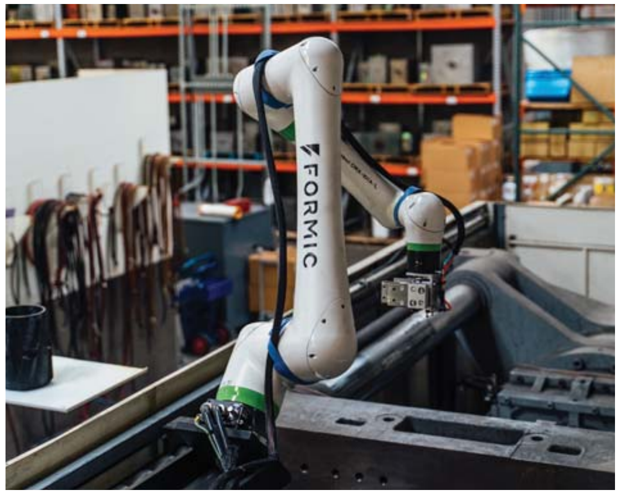
With a command center for remote login, Formic monitors its systems 24/7 to moderate temperatures, look for anomalies and find opportunities to improve usage and performance, according to Ilkhechi. “In addition, when a customer’s needs change, we can reprogram systems to accommodate new projects. And for customers with Formic Flex, we can even swap out their entire system—all at no cost to them,” he notes.

Kleitsch-Killam adds, “We can also monitor our system via a handy app, but Formic is committed to identifying and fixing problems before they even arise.”

She says the onsite staff training was an informative six-hour-long, hands-on course. “The cell includes a customized robotic machine operator (a 6-axis articulated FANUC robot arm), which was installed on our largest injection molding press, a 720-ton Nissei FV9100 that is over 20 years old,” she says. “It also includes a vertical conveyor that fully automates the process of loading, unloading and lowering the finished parts into the cooling bath for the final annealing process. This project consists of eight different parts, and programs for each size are set by Formic and maintained with software from Rockwell Automation.”



Since implementing the emergent technology, ICON Injection Molding has experienced a 20% increase in production, a 40% reduction in operational expenses and a 30% improvement in cycle-time efficiency. *Courtesy Formic*



The impetus for ICON Injection Molding to explore automation arose when the company was faced with a project that required operators to repeatedly retrieve 300° hot plastic parts and place them in a cooling bath. *Courtesy Formic*

Increased Performance, Future Growth Opportunities

Since implementing RaaS, ICON has experienced significant improvements across various performance indicators, including a 20% increase in production, a 40% reduction in operational expenses and a 30% improvement in cycle-time efficiency, according to Kleitsch-Killam.

The integration of this emergent technology has not only enhanced productivity but also improved safety for ICON’s operators. “Safety-wise, we’ve noticed a significant reduction in minor injuries associated with handling this component, effectively eliminating that risk for our operators,” she says. “Now, the only manual touchpoint occurs once the part has sufficiently cooled, allowing for safe handling without the need for personal protective equipment (PPE).”

The workplace is not only safer, but employee satisfaction is up and there is a reduction in employee turnover. Kleitsch-Killam says ICON’s corporate management team tries to frame the use of automation as a “productivity enhancer” rather than a “person replacer,” but there was initial skepticism from some of their long-time employees. “Once they saw that nobody was getting laid off to ‘make room’ for this automation, however, they recognized how much easier and safer it made their job. Those working on the less-staffed overnight and weekend shifts, in particular, now see much more opportunity to take on skilled roles within the company than before.

“This collaboration with Formic has been a case study of sorts for us, reflecting the potential of RaaS and its impact on ICON’s future,” she continues. “Right now, we’re focused on expansion to a new building on our premises, which ultimately means we’ve got room to amplify the role of robotics in what we do… We look forward to collaborating with Formic to determine what project or task to automate next.” ■

How Voxel Combines Video Feeds and AI to Assess and Mitigate Workplace Safety

Voxel AI is a platform that combines computer vision technology and AI modeling to help industrial workplaces coach out unsafe behaviors.

by Rehana Begg, Editor-in-Chief

A BIG DIFFERENTIATOR for Voxel's computer vision technology is that it combines AI tools with existing security cameras to avoid slips, trips and falls in industrial workplaces, according to Alex Senemar, CEO, Voxel.

A high-level description of the startup's technology is this: Video feeds from a facility's existing security camera systems are connected to an edge computing appliance, which sends information to Voxel Cloud for analysis. The footage is analyzed and flagged for unsafe events and risky behaviors. This footage is then shared with the client for review and anomalies can be addressed at the facility.

"We look at the leading indicators of risk and leading indicators of safety and injuries that take place in the workplace, and we try to identify them via the existing security cameras, using the artificial intelligence and computer vision models we develop," explained Senemar, who previously co-founded Sherbit, an AI-powered remote health monitoring system for hospitals. (The company was acquired in 2018.)

