

AUTOMATION FOR MANUFACTURING KEEPS EVOLVING



Industrial automation isn't just big robots in automotive plants; it's also a rapidly diversifying set of tools that can help in any production environment.

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Editor's Note

Welcome to *Robotics 24/7's* Special Focus Issue on developments

in manufacturing automation! The past two years have been difficult for the industry, with trade conflicts, political uncertainty, and last but not least, a global pandemic complicating planning for factory operators and floor managers.

However, the only way to move is forward. As we've reported across Peerless Media's sites, manufacturers, designers, integrators, and suppliers are looking to automation to augment human capabilities as labor shortfalls persist. In this issue, I share insights from both the International Federation of Robotics and the Association for Advancing Automation. Their data provides some cause for optimism.

At the same time, robots are only as good as the people working with them, the software controlling them, and the data that they yield for business decisions. Automakers have decades of experience with robots, but they're still buying new machines as the industry shifts. Many other manufacturers are just getting started.

This Special Focus Issue looks at retraining efforts, robots in metalworking, and the importance of precise motion control for emerging applications. Most robots aren't plug and play, so you'll need to assess tasks and processes before picking the right tools. That's where *Robotics 24/7* can be a key resource.

We also look at megatrends and how the cloud, artificial intelligence, and robots are converging for a bright future for manufacturing. It won't happen without careful decisions and hard work, but I hope you find this issue helpful. As always, let me know what you'd like to see!

Eugene Demaitre, Editorial Director

Comments? E-mail me at edemaitre@peerlessmedia.com



EXECUTIVE CONTACTS

**Group Publisher/
International Sales**
Tom Cooney
tooney@peerlessmedia.com
973-214-6798

President and CEO, Peerless Media
Brian Ceraolo
bceraolo@peerlessmedia.com
508-663-1553

Editorial Director
Eugene Demaitre
edemaitre@peerlessmedia.com
508-380-5457

Office Manager
Laurel Peddie
lpeddie@peerlessmedia.com
508-663-1559

SALES

Western Regional Manager
Len Pettek
lpettek@peerlessmedia.com
805-493-8297 office
805-231-9582 Mobile

Midwest/Eastern Regional Manager
Michael Worley
mworley@peerlessmedia.com
508-663-1561

Advertising & Support Specialist
Michele Mittenzwei
mmittenzwei@peerlessmedia.com

CLIENT SERVICES

Director of Client Services
Mary Ann Scannell
mascannell@peerlessmedia.com
508-663-1560

Director of Marketing
Karen Bligh
kbligh@peerlessmedia.com
508-663-1550

Director Content Management
George Kokoris
gkokoris@peerlessmedia.com
508-663-1555

Director Online Technology
John Brillon
jbrillon@peerlessmedia.com

Webcast Project Manager
Steve Paul
spaul@peerlessmedia.com
617-281-7125

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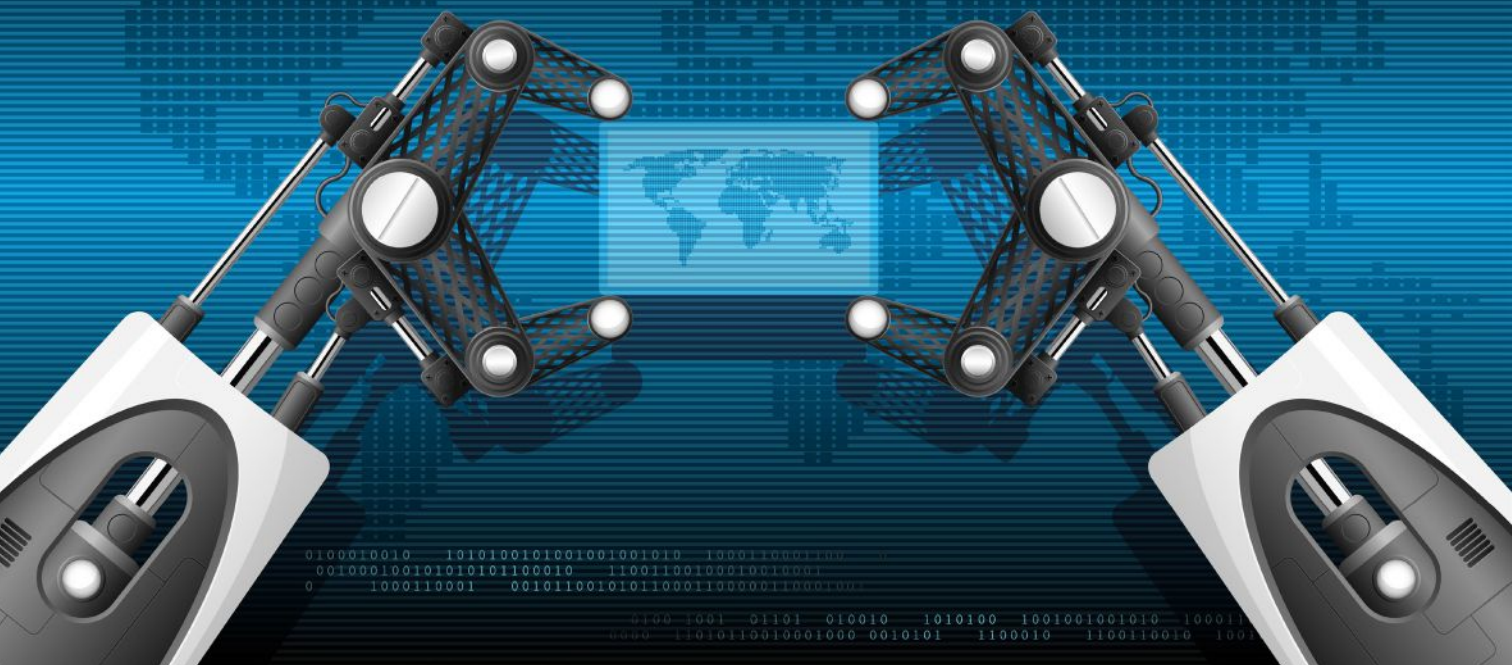
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Robotics Can Boost Business Recovery From COVID-19, Says IFR President

BY EUGENE DEMAITRE



Both industry veterans and newcomers to automation can benefit from the experience of others, notes **Milton Guerry**, who is also president of Schunk USA.

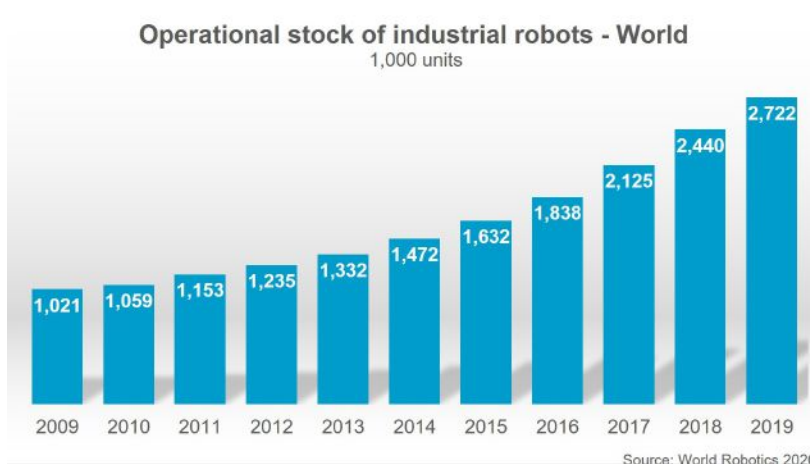
The past year has been challenging for manufacturing, supply chain, and other industries, but it has also provided opportunities for improving safety, efficiency, and productivity with robots and automation. Milton Guerry, president of tooling supplier Schunk as well as the International Federation of Robotics, or IFR, recently answered questions from Robotics 24/7 about current trends in technology and industry.

Recession and recovery

Global manufacturing had started to slow down even before the pandemic because of factors such as China-U.S. trade tensions. How quickly do you expect it to return to steady growth?