Where AI shines in the environment, health and safety (EHS) space is in its predictive capabilities that provide leading indicators for mitigating risk and creating safer workplaces. From data analysis to automation, artificial intelligence tools can be used to proactively manage risk in various EHS applications.

Voxel's team is led by CEO Alex Senemar, who previously co-founded Sherbit, an AI-powered remote health monitoring system for hospitals (acquired in 2018); as well as co-founders, CTO Anurag Kanungo, who co-founded Sherbit with Senemar, and led the Machine Learning Systems Team at Uber's Self Driving Unit; Harishma Dayanidhi, who developed self-driving car technology at Uber and Aurora; and Troy Carlson, former software engineer at Google. *Images courtesy Voxel*

San Francisco-based Voxel's platform is geared toward analyzing environmental hazards and ergonomic risks. Analyzing repetitive movements and motions that could lead to injury over time, such as poor lifting and overreaching, are examples. Another is logging events around powered vehicle safety, such as forklifts speeding in a warehouse that result in collisions.

"Our algorithms are consistently picking those up and giving insight into where the speed is occurring, and how people are turning and the types of driving patterns that take place in those environments," explained Senemar.

Voxel's AI can capture protective equipment, such as hard hats and safety gloves and boots. "These are things that could cause injury if you don't wear the right type of equipment in the workplace," Senemar said.

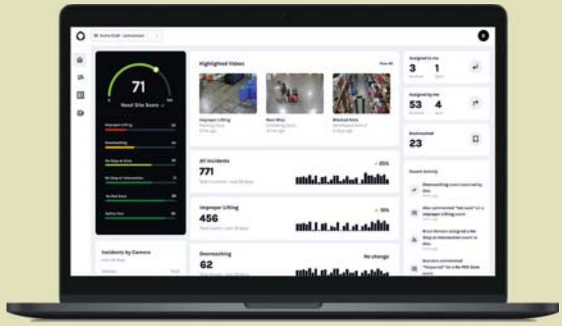
The leading cause of work-related injuries and illnesses involving days away from work in 2020 is exposure to harmful substances; followed by overexertion and bodily reaction; then slips, trips and falls, according to the National Safety Council (NSC). These three causes account for more than 75% of all nonfatal injuries and illnesses involving days away from work.

If Voxel aims to make a lasting impression on industrial operations by creating real-time visibility and offering analytics that can protect workers, Fortune 500 firms are taking note. Voxel already counts Clorox, PPG Industries and Office Depot among users of its platform. Strategic partners report up to an 80% reduction in workplace injuries, along with improvements in operational efficiency, said the company's press release.

In a recent strategic funding round, the company secured $12 million from Rite-Hite, bringing total funding to $30 million since it launched in 2020. Existing investors include Eclipse Ventures and World Innovation Lab.

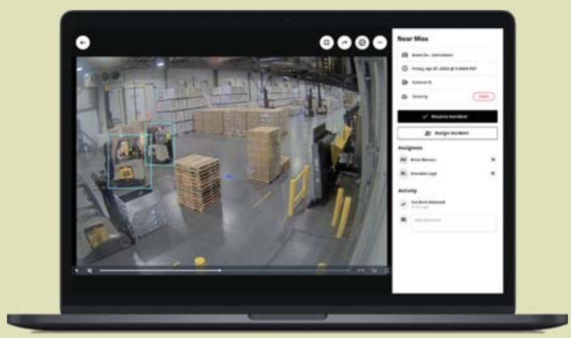
"This strategic investment was led by Rite-Hite," Senemar said. "They are one of the largest players in the industrial safety space, looking specifically at loading dock doors and other types of fencing and guarding that is [used in] different industrial environments. And the partnership with us is to grow with them as a company and also help support more customers through that partnership. The other part that we're looking at is more of a global expansion. We're looking at trying to tap into other markets outside of the North American market, and scaling the business."

What follows below is a sampling of questions based on an interview with Senemar. (Content has been edited for clarity.)



The persistent challenge of workplace injuries and operational inefficiencies can be mitigated with emergent computer vision and AI solutions designed to send real-time alerts to on-site personnel.

Voxel integrates state-of-the-art computer vision technology into existing security cameras to identify hazards, risky behaviors and operational inefficiencies.



Integrated computer vision technologies help sites identify operational inefficiencies and design ethically responsible policies to prevent future issues.

Rehana Begg: Can you elaborate on how Voxel integrates the computer vision technology into existing cameras? What sets you apart? What makes it state of the art?

Alex Senemar: We've essentially built very generalized AI models that we can deploy right off the bat. And they've seen hundreds of thousands of hours of video at this point. We've been able to train on different versions and iterations of each one of these events. And those connect directly to the camera. We get up and running within 48 hours at customer sites.

It's matured quite a bit. And if you actually look at our team, most of them came from the self-driving car space, where a lot of the key learnings have happened in computer vision and AI from that world. We are looking at environments constantly, and how those models can generalize and effectively scale across

200-300 warehouses at a time. When you look at these large companies, they have quite a large footprint of industrial areas where injuries can take place.

We've developed everything internally and we do have a really strong AI research team within Voxel itself that has developed it. It's really a mix of the IP that we developed, but also the data that we've been able to see and train our models on to grow and understand these environments in a more mature way.

RB: You mentioned identifying potential risk such as near-miss vehicle collisions, blocked exits, improper ergonomics or spills. These are very different scenarios. Talk about the data collection and the analytics for these seemingly unique situations. For example, do you customize the application for various facilities or various customers?

AS: We do customize based on the use cases and the safety rules and behaviors that site is looking for. We have generalized models that look for key things around a forklift or the speed at which it's taking place, or how fast it's moving compared to a person, and how close those two objects are getting together. So, we're doing a lot of modeling as well within the two-dimensional camera image. And then we are able to extract that information via AI models. We have rules and parameters the customer can adjust accordingly.

I can give you some examples: At some customer sites, they want people to slow down at the end of an aisle, whereas in another, the customer site wants someone to come to a complete stop. Our system needs to be able to effectively adjust, based on the behaviors and the patterns of safety that are being put in place at that workplace and adjust to their environment. So that's a big part of the value proposition of Voxel.

RB: It all seems a very proactive in the way the company can approach it. How do plants use the data, for example, to reduce workers compensation and general liability costs and then also improve operations? I guess I'm having trouble understanding how they analyze the data and make those determinations.

AS: Capturing a lot of data is just one part of that life cycle. It's how do you integrate into the culture of the environments that you're in, and also help them be effective with that information, and training employees, and getting in front of potential injuries that could take place in that worksite? When we do actually capture this data? There are a few things. One is that we're providing the leading indicators of risk and then safety.

Typically, the way it works today is, you have an injury or some kind of near-miss event that occurred. You take a record of that and then try to update your safety policies. Now, the way that we are fundamentally changing that with Voxel is that we provide [tangible data] on unsafe behaviors in that lower level of the safety pyramid, such as what are those key things that are happening that are driving those injuries for you, and give you 24/7 visibility into those things.

When you run a program like Voxel, essentially, what you're looking at is, how do you coach those behaviors out? And how do you engage—whether it's in your safety meeting, or if there's some kind of activity that's taking place—how do you engage the employees and have the right discussions?

We don't provide any facial recognition as part of our platform. So, we don't actually know who the individual is. That is actively violating a rule, or some event might have taken place. It's more a coaching platform that [provides concrete data] and taking that information and having effective discussions. It's not just discussing poor behavior, but also rewarding good behavior.

That's the program we built around the Voxel platform, where we actually support the customers, to bring that into the workplace and help behavior change.

RB: Anonymity is an important aspect here. Alex, I binge-read anything related to AI and existential threats. But setting aside over-hyped, hypothetical harms, ethics will still play a huge part in developing responsible data-driven solutions. What I'm really interested in is how individual, valid and useful applications can be leveraged for negative impact and unintended consequences—for example, cyberattacks, or misinformation, or malicious use. Tell me more about the privacy and security safeguards and how your development and design team build that into their thinking.

AS: I think there are two parts to this. One is the security and one is the privacy.

On the security side: That's a place we made a significant amount of investment as a company because we work with leading companies in the country—a lot of Fortune 500 companies. And our systems are fully SOC 2* compliant. We do a lot of processing on site to avoid sending a lot of video across internet where there could be potential vulnerabilities for a customer.

And then, the other thing we do from a privacy standpoint is that we don't actually detect the individuals on site. This is video they already have. We're just telling them key analytics and moments that they should be reviewing and discussing with their teams to help reduce those events, that it could take place from an injury standpoint. ■

**Editor's note:* "SOC" or system and organizational controls, refers to a cybersecurity compliance framework as outlined by the American Institute of Certified Public Accountants (AICPA). To be compliant means a service organization has completed third-party audits that demonstrate it has certain controls and safeguards in place. SOC 2 provides controls for various Trust Services Criteria, including security, confidentiality, processing integrity and privacy.*