GUERRY: This is exactly right. In 2019, we were feeling the slowing related to trade tensions and changes in the automotive industry related to EVs [electric vehicles]. The slowdown was coming off an all-time high in 2018, but robot deployments remained at a high level, even with trade tensions and changes in the automotive industry.

With the challenges of 2019, the worldwide operational stock reached a high of 2.7 million robots, which equals a 12% growth year over year. The early indications show we are close or even back to steady growth.



The IFR has reported a steady increase in automation.

Even as unemployment drops with the COVID-19 pandemic finally easing, how can automation help businesses?

GUERRY: Companies that adopt and embrace automation are more productive and competitive, and through their success, they employ more people. Automation played a crucial role during the pandemic. Many goods were in short supply due to the disruption, and automation

was quickly deployed to scale and fill the critical needs from everyday products to PPE [personal protective equipment].

As the grip of the pandemic eases, we see the advantages of automation more clearly than ever. When we automate, supply is more distributed, more secure. When we produce more locally, our carbon footprint is smaller. When manufacturers are more productive, wages and standards rise.

Put these factors together with unemployment dropping to pre-pandemic levels, jobs will soon go unfilled. Automation will keep us moving forward and will help us will help us ensure that jobs stay in our country.

Which countries does the IFR project to increase their robot density the most?

GUERRY: Robot density, operating robots per 10,000 employees, is one of the most telling indicators of the culmination of many factors. We consider the following by region: the outlook for manufacturing, the economic growth cycle, technological advances, the policy position for investment, and the available labor to adopt the automation. The countries able to align these factors will have the high-

est density increases.

China has recently aligned these factors and has progressed from No. 28 to No. 15 in only five years, thereby increasing its robot density from 36 in 2014 to 187 in 2019, as published by the IFR.

Singapore is a second example, growing its robot density from 299 to 918 within five years.

So far, the frontrunner countries with respect to robot densities are strongly active in the automotive and/or the electronics industry. Once we manage a broader diffusion into general industries, the picture can quickly change—to the benefits of those economies being most successful in this process. We already see that economies that invest in their automation infrastructure are more successful.



Does the IFR have any projections on how much robotics will grow this year in verticals other than manufacturing, such as agriculture, construction, healthcare, or food and beverage?

GUERRY: With the uncertainty remaining, predictions could be a little difficult. If we look at the success in 2020 in North America, the 3.5% growth in 2020 reported by the Association for Advancing Automation was amazing. More interesting, general industries like you mentioned surpassed automotive in unit sales for the first time in history.

The unexpected success in 2020 coupled with the current optimism in North America and growth in areas like China, pushes overall expectations close to 2018 highs, possibly even exceeding those levels this year.

Manufacturing sectors, particularly automotive, struggled most in the crisis, while the services sectors invested heavily in automation technology to keep up with demand. Healthcare and logistics were among the beneficiaries of

this shift. Nontraditional industries will lead the charge.

Robots for both industry veterans, newcomers

You've noted that the automotive industry is likely to continue leading the way for industrial automation and robotics. How will the push toward electric and autonomous vehicles affect that?



GUERRY: The automotive industry knows what automation

brings to a business: quality, flexibility, productivity, and the ability to produce all over the world. With the automotive industry's deep understanding, [companies] will embrace new automation technologies and find new applications through sensing, collaborative equipment, and mobile solution developments.

The push towards electric and autonomous may change some processes and even cause some small blips in consumption. Schunk's engineers are getting inquiries daily for new processes related to battery production, motor housing assembly, winding, and assembly. Automation will be part of their ability to scale, and this industry knows it very well.

Robotics adoption is growing in the U.S., but what should companies that have never used robotics know now?

GUERRY: It can be very hard to get started or know where to start. Manufacturers have so many things to think about these days—the ever-increasing competition, short business cycles, and labor shortages and gaps, to name a few. These are such universal subjects, so why not learn from those who have paved the way?

Listen to the stories of the companies that have implemented robotics.

There are communities out there with resources to help. For example, with users, suppliers and implementors, A3 is a great place to start. Technology suppliers are also a tremendous resource. Schunk's engineers have decades of experience and are working on cutting-edge applications. Challenge us.

Business and tech trends in robotics

Supply chain and logistics are areas of strong interest in robotics—do you expect consolidation among mobile robot providers?

GUERRY: Today is a very exciting time in the robotics industry. The IFR is tracking approximately 900 mobile robotics companies for “World Robotics – Service Robots.” The service robotics industry is a young and growing industry, showing tremendous diversity from technology to industries to applications.

About 20% of the companies qualify as startups, being founded within the past five years. Eighty-two percent of those companies are SMEs, a quarter of them with 10 or fewer employees. There will likely be some settling in the future, and this could mean consolidation, as we have monitored for the industrial robotics industry in the past.

You've mentioned artificial intelligence and machine learning as enabling capabilities such as more precise piece picking. Where do you expect AI and manipulation to advance the most this year?

GUERRY: AI is on everyone's minds and there are a lot of predictions out there; we all agree machine learning will have a huge impact on the future of robotics. Manipulation, vision and gripping have been working together for a long time.

With the changes in computing power, computing location—edge— machine learning

is a natural step. What I see progressing is packages ready to implement. Packages consisting of hardware, sensing, and software will unweight deployment.

As for Schunk, do you see grippers and end-of-arm tooling becoming more specialized or more generalized in the near future?

GUERRY: Can I pick both? Specialized grippers today become standardized tomorrow. Our experience is as market areas open, the first grippers are very specialized. We see so many new markets for robotics, and many will require specialty devices for those workpieces.

The end-of-arm tool, the primary touch point where the work is being done, is critical to the success. If we use cobots as an example, the first applications required self-compliance for gripping.

Now, Schunk's offering of certified off-the-shelf collaborative grippers is growing rapidly. These developments are one of the many factors making our industry and our work so much fun.



As shops begin to deploy robots from multiple vendors, how important are data management, integration, and orchestration of different robots?

GUERRY: With the arrival of new technologies like cobots and mobile robots, there is an increasing necessity to have multiple platforms working in the same company. In the past, ro-

bots and machines were often deployed as cells.

In the future, integration of the systems will provide further productivity and the capability for connectivity will be a given. Communication and interoperability standards like OPC-UA will help to facilitate this process.

Considering collaboration

At Automate Forward, you participated in the session on “How Collaborative Automation Is Driving Productivity.” How have cobot arms, autonomous mobile robots, and light industrial arms with new sensor and safety features converged?

GUERRY: This was such a great panel, and I was honored to be included in this group of industry leaders. We discussed the rapid growth of cobot and light industrial applications. Three of us are rooted in this area. I happen to know that Joe Gemma, [global vice president of sales and marketing at] Calvary Robotics, has a passion for mobile platforms.



Source: Calvary Robotics

Greg Smith, [president of the Industrial Automation Group at] Teradyne, obviously has a tight connection to diverse technology—MiR, AutoGuide, Universal Robots [UR], and Energid. Dave Robers, [sales manager—Americas at] DENSO, had a unique perspective [being from] a robot company with strong connections to one of the world’s largest automotive tier suppliers.

This new class class of robots includes features such as ease of programming, ease of han-

dling, software integration, and components ecosystems now bundled to applications.

The adoption of cobots has grown slowly among small and midsize enterprises (SMEs)—do you expect that to grow this year or next?

We are seeing and hearing a lot of buzz from SMEs about robotics. The leaders of SMEs have a lot of forces acting in their investment strategies, from short business cycles to staff development and investment incentives, naming a few.

If we look to what is changing on the technology side, there are many positive developments that will drive adoption for these crucial companies. Programming simplification is advancing; FANUC’s new CRX and UR’s new interface are shining examples of user-friendly software.

Robot ecosystems, where companies like Schunk are developing interfaces and software modules to speed deployment and redeployment, may be one of the biggest drivers to lower the barriers for SMEs. Many Schunk products now come packaged with software. This is a jumpstart to deployment.

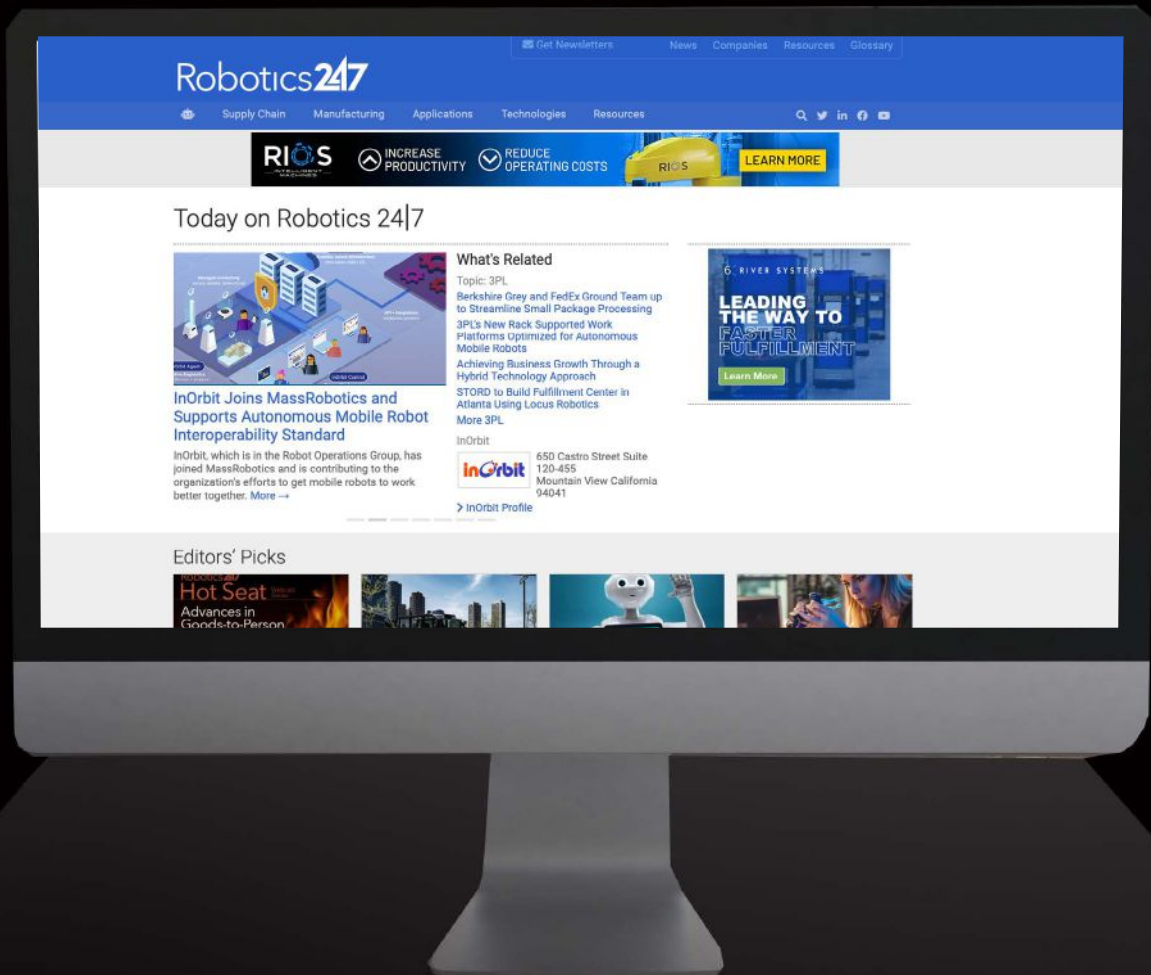
What would you like to say to Robotics 24/7’s audience of robotics developers, integrators, and users?

First, thanks for making it to this point in the interview. You are on Robotics 24/7, so I am confident you are a fan of robotics and the awesome coverage on this site. In the past 20 years, there has never been a more exciting time for robotics. We are not at the peak. Stay in touch, stay informed, get involved every where possible. Join me in absorbing all the industry news on Robotics 24/7. ■

Eugene Demaitre is editorial director of Robotics 24/7.

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eKENTUCKY ADVANCED MANUFACTURING INSTITUTE Opens New Training Center *Adds Robotics Coursework*

BY ROBOTICS 24/7 STAFF

eKAMI's new Robotics Center will train students on both mobile robots and robot arms for jobs in manufacturing and logistics.

The Eastern Kentucky Advanced Manufacturing Institute, or eKAMI, has announced the opening of a new Robotics Center that will offer hands-on training with robots that are used daily in factories and logistics facilities around the world. The Paintsville, Ky.-based institute, which is a model of workforce retraining, will include mobile robots and fixed robot arms from major vendors.

“We are excited to open this new chapter in the eKAMI story,” said Kathy Walker, founder and CEO of eKAMI. “This expansion provides additional cutting-edge skills, which are in high demand by employers. To deploy automation, more companies are looking for individuals with a basic understanding of robotics. eKAMI will be able to assist with this transition by providing a new workforce skilled in this area.”

A shortage of skilled labor in U.S. manufacturing could leave as many as 2.1 million jobs

unfilled, according to Deloitte and The Manufacturing Institute. This in turn could cost the U.S. economy \$1 trillion, said the study.

Programs like that of eKAMI have been nationally recognized for addressing the skills gap by providing students with training in areas that employers need. While enrolled in the program, eKAMI students will earn national credentials from the National Institute of Metalworking Skills (NIMS).

eKAMI offers accelerated training

Founded in 2017, eKAMI said its mission is to prepare people for 21st century jobs in advanced manufacturing, automation, and robotics. Students train on Haas CNC (computer numerical control) equipment, learning to program, set up, and operate machines that produce parts for industries including aerospace, medical, defense, and automotive. The expanded coursework provides technical skills training in robotic programming and various collaborative robotic tasks such as machine tending.

The 40,000 square-foot workforce training facility offers an accelerated five-month program for adults and a 10-month program for young adults.

The Robotics Center has the support of many companies that operate in the robotics and automation space, with many of them providing robots, software, services, and accessories. Sponsors and supporters of the new center include:

- Teradyne, owner of Universal Robots (UR), Mobile Industrial Robots (MiR), and AutoGuide Mobile Robots
- Heartland Automation
- Yaskawa Motoman
- OhmniLabs
- READY Robotics
- ROEQ
- Robotiq
- Vention
- FedEx
- Appalachian Wireless

“We’re excited about our robotics contribution to eKAMI’s curriculum, and we’re excited to build on these efforts in a way that can solve the skilled labor shortage at scale and enable every U.S. manufacturer to easily deploy automation.” said Ben Gibbs, CEO of READY Robotics.

READY, an early supporter of eKAMI’s efforts to add robotics to its curriculum, said it has already worked with three of the class cohorts taking them from zero robot knowledge to doing “lights-out” production runs using the robots.

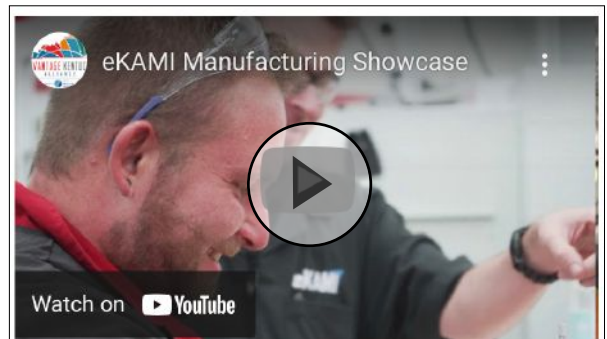
Kentucky looks to a robot renaissance

“Our students were already in high demand by employers due to their advanced training in CNC Machining,” said Walker. “Adding robotics to the curriculum is the natural next step in our goal of developing the skills needed to attract more manufacturers to eastern Kentucky.”