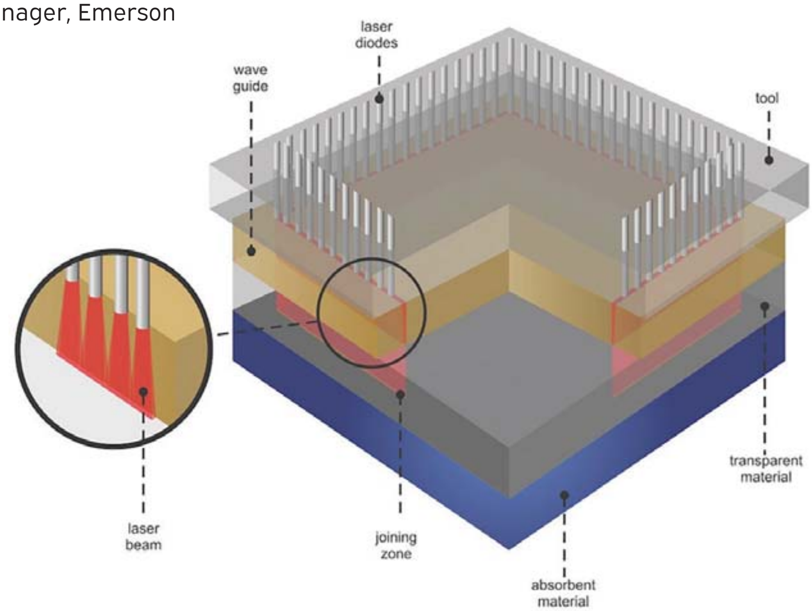
New Type of Welding Adds Capabilities to Plastic Laser Welding for Medical Devices

Simultaneous-through-transmission-infrared laser welding forms highly precise welds which can be made virtually invisible.

by Priyank Kishor, Global Product Manager, Emerson

LASER PLASTIC WELDING HAS grown in popularity for medical applications because it reliably joins a wide range of materials, including dissimilar materials. At the same time, the process uses no vibration energy, so it is gentle enough to bond plastic parts with thin walls, geometrically complex shapes, and embedded electronics or sensors. At the same time, it can provide a Class A finish. Laser welding is ideal for making medical products that require narrow, particulate-free fluid pathways. Thus, it is often used to make drug-delivery devices, in-vitro diagnostic (IVD) devices, glucose monitors, insulin pumps and similar applications.

Simultaneous through-transmission IR (STTIr) laser-welding technology, developed by Emerson, gives engineers new capabilities for welding plastic parts. That's partly because it employs a series of laser-emitting diodes to heat the entire weld surface at once. This ensures precise heating and reduces the clamping force required to press parts together while the weld is made and then cools.



Laser welding uses heat provided by a 980-nm laser generated by diodes. This light is concentrated through fiber-optic bundles connected to the weld tooling, then precisely aimed through wave guides (seen in circle view) along the part's weld area according to the heating density required. *Images courtesy Emerson*

Traditionally when welding two plastic parts together, one part had to be "clear" or "transmissive," which would let the laser pass through without causing warming; the other part then had to be "dark" or "absorptive" to be heated by the laser. This assured the applied laser energy would selectively heat the weld zone of the absorptive part. There, the heat softens the mating edges of both parts, letting them be brought together under compressive force into a clean, particle-free welded assembly.

STTIr welding, combined with precise ultrasonic spray deposition developed by Sono-Tek can weld two optically clear plastic parts made of a wide range of polymers. This opens up new design possibilities for those designing and making medical devices, drug delivery systems and in-vitro testing products.

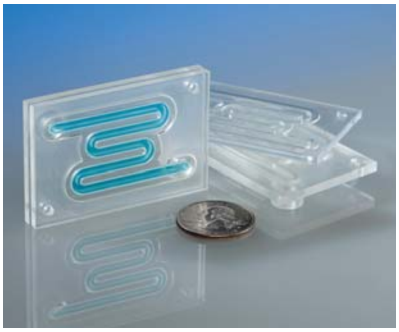
This new "clear-on-clear" laser process overcomes the traditional transmissive/absorptive part limitation by treating one of the two "clear" mating parts with a biocompatible laser absorber before laser welding. The absorber consists of microparticles of pigment dye or carbon black suspended in a carrier fluid such as isopropyl alcohol or acetone.

The absorber can be added to resin in the form of a masterbatch prior to molding, applied to molded parts using pad printing or, for maximum precision, applied to individual parts with ultrasonic spray deposition.