Many eKAMI students have already been hired as robot technicians by firms such as Heartland Automation and AutoGuide Mobile Robots.

In March, eKAMI received \$3 million for a second training facility to expand training offerings to the East Kentucky Correctional Complex.

The new Robotics Center officially opened in June with a celebration that was attended by representatives from both industry and government. Instructors and students demonstrated how each robot operates and how they can be used in different environments from manufacturing to logistics. ■



HUMAN-MACHINE INTERACTION STILL EVOLVING

NOTE GLOBAL ROBOT CLUSTER PANELISTS



BY EUGENE DEMAITRE

Experts from around the world share advances in robots and AI for assistance, rehabilitation, voice interaction, and industrial uses.

From prosthetics to voice controls and artificial intelligence, advances in multiple technologies are helping robots and assistive devices to work more closely with humans. Speakers during a virtual event on “The Evolution of Human-Robot Interaction” produced by the Global Robot Cluster explained how these systems can augment human capabilities and improve both industrial productivity and the quality of life.

In his opening remarks, Changho Kim, chairman of the Global Robot Cluster, noted that progress is being made worldwide in human-machine interfaces. The event involved experts from South Korea and Europe, as well as U.S. robotics clusters MassRobotics and Silicon Valley Robotics, which co-hosted.

The GRC welcomed new member Taipei Computer Association (TCA), and André Montaud, director of the Coboteam Auvergne-Rhône-Alpes robotics cluster, invited attendees to SIDO Lyon, a robotics exhibition in France in September.

Democratizing access and revising rehab

One of the top goals for researchers and companies developing wearable technologies is to democratize access to systems that can help people with disabilities.

Only 5% to 15% of amputees have access to advanced prostheses, said Hamayal Choudhry, founder and CEO of smartARM. His company is working on a low-cost bionic arm and hand that uses 3D printing and machine learning. It includes a camera embedded in the wrist to calculate grasp, as well as pre-loaded grasps.

“We want this to be affordable, intelligent, and personalized,” he said. A companion app for training custom grips will be available as a service from Toronto-based smartARM.

A combination of human control and different robots promises more flexible treatment. “Rehabilitation robots must provide common ground between doctors, patients, and government sectors,” said Yeung Ki Kim, M.D., Ph.D., and founder and CEO of Leaders Rehab Robot. “We have diversified robots based on needs and evidence-based functionality, from very sophisticated to simple telemedicine models.”

The South Korea-based company has developed evidence-based function robotic systems that provide patient support, freeing clinical personnel to focus on helping patients improve their gait.



Improving assistance and robot touch

Exoskeletons are typically bulky and expensive, added Rob Palfreyman, CEO of Seismic Robotics, which spun out of military supplier SRI Inter-

national in 2015. By contrast, Menlo Park, Calif.-based Seismic has commercialized the Flex-Drive electric muscles for “powered clothing” that’s more wearable for worker safety and wellness applications.

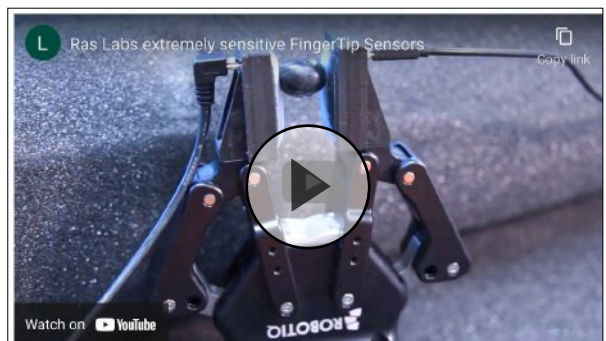
Seismic’s elastic system weighs a total of 7 lb. and is now available for preorder. However, it is intended for commercial uses rather than therapeutic ones and includes behavior apps for construction and logistics. Healthcare reimbursements can be a challenge, particularly in the U.S., Palfreyman acknowledged.

“We’re still exploring how this will be charged out,” he said. “It’s not an FDA-approved device; it’s ultimately a consumer product. We’re willing to license it out to healthcare applications.”

In addition to machine vision, a sense of touch is essential for human-level manipulation. RasLabs originally developed its electroactive polymer with the intention of using it for actuation, said Peter Vicars, CEO of the MassRobotics resident in Boston.

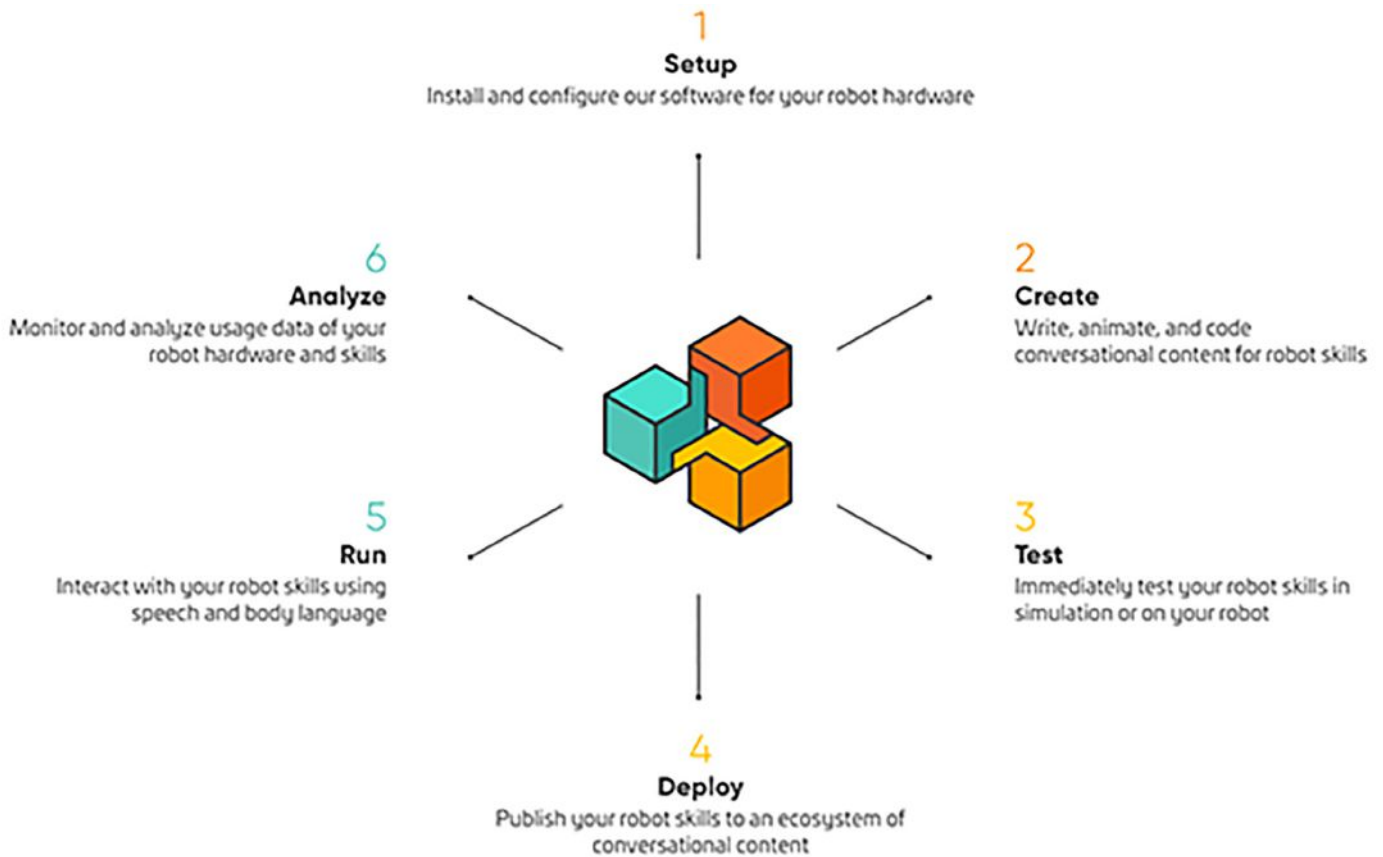
“It can change shape with low voltage—12 to 15 volts—by 35%, and there’s also an enormous attenuation of force,” he said. “With the smart material, we can make a sensor fit on the end of a traditional robotics gripper, providing a sense of touch similar to our own fingertips.”

RasLabs’ sensors could fit inside a robotic gripper or prosthetic hand, and it is working on a soft gripper, said Vicars. “It has a sensitivity of 0.05 newtons—the touch of a feather,” he explained. The company is looking at working with existing robotic grippers, Vicars told Robotics 24/7.



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Developers get tools for usability

Another goal for human-robot interaction that is becoming attainable is the ability for non-Ph.D.s to tell robots what to do.

“We won’t need to program robots in the future,” said Matthias Scheutz, CEO of Thinking Robots Inc. in Boston. “Next-generation human-robot interaction will be task-based, multimodal, natural language instruction.” He shared a video demonstration of a robot responding to human directions without prior knowledge.

“We want to get from the DOS of robotics to Windows,” said Ross Mead, co-founder and CEO of Semio. “We call arora, our software platform for natural language-based applications, ‘Android for androids.’”

The Los Angeles-based startup is developing tools for managing and deploying apps for social robots. “There are three categories of functionality—user interfaces, the app ecosystem, and developer tools,” Mead said.

Semio is designing for conversational interactions and includes some controls for making robots move (see diagram, previous page). At the same time, major entertainment companies are interested in defining specific movements for branded characters, he said.

AI to aid industrial automation

Refinements to robotics hardware and AI software are also helping humans in industry. “We’re using AI to fuel industrial automation and inspection,” said Dr. Anatoli Gorchet, co-founder and

chief technology officer of Neurala. He described the use of deep neural networks (DNNs) for “trainable feature extractors” in quality inspection.

In other AI techniques, trying to train for all possible variations leads to infinite branching. “The system needs to correct wrong inferences,” Gorchet said.

“We’ve replaced deduction with induction and added the ability to add knowledge on the fly,” he added. “Systems need less training and less images.”

“What about computation at the edge?” asked Tom Ryden, executive director of MassRobotics and moderator of the panel discussion.

“Yes, we can do it [AI processing] on the factory floor,” replied Gorchet. Boston-based Neurala recently launched a European subsidiary. It has also raised \$12 million to scale its VIA AI for industrial inspection.

“There are more startups and more experimentation than ever before,” observed Ryden. Progress in robotics and AI to benefit humanity will continue along multiple paths worldwide, agreed attendees. ■



Semio's arora is intended to help developers build features for human-robot interaction. Source: Semio AI

In a First, Yearly Non-Automotive Robotic Orders Higher Than Automotive Orders



BY MMH STAFF

Robotic Industries Association statistics on industrial robot arms also finds fourth quarter of 2020 was second-best quarter for orders

For the first time, yearly orders of robots from non-automotive sectors surpassed automotive robot orders, as sales of robotic units in North America increased 3.5% in 2020 from 2019. This growth was driven by a strong Q4 that was the second-best quarter ever for North American robotic sales with a 63.6% increase over Q4 2019.

Industry statistics – released by the Robotic Industries Association (RIA), part of the Association for Advancing Automation (A3) – show that North American companies ordered 31,044 robotic units, valued at \$1.572 billion in 2020. In Q4, companies ordered 9,972 units valued at \$479 million. The RIA statistics are focused on industrial robot arms used in multiple industry segments.

“The surge in robot orders that we’re seeing, despite the pandemic, demonstrates the growing interest in robotic and automation solutions,” said Jeff Burnstein, A3 President. “It’s promising to see the growth of robotics in new applications and reaching a wider group of users than ever before.”

Year-over-year orders in life sciences increased by 69%, food and consumer goods grew by 56%, and plastics and rubber saw a 51% increase. Automotive orders increased 39% in 2020.

“In 2020, we saw two trends in particular that propelled growth in non-automotive orders for robotics technology,” said John Bubnikovich, Chief Regional Officer – North America, KUKA Robotics. “First, the automation competence level in general industry has grown, and that matured into greater demand for the technology. Second, consumer behavior shifted significantly and the expectations created by this shift were tough to satisfy without automation.”

At the same time, Bubnikovich said, supply chain disruptions and instability in the workforce made industries accelerate automation strategies. The same trends are being noticed by other major robot manufacturers.

“With the changes in people’s personal buying behavior caused by COVID, robots have been utilized in record numbers to allow for the fulfillment of orders in the e-commerce space while allowing for correct social distancing practices,” said Dean Elkins, Segment Leader – Handling, Yaskawa Motoman. “In addition, robots largely aided in the production of personal protection and testing equipment and the medical devices needed to keep our society healthy and safe.”

“We have seen a substantial increase in activity in non-automotive sectors, as customers focus on making their production lines more flexible and better able to efficiently achieve high mix, lower volume production in response to constantly evolving customer demands,” says Mark Joppru, Vice President – Consumer Segment & Service Robotics, US ABB Robotics and Machine

Automation. “In food applications, for example, where robots were traditionally used to automate simpler processes like case loading, they are increasingly being commissioned for higher value processes, like directly preparing food, resulting in improvements to food safety and hygiene. While these trends have existed for several years, COVID has changed perceptions and priorities for customers, accelerating the adoption of robotic automation.”

Uncertainty followed by industry strengthening

In August of 2020, A3 reported on the strain to supply chains and economic uncertainty due to COVID-19. Alex Shikany, A3 Vice President, Membership & Business Intelligence, noted that despite a drop in orders, industry leaders showed optimism about the remainder of 2020, and accurately predicted the strong finish to 2020.

“The pandemic has created a sense of urgency for manufacturing companies to invest in automation like never before,” said Mike Cicco, President and CEO of FANUC America. “Traditionally, companies have implemented automation to reduce cost, increase output, and improve quality.

“However, the pandemic has added an additional factor that is driving manufacturers to re-examine their supply chain to increase flexibility, minimize disruptions, and move it closer to their customers,” he said. “With this mindset, there are more opportunities for scaling robotic applications across multiple facilities, especially for larger companies. The untapped potential for automation is a promising sign for our industry; the opportunities for automation today are truly limitless.” ■



ROBOTS RISE TO HELP HUMANS IN METALWORKING

BY JIM ROMEO

Robots and 3D printing can help manufacturers push the pedal to the metal

Automation anxiety is an undercurrent of modern labor. Will a robot take over and run me right out of a job? When it comes to metalworking, robotics is supplementing labor without displacing it. In fact, highly skilled workers can supervise robots that are safe, fast, and efficient.

The U.S. will have a shortage of 400,000 welders by 2024, predicts the American Welding Society, as workers age out and young people are reluctant to enter the profession.

When manufacturers add advanced robotics to human workers, they can benefit from increased productivity, quality, and the ability for employees to focus on other value-added tasks.

Retraining skilled workers

KUKA AG recently opened a training center in Ireland to clarify the path ahead for skilled operators. The company is providing the Irish Louth & Meath Education and Training Board with multiple robots for the

new Advanced Manufacturing Training Centre of Excellence (AMTCE), touted as “the largest vocational training facility of its kind in Europe.”

According to KUKA, the training facility will be well-stocked with robots, including customized six-axis industrial robots with vision systems, robot welding cells, robot milling/machining cells, and collaborative robot cells.

The center will be the site of new training courses designed to retrain operators and technicians. This comes at a time when industrial manufacturing and metal cutting is undergoing an automation renaissance with greater implementation of Industry 4.0. It’s also part of the Irish government’s COVID-19 reconstruction plan.



New possibilities with additive manufacturing

When it comes to arc welding with robots, scientists and engineers are developing technologies that promise to improve production. 3D printing is no longer just for prototyping and has made its debut in the aerospace manufacturing and construction industries. Suppose we combined arc welding with additive manufacturing? It's already happening around the globe.