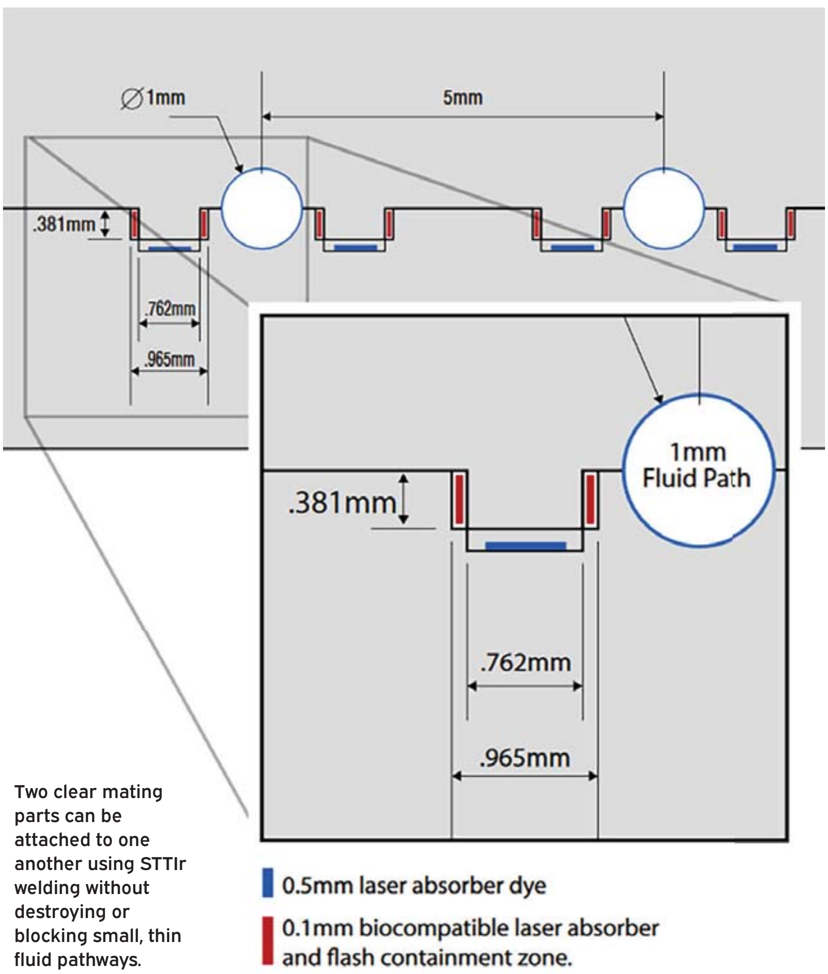
Spray deposition relies on an ultrasonic atomizer that precisely deposits the laser-absorbing dye on one of the mating parts, creating a spray pattern as thin as 0.5 mm.

When deposited using the right ultrasonic frequency and spray pattern, the carrier fluid essentially flashes off, leaving a precise pattern of laser-absorbing particles, one micron or smaller in size, on the surface of the thermoplastic. During welding, laser energy gets absorbed by these particles and consumes them, releasing heat that travels through the weld zone of the mating parts, which then become bonded together under compressive force.

Typical targets include the interior surface of tongue-and-groove joints and the interior surfaces of a "double V" joint on one of the mating parts. Precisely depositing the absorber within enclosed joints like these focuses the laser-generated heat needed to create the part-to-part melt and creates a "flash-trap" that contains the melt's treated area, isolating it from any nearby microfluidic flow paths in the finished assembly.



These tongue-and-groove laser joints show the biocompatible laser absorber and flash containment zone.



Two clear mating parts can be attached to one another using STTIr welding without destroying or blocking small, thin fluid pathways.

This new method of plastic laser-welding reliably produces complex fluid paths while maintaining superior aspect ratios in the submillimeter flow path pitch. Such precision is essential for microfluidic parts, which must be reliably bonded, yet maintain consistent dimensions along extremely small flow paths.

This new clear-on-clear laser-welding capability relies on equipment added to the STTIr process (i.e., the biocompatible laser absorber and ultrasonic spray deposition equipment) and it can be "bolted on" to many existing laser-welding applications. It delivers cycle times measured in seconds, making industrial-scale laser welding of medical-quality clear-on-clear microfluidic parts economically viable for the first time. And, since spray deposition can be adapted to coat several parts at once, both the spray deposition and welding processes can be further scaled up to accelerate production throughputs.

The new process also joins a far greater range of clear thermoplastics, regardless of chemistry. Because the laser-absorbing pigment dye efficiently generates and conducts heat and melt, it can compensate for large differences in the glass transition temperatures (Tg) of different polymers used in mating parts.

A typical example of the process is its use on two clear plastic "coupons" or injection-molded parts that mate to form a serpentine flow path like those found in a host of medical devices. The coupons will become the "absorptive" half of each assembly, so they are placed in the spray deposition equipment for a coating of the laser absorber.

From there, parts are transferred to the laser welder (see photo on facing page), which makes a clear-on-clear, laser-welded part. For medical or IVD devices that demand optically clear flow paths, the technology is invaluable. It simplifies everything from automating blood cell counts in capillary-sized fluid paths to providing visual validation to technicians that a microdose of a powerful therapy is being properly administered to a patient.

The Branson GLX Micro laser welder from Emerson is the smallest of five units in the GLX Series. The welding unit (left) features a color touchscreen, a lift table measuring 150 × 150 mm, and clamp forces up to 0.05 kN. These make it an excellent choice for welding microfluidic parts for medical applications. The unit at right contains the laser source and power supply.

The Benefits of Laser Welding

Laser welding offers a range of important benefits to product assembly operations, including:

Superior aesthetics. Manufacturers increasingly use laser welds for their aesthetics because they are precise and flash-free. Weld lines are virtually invisible.

Greater part-design freedom. Traditional plastic welding methods often require flat-plane parts, but laser-emitting waveguides can conform precisely to complicated part geometry, letting lasers weld part designs that maximize aesthetics or functional performance. Laser welding also frees designers to use several reflective compartments or embed sophisticated electronics, sensors or lighting—such as organic light-emitting diodes (OLEDs)—resulting in more striking, brand-differentiating designs.

Excellent weld quality. Laser welds require no friction, vibrations or movements. Laser-emitting waveguides can conform precisely to even complex parts to ensure rapid and uniform melt across the weld interface. The leaves a uniform, consistently strong weld joint with precise melt-collapse depth and perfect part alignment.

Low mechanical stress. The latest laser welders can manage ultra-low clamp forces, letting delicate and larger parts be joined without introducing mechanical stresses. This eliminates the need for annealing parts and putting them through material stress reduction.

Ultra-cleanliness. Laser welding produces no flash or particulates. It's a cleanroom-capable process that's equally at home on any production floor.

Great versatility. Laser-welding technology can bond a wide range of polymer materials, including PC, PA, PS, ABS, elastomers (TPU, TPE), PP HDPE, LDPE, PETG, PBT, PPS, PMMA, PEEK, COC and more. ■

Emergent Robotics: Pioneering Solutions in Modern Industrial Automation

Collaborative, mobile autonomous, swarm and vision-guided robots are redefining planned work and intralogistics operations.

by Tara Van Geons, Business Group Marketing Manager, Motion

Programming a cobot for a machine-tending application. *Courtesy Universal Robots*

CONTINUALLY PUSHING THE BOUNDARIES OF industrial automation, robotics delivers unparalleled efficiencies and solutions that were once deemed the stuff of science fiction. Industries across sectors are racing to leverage robotics to transform and optimize their operations. Exciting solutions reshaping the industrial landscape include collaborative, mobile autonomous, swarm and vision-guided robots.

Collaborative Robots

Large-scale robots are often isolated from workers due to safety concerns. They are sometimes massive, exceptionally heavy, and usually placed behind safety glass or industrial framing cages. Unlike these conventional industrial robots, collaborative robots (cobots) are designed to work and share space with humans. They are built with safety features such as force and torque sensors, so the cobot would instantly stop or slow down its operation if it comes into unexpected contact with a human worker.

Cobots are designed specifically to enhance human capabilities rather than replace them. They are programmable, adaptable and user-friendly. While traditional robots require specialized knowledge to program and operate, workers don't need a robotics background to reprogram cobots when required.

Industrial applications for cobots are vast. Cobots are used in many industrial processes, including assembly line operations, machine tending, pick-and-place, quality control and collaborative welding.

While cobots enhance production and efficiency, they also benefit the overall worker experience. Leaving boring, repetitive tasks to cobots allows workers to focus on more substantial, complex and fulfilling jobs. Cobots also reduce the physical strain humans can experience with repeated movements.

The introduction of cobots in the workspace was a paradigm shift in how we perceive robotics. Robots are not replacing human workers; if anything, the cobot and human worker can both leverage their unique strengths. The technological advances of cobots and robotics are playing an even bigger role in shaping the future of manufacturing.

Mobile Autonomous Robots

Industrial floors are hubs of activity. Precision, timing and efficiency are paramount. Mobile autonomous robots add a new layer of adaptability and intelligence to manufacturing operations. They are used in industrial applications such as material handling and transportation, inventory management, safety and security, collaborative picking, facility cleaning and more.

Unlike traditional stationary robots, mobile autonomous robots are not tethered to a specific location. They have sensors, cameras and advanced navigation algorithms that enable them to move freely across the factory floor without human intervention. Infrared sensors and depth cameras map these robots' surroundings, so they avoid obstacles and reach their destinations safely.

Mobile autonomous robots are highly adaptable. Manufacturing lines and warehouses often change layouts, but these robot types require little reprogramming and can adjust quickly. Also, industries can scale their operations by adding more mobile autonomous robots rapidly and easily.

Collision avoidance systems, emergency stop functions and real-time monitoring ensure that human workers and these robots can coexist harmoniously.

The real-time data, enhanced safety and adaptability of these mobile autonomous robots signal an industrial automation transformation. As their capabilities expand and technology advances, mobile autonomous robots may play an even more central role in manufacturing efficiency and production.

Swarm Robots

Swarm robotics is turning traditional robotics on its head. Once, we had a single, powerful machine. But now, swarm robotics focuses on strength in numbers. Mimicking the natural behavior of ants, bees or birds, swarm robots work with coordinated action.

Each swarm robot operates based on local information and simple rules. Instead of a single control source, swarm robotics works on the principle of decentralized control. The collective behavior comes from the individual robots interacting with each other and the environment.

Because swarm robotics offers scalability, flexibility and robustness, they are highly desirable in large warehouse footprints. Without changing or modifying the system, swarm robots can easily be scaled up or down by adding or removing a robot. This flexibility allows for fluctuation in demand.

If a robot malfunctions, operations can carry on because of the decentralized nature of the control system. If a robot shuts down, the swarm continues its tasks.