Doctoral students at University of Waikato in Hamilton, New Zealand, are working on the production of heavy parts using additive manufacturing and robotic welding.

TiDA Ltd. is working with the researchers to use wire arc additive manufacturing, or WAAM, to repair, remanufacture, and fabricate large metal components in almost any shape. 3D metal printing has made great strides globally in recent years, allowing heavy parts made from metallic feedstocks to be created from digital scans and following the rules and commands of a programmed application.

Using complex software, the New Zealand team developed software to enable a robotic arc welder to serve as the "printer." The researchers said they see it as a boon to self-sufficiency in the supply chain for things like heavy parts. This a particular concern because trade conflicts and the COVID-19 pandemic have disrupted the global supply chains for things like large metallic parts required for heavy machinery in power plants, process plants, and other large-scale industrial facilities.

Instead of transporting the finished goods, the team merely transferred a digital file that can run on the software they created to produce a part with local materials.

It's still in its infancy, but this process demonstrates how an audacious vision and smart technologies can create useful things, especially when manufacturers are struggling to keep up with demand.



TiDA Ltd.'s robotic welding 3D-printing system in action, using WAAM technology. Source: The University of Waikato

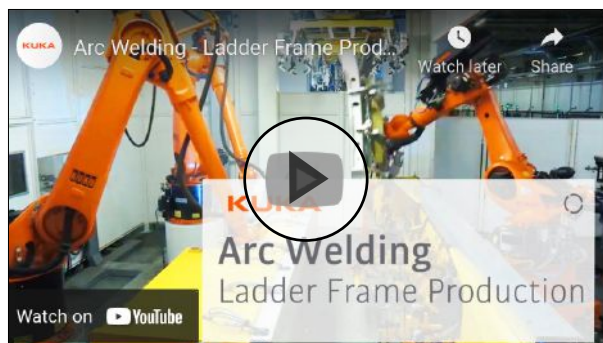
Automotive sector leads a bright future for welding robots

The global market for arc welding robots alone is about \$5 billion today and could surpass \$8 billion by 2027, according to Fortune Business Insights. The research firm asserted that growth in robotic welding technology is in lockstep with the "technological advancements in automation technology."

Welding robots can cut down process time. This is due in part to devices that automate processes such as nozzle cleaning, wire cutting, and other tasks to speed up the overall process. Robots can also create a safer and streamlined environment on the production floor for human workers.

Fortune Business Insights added that arc welding is expected to lead the pack in robotic welding applications, with the most demand realized from the automotive sector. It also said the Asia-Pacific region is expected to create the greatest demand.

While automotive manufacturers have long used robots for metalworking, automated welding is still in the early adoption phase. Workers will need to be retrained, and the industry will need to be educated to scale use. However, the combination of improving technologies in robotic welding and additive manufacturing could result in brand-new processes and products. ■





PRECISE MOTION CONTROL PROVIDES ROBOTS NEW DEGREES OF FREEDOM

BY JIM ROMEO

FROM INSPECTION TO SURGERY, ADVANCED MOTION CONTROL IS ENABLING NEW APPLICATIONS FOR ROBOTS.

As multiple industries look to robotics for augmented capabilities, the age of precise motion control is upon us. Depending on the application, developers and suppliers need to design or select the best motors, encoders and controls for the job.

As fleets of autonomous systems pick, assemble, and move materials from one point to another, end users need to be confident that they will provide reliable, precise, safe motion. Some examples include robots that can collaborate with humans and even aid surgeons performing complex procedures in the operating room.

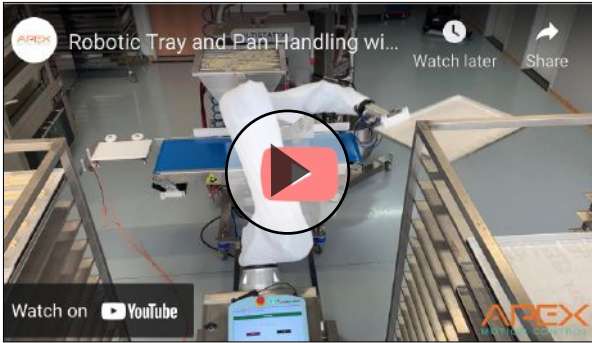
Robotic motion control leads to cake

How about baking a cake? Well, yes, robotics can help with that also. Food machinery provider Unifiller Systems Inc. teamed with integrator Apex Motion

Control Inc. on the Baker-Bot. It was designed to be a versatile robotic bakery assistant that can be easily integrated into any new or existing cake line.

This robot can assist bakeries and baking plants with an extra set of hands, according to Unifiller Systems. It can be programmed to load and unload pans onto conveyors and baking racks. The companies also said it can “decorate cakes, deposit flowable products, and pick and place items with precision—no breaks needed.”

Collaborative robots can also provide the benefit of socially distancing scarce workers, who can focus on less repetitive tasks, said Apex Motion Control.



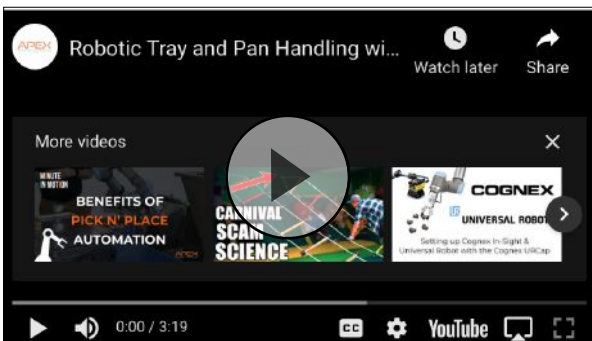
Motion with multiple limbs

When we think of robots, a common configuration is one with a single arm. However, we can look at legged robots as having multiple articulated limbs. One of the best-known quadruped robots is Boston Dynamics' Spot, which is now available for sale.

The company, now a unit of Hyundai Motor Group, describes Spot as "an agile mobile robot that navigates terrain with unprecedented mobility, allowing you to automate routine inspection tasks and data capture safely, accurately, and frequently."

As seen on *60 Minutes*, Spot can travel on battery power at 3 mph and has a range of about 90 minutes. The mobile robot's battery packs are interchangeable, and it can be equipped with an arm and a gripper.

Spot is designed to be able to work in harsh environments. If it gets knocked down, Spot can right itself back up and into motion. What's more, it can carry a payload of about 30 lb. and a variety of sensors. Boston Dynamics is initially positioning Spot as a tool for remote inspection of mines, nuclear power plants, construction sites, and secure locations.



Advancing robots in healthcare

At Citrus Memorial Hospital in Inverness, Fla., the staff almost considers robots as additional members. Robotics is a designated department, and robotic precision is being used to assist surgeons to perform complex surgeries, like operating on a patient's lung.

Recently, a robot assisted with thoracic surgery by helping to perform lung wedge resection. The surgery, known as a lung re-sectioning, removed a portion of a patient's lung where a cancerous tumor had grown. The physiology in such a procedure is obviously delicate and fragile, but a robot can be trained and used to perform with minimal margin of error, according to Mark Fernandez, MD.

A surgical robot allowed a surgeon to perform the procedure by very meticulously dissecting a lymph node or conducting scarless thyroid surgery. This enabled the surgeon to access the area and perform the procedure accurately and with the greatest precision.



Motion control and the future of human-robot collaboration

Note that all of these examples include humans "in the loop," from working alongside bakers and remotely controlling Boston Dynamics' Spot to assisting surgeons. Precise motion control can transform robotic assets in flexible and useful tools, as they move autonomously or semi-autonomously through production sites, carry out multiple tasks, or carry payloads.

Just as autonomous vehicles require increasingly sophisticated perception and navigation technologies to be safe and reliable, so do emerging industrial robots need the advantage of modern motion control. Those who embrace it are not just embracing new technologies; they are creating new ways to perform tasks and assist human beings. ■



LOGISTICS, MANUFACTURING, AND ROBOTS: 5 Big Things to Know and Watch

BY AARON PRATHER, FEDEX

Here are five things that are leading us toward more robotics in the future and how we can prepare, says FedEx's Aaron Prather.

In 2019, just prior to the pandemic, many of us were predicting that robots and automation would have a big impact in the new decade that was coming. All of the numbers were pointing to growth, not only in industries that had a long history of using robotics like the manufacturing sector, but in new industries like logistics, which was starting to make bigger investments in robotics. Then COVID-19 hit, and for a while, there was a break in the action, but that all quickly changed.

So what are some of the key things that are driving this push for robotics as we come out of the pandemic? How will more robotics, not only in our workplaces,

but also out in the general public, change how people work and go about their lives?

Here are five things that are leading us toward more robotics in the future and how we can prepare:

“The pandemic put the brakes on a lot of stuff early in 2020, but by the end of the year, it was rocketing back. The pandemic accelerated companies’ decisions. They were looking at how to automate beforehand.”

— Jeff Burnstein, president, A3

1. E-commerce is here to stay

People were already ordering a lot online prior to the pandemic. When the pandemic came, ordering anything and everything online became the norm. Those who had never ordered anything online no longer had an excuse and now that they have tried it, most of them are going to continue to shop that way.

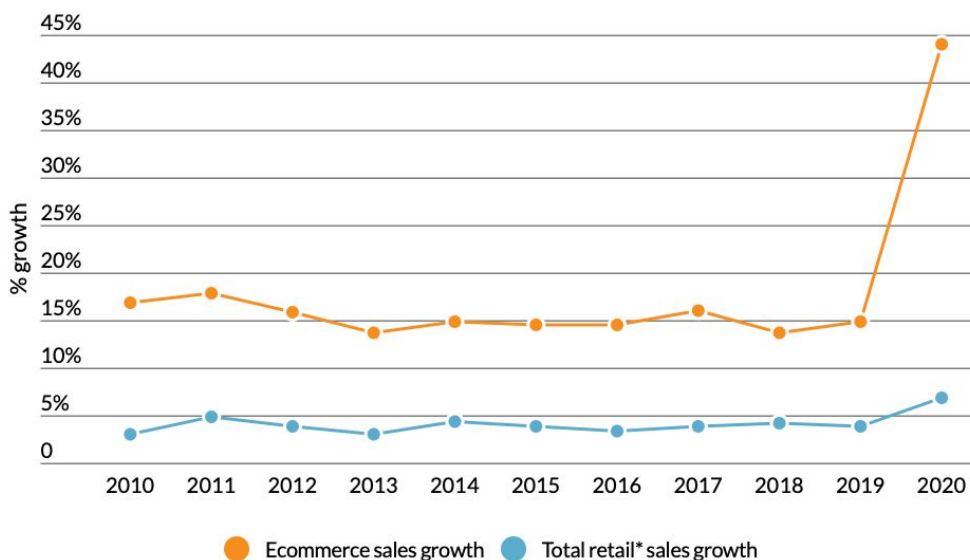
In 2020, consumers spent \$861.12 billion online with U.S. merchants, up an incredible 44% year

all gains in U.S. retail in 2020. This means sales through all other channels—stores, catalogs and call centers—declined. Again, this is a historical first where e-commerce accounted for all of the sales gains in U.S. retail.

This growth in e-commerce was not limited to just the U.S. Other regions of the world saw similar pops in e-commerce sales. While worldwide retail sales overall fell 3% to \$23.839 trillion, e-commerce sales grew 27.6% to take \$4.28 tril-

Comparing growth: US ecommerce vs. total retail* sales

Year-over-year growth, 2010-2020



Source: Digital Commerce 360, U.S. Department of Commerce; updated January 2021
*Total retail figures exclude sales of items not normally purchased online such as spending at restaurants, bars, automobile dealers, gas stations and fuel dealers

over year, according to Digital Commerce 360.

It is of note that 21.3% of all retail sales were done online in 2020. This is up from 15.8% in 2019 and 14.3% in 2018. According to Digital Commerce 360, the more than five-percentage point gain in e-commerce penetration is by far the biggest year-over-year jump for U.S. retail sales ever recorded.

Overall, online sales accounted for 101% of

lion of the overall sales pie. Some countries, like Argentina, saw their retail e-commerce grow by an astounding 79% in 2020.

This growth has led to a hiring frenzy by companies like Amazon and FedEx, while they have also turned to deploying robotics and automation into their operations. Why? Because the boom in e-commerce is growing faster than firms can hire.



2. More manufacturing to reshore

As the pandemic closed borders and factories around the world, supply chains took a major pounding and continue to do so. This has caused many business executives to rethink their supply chains, and some are even reshoring manufacturing back to the U.S. The Biden

“We had planned to do this for years, but I think the pandemic put an exclamation point on why it’s going to be awesome. Having more flexibility in running a global supply chain is also going to allow us to sleep better, as you can imagine.”

— John Foley, co-founder and CEO, Peloton

administration is also actively encouraging the reshoring efforts through new programs and incentives.

Peloton recently announced that it would build a \$400 million factory in Ohio to not only address its growing e-commerce business, but to close the gaps in its supply chain. A critical component that is allowing manufacturers to return to U.S. is the rise of robotics and automation. By using technology, manufacturers can build at a similar cost structure by building closer to their customers in the states.

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3. The shrinking workforce and growing skills gap

Earlier in the year, Deloitte and The Manufacturing Institute came out with a stunning report that the growing U.S. manufacturing skills gap could leave 2.1 million jobs unfilled by 2030 and cost the U.S. economy as much as \$1 trillion! Other key points in the report were:

- 36% of U.S. manufacturers believe finding the right talent now is 36% harder than it was

in 2018, despite a much-higher unemployment rate (yes, that is 36% twice).

- 71% of U.S. manufacturers say they will have ongoing difficulties in attracting and retaining workers in 2021 and beyond.
- Only 30% of manufacturing professionals are women. In addition, women surveyed were 1.8 times more likely than men to contemplate leaving the industry, citing lack of work-life balance and the need for flexible schedules.

“Given the foundational role the manufacturing sector plays in our nation’s economy, it is deeply concerning that at a time when jobs are in such high demand nationwide, the number of vacant entry-level manufacturing positions continues to grow,” said Paul Wellener, vice chairman and U.S. industrial products and construction leader at Deloitte LLP.

“Combine this with the problem that the median age of an American working in manufacturing is 44 years old, and older workers are retiring faster than they are being replaced.

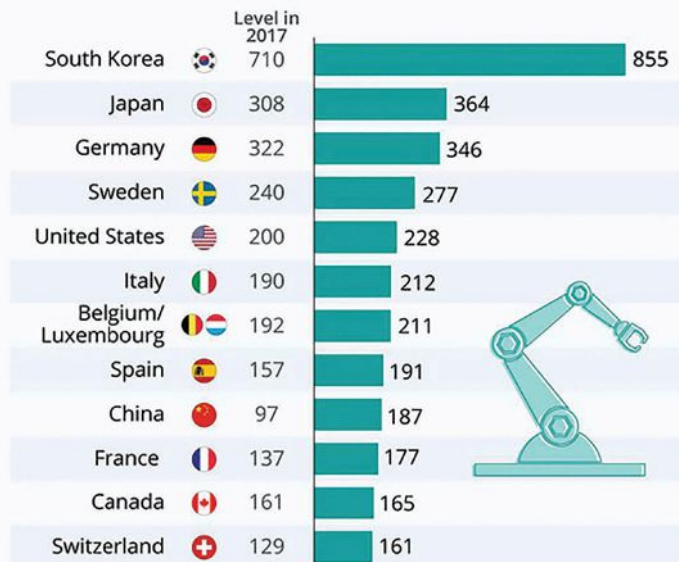
This worker shortage has led many corporate leaders to seriously look at adding robotics and automation to their workflows.