Distributed assembly, warehouse management, surveillance and inspection, and cleaning and maintenance are all perfect uses of swarm robots.

Swarm robots are a significant departure from traditional approaches to industrial automation. Collective action and decentralization mark a leap in robotic advancement. As innovation continues, we can expect swarm robotics to integrate more into industrial applications.

Distributed assembly, warehouse management, surveillance and inspection, and cleaning and maintenance are all perfect uses of swarm robots.

Vision-Guided Robots

Vision-guided robotics (VGR) is a game-changer in the industrial arena. These robots can "see" and "understand" their surroundings. VGR equips robots with vision inspection sensors and algorithms to process and interpret images. Manufacturers are embracing this robotic technology and the possibilities are endless.

Sophisticated image-processing software and high-resolution cameras work together with VGR. The robot uses cameras to gather visual data from its surroundings and process it in real-time. Then, the robot can make decisions or change its movements.

VGR's benefits for industrial automation include decreased fixturing, improved flexibility and greater precision. Traditional robots are often in highly structured environments, whereas VGR allows for adaptation to variations. They can work with a broader range of products and switch tasks without manual assistance.

By seeing and processing, VGRs achieve high levels of accuracy and excel in tasks like assembly, pick-and-place operations and material handling. VGR can also identify parts presented in random orientations. Thus, custom or static fixtures in more traditional robotics applications are unnecessary, saving the manufacturer time and money in the long run.

Integrated with artificial intelligence (AI) and machine learning capabilities, VGR can provide facilities with consistent quality control inspection. VGR, combined with AI algorithms, can identify and recognize objects and detect defects in products ranging from medical syringes to automotive engines. As this integrated system processes more and more data, its accuracy and efficiency improve.

Integrated into Infrastructure

Today's industrial work is reimagining human and robot worker collaboration. Cobots enable smooth integrations and symbiotic work environments where humans and robots complement one another's advantages. Mobile autonomous robots are redefining the logistics warehouse with their independence and agility. Swarm robotics demonstrates the strength of the collective and that the whole is more impressive than the sum of its parts. VGR, especially with its AI integration, has reformed what robots are capable of: perceiving, understanding and interacting with surroundings like never before.

We will see robotics increasingly used across all manufacturing industries and business sectors. Robotics is no longer a luxury but vital in the industrial automation space. This leap in technology and innovation is exciting and essential to industrial growth. ■

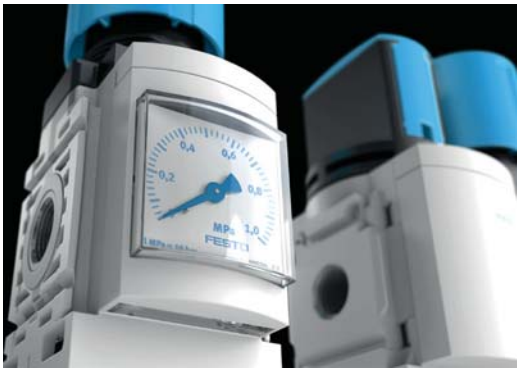
Moog GAT Enhances Robotics Applications with Rotary Unions and Slip Rings

Seamless and continuous rotation at the joint of a tool interface is important in robotics. Moog GAT blends rotary unions and electrical slip rings to enhance these capabilities. The technology streamlines robot-guided, automated screwdriving processes specifically suited for plastic screws, including real-time torque monitoring.

MOOG

www.machinedesign.com/21277692

Festo Launches MS-Basic Line of Pneumatic Service Units

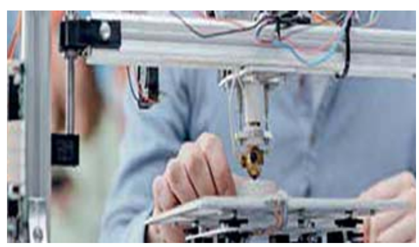


Components in the MS-Basic line include pressure regulators, filter regulators, on/off and start valves, and manual on/off valves with filter/regulator combinations. This line is designed to be a combination of low-cost basic functions with high-end functionality. Key features of the MS-Basic line of pneumatic service units include lightweight pressure regulators and filter regulators; electric on/off and soft-start valves; online configurator to customize air preparation systems; and Festo pneumatic essentials program. The regulators offer a high flow rate of up to 6,000 l/min, and their polymer materials reduce unit weight by up to 30%, according to a company press release. An integrated filter in the transparent bowl accommodates easy and space-saving filter changes as well as a clear indication of dirt accumulation. Manual or fully automatic condensate drains ensure process reliability and protection against contamination. Additionally, the soft-start valve gradually builds working pressure before switching to full set pressure.

FESTO CORPORATION

www.machinedesign.com/21274542

Ad Index



R&D Spotlight: Inventing Wearable Sensors that Monitor Uric Acid in Sweat

by Rehana Begg, Editor-in-Chief

WEARABLE BIOSENSORS are revolutionizing point-of-care diagnostics by offering real-time monitoring of physiological metrics and biomarkers. Researchers at Purdue University's College of Engineering have invented non-invasive, wearable sensors that monitor levels of uric acid in human sweat.

Wenzhuo Wu, the Ravi and Eleanor Talwar Rising Star Associate Professor of Industrial Engineering, said that their creation allows for the non-invasive, repeated monitoring of uric acid (UA) levels in human sweat over long periods of time and could enable the unprecedented diagnosis, therapy and prognosis of several conditions, including anxiety and hypertension.

Dubbed EPICS (flexible piezo-electrocatalytic uric acid sensor), the sensors were created from zinc oxide, a nontoxic, biocompatible and electrochemically active material. The flexible UA sensors are based on ZnO nanorods and are designed to monitor uric acid in human sweat.

"These patent-pending sensors, called EPICS, have higher sensitivity and better wearability and can be made from less expensive materials than traditional sensors that measure uric acid levels," said Wu, whose research was published in Nano Energy.

Uric Acid Testing

Uric acid (UA) is a waste product that is formed when the body breaks down purines. High rates of UA or build-up increases the risk of some health problems (such as gout and hypertension).

UA tests help medical practitioners diagnose the cause of recurrent kidney stones and monitor people with gout. UA also acts as an alarm that triggers inflammation as an immune response.

"Recent studies report the physiological diseases associated with abnormal UA levels affect approximately 1%-4% of the world's population and cost more than $20 billion in annual medical expenditures. The psychological conditions associated with abnormal UA levels impact 8.74% of the U.S. population and cost $33.7 billion in related medical expenses annually," Wu said in a press note.

Drawbacks of Typical UA Monitoring

Despite well-established clinical practices for measuring UA levels in blood (used for monitoring metabolism and nutrition), shortcomings remain.

Current wearable sensors used to measure UA levels in sweat have limitations, including complicated fabrication processes, sophisticated instruments, expensive raw materials and unsatisfactory performance, noted the researchers.

Researchers at Purdue University's College of Engineering have developed a non-invasive, wearable sensor technology designed to monitor uric acid levels in sweat. For a detailed discussion of the technology, read their paper published in *Nano Energy*. *Purdue Research Foundation photo/Jennifer Mayberry*

"The UA levels in the sweat of a healthy human are significantly lower than the UA levels in blood. This means sensors must have superior limits of detection," Wu said. "Additionally, continuous monitoring requires intimate contact between the UA sensor and human skin, which imposes further requirements for the wearability of the sensors."

Flexible UA Sensors

The researchers reported that advanced technologies such as wearable sensors can address these shortcomings.

The authors reported that their EPICS devices could achieve "a fourfold enhancement in the UA sensing performance with a small compressive strain (–0.9%), boosted by piezo-electrocatalysis during the electrochemical oxidation of UA on the surfaces of mechanically deformed ZnO nanorods."

The EPICS devices exhibited a superior sensitivity that outperformed all reported flexible electrochemical UA sensors, according to the researchers, who have tested EPICS at Purdue University's Flex Lab since the summer of 2021.

"Our design allows the possibility of non-invasive monitoring of UA with a boosted performance by otherwise wasted mechanical energy, such as that from the human body," noted the authors.

Sensor Innovation Patent Application

Wu and his team have applied for a patent to protect the intellectual property through the Purdue Innovates Office of Technology Commercialization.

They reported that the fundamental piezo-electrocatalytic principles can be extended to other piezoelectric materials with catalytic properties. The technology is applicable for high-performance sensing uses in the biomedical, pharmaceutical and agricultural areas, they said. ■

Driving the world

SEW EURODRIVE

No coating.
Brilliant for the environment.

Coating-free aluminum gearmotors in the ECO2 design –
ECOlogical, ECOnomical, and uncompromisingly sustainable.

Aluminum reacts with oxygen to form a **thin protective layer**.

Drives in the ECO2 design: Efficient and reliable

- In indoor spaces with a maximum humidity of 60%
- At temperatures of -20 °C up to a maximum of +60 °C
- The ECO2 design meets the requirements of ISO 12944 corrosivity category C1.

ECO2

In a dry, neutral environment, aluminum and plastic are **well protected from corrosion**.

100%
coating-free
outer surfaces

ECO2: economical and ecological

The demand for eco-friendly products is growing. We have responded to this with our sustainable, coating-free drives and our responsible use of raw materials. **ECO2** describes our high performance gearmotors made from uncoated aluminum. They're both ecological – thanks to their environmentally friendly coating-free design – and economical, as a result of their cost-efficient manufacturing and assembly process. What's more, components can be recycled more efficiently and sustainably at the end of their life cycle. All this is good for the environment and for your wallet.

*Available in select sizes and configurations.

Get more technical info and configure yours here

www.seweurodrive.com