“Every eight seconds, a baby boomer retires.”

— Carolyn Lee, National Association of Manufacturers

The Countries With The Highest Density Of Robot Workers

Installed industrial robots per 10,000 employees in the manufacturing industry in 2019*

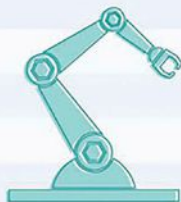


* Selected countries

Source: International Federation of Robotics



Forbes statista



For Germany, manufacturing made up over 19% of the economy. For the U.S., though, only 11.39% of economic output in 2019 was linked to manufacturing. So what is the relationship between South Korea's use of robotics and its large manufacturing sector? It is complex, but it does show what could be in the future for the U.S.

In 2020, South Korea crossed 300,000 industrial robots installed, which was double the number of robots in use from five years earlier. In 2020, the U.S. saw a total of 293,200 industrial robots installed. So even though South Korea has a human population of only 16% of that of U.S., it has a larger robot population. It should also be pointed out that in 2020, South Korea reported an unemployment rate of 3.94%.

South Korea has a rapidly aging population. By 2050, over half of the workers in South Korea will be over the age of 50. This means robots are going to be essential to maintain the country's manufacturing sector. This is why South Korea has laid out its "Third Robot Basic Plan," which pushes for 700,000 robots installed by 2023 and a workforce to support them.

4. The rise of the robots

"Worker shortages in manufacturing, warehousing, and other industries are a significant factor in the current expansion of robot use that we're now seeing," stated Jeff Burnstein, president of the Association for Advancing Automation (A3).

Robots and automation are nothing new. However, what most people don't realize is that the U.S. is not even close to having the level of robot density as other countries, especially those with large manufacturing sectors. This goes against the false narrative that robots destroy manufacturing jobs.

In 2019, over 25% of the South Korean economy was tied to manufacturing. It is not surprising that South Korea has one of the highest densities of robots to employees in the world, according to the International Federation of Robotics (IFR).

5. Reskilling and upskilling for the 21st century

It should be no surprise that one of the recommendations from the Deloitte and The Manufacturing Institute was for investment in programs that will allow people to reskill and upskill.

The Biden administration's American Jobs Plan is looking to fund numerous workforce development efforts:

- \$100 billion in workforce development programs for underserved groups and high school students

- \$40 billion investment in a dislocated workers program
- \$12 billion in general workforce development

However, the challenge will be getting people into those programs. Small businesses can seldom afford to invest in long-term workforce development and as a result there are less employer-funded training including programs like apprenticeships. Government programs will have to fill the gap through direct programming or investments in partnership programs with third-party vendors.

“We know workforce development works,” stated Karin Norington-Reaves, CEO of the Chicago Cook Workforce Partnership. “For me, it is really about scale and quite frankly the bandwidth of organizations within our network. We will never be able to fully meet the needs of all of the people who so desperately want to work and who need the additional skills. It’s not a question of will people be successful; it’s a question of will they be able to gain access to the program.”

This means that programs will need to be laser-focused on their training, so that they can quickly train individuals and graduate them into jobs. This will allow more individuals to be trained. So how can programs accomplish this? There has been much written on the topic, with these being the biggest keys

to success:

- 1.) Define strategic workforce and skills planning based on industry needs. Industry leaders need to talk with their local academic partners to ensure current curriculums are leading to Day 1-ready jobs.
- 2.) Creating a skills framework for each job role. Discover where there is crossover between skill sets. App developers may already have skills that lead to becoming robot programmers.
- 3.) Creation of a standardized skill taxonomy and people profiles beyond company boundaries. The establishment of company-independent “digital skills record” has already started with the rise of so-called “digital badges,” which can be published in a verifiable way on social business networks like LinkedIn.

At organizations like eKentucky Advanced Manufacturing Institute (eKAMI), which re-trains former coal miners in advanced manufacturing and robotics, has been successful by hitting on these key success factors.



*eKAMI has helped retrain coal miners to be robotics technicians.
Source: Eastern Kentucky Advanced Manufacturing Institute*

In five to 10 months, depending on the program, eKAMI is able to take a student from not having the needed skills for the new 21st century jobs in manufacturing and robotics to being fully employed. The following are reasons why:

- 1.) eKAMI has partnered with many companies to ensure they are training students in the skills needed. Many students are ready to start work prior to graduation because of this alignment. These companies are also now repeat customers of eKAMI and continue to hire from there.
- 2.) Many students come to eKAMI with skills from the mining industry that translate well to their new skills in advanced manufacturing and robotics. Instructors leverage these transferable skills to help students quickly pickup their new skills.
- 3.) eKAMI students receive credentials from organizations like the National Institute of Metalworking Skills (NIMS) that can be transferred from job to job.

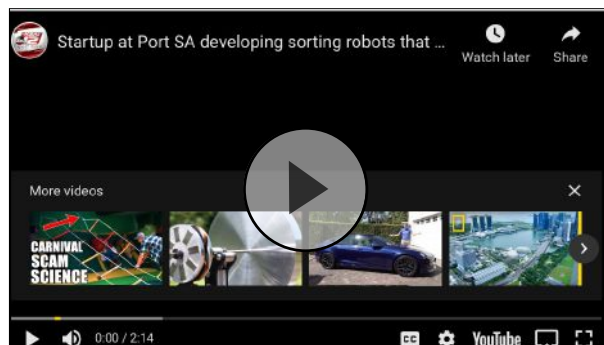
Successful reskilling and upskilling programs will need to move at the speed that industry needs skilled people. There will also need to be ongoing life learning programs to keep employees ahead of the technology curve. Smart investments in programs that produce skilled workers will be critical to keep up with a rapidly changing economy.

The U.S. will need to re-vamp its education process and ways of thinking if we want to grow in our use of robotics and our ability to use them in this new post-pandemic world. We will

need workers who can be quickly given the skill sets they need and then be employed to work with robots in numerous industries, from logistics to manufacturing. We need to realize that robots are not robbing us of our jobs, but creating more specialized positions for workers. ■



Aaron Prather is senior technical advisor and R&D evangelist at FedEx. He is a proponent of the intelligent use of robots, software, and re-skilling the workforce. This column reprinted from LinkedIn with the author's permission.



CloudNC is focusing on parts manufacturing with CNC machines, which is ripe for disruption by automation.

The Future of Manufacturing Is Automated and Autonomous

By Theo Saville, founder and CEO of CloudNC,
and Yoav Zingher, founder and CEO of Launchpad.build

In addition to the cloud and simulation, robotics and AI are essential to improving flexibility and reshoring of production, say two tech CEOs.

Shortly before Christmas, we were both invited to participate in The Eric Miscoll Show, co-hosted by EMSNOW Publisher Eric Miscoll and Forbes and Entrepreneur writer Philip Stoten. The panel explored a future state of manufacturing where autonomous systems manage machines, factories, and even supply chains. This was the first time we had met, but we soon realized we had many ideas and ideals in common. Here are some highlights from that discussion and our vision of the future, as well as some of the challenges and barriers that sit between us and the future of autonomous manufacturing.

The pandemic has been an accelerant for change in the manufacturing world, and particularly for digital transformation, exposing weaknesses in the status quo. The use of collaborative tools, starting with Zoom, then shared documents, is teaching people to trust in the cloud and digital ecosystems. The disruption of the COVID-19 pandemic and the resulting hit to the economy have underscored the need for greater resilience and efficiency.

We all know that long supply chains sacrifice agility for price, and the pandemic showed us that many companies had pursued low costs to their detriment and risk of a lack of adaptability. Supply chain managers may be realizing that a more agile, faster supply chain will be better in the future.

On top of this, many are starting to question the globalization of manufacturing and constantly chasing low-cost labor, particularly when that means an overdependency or overexposure, to certain loca-

tions like China. Systems are needed that allow us to manufacture closer to design, closer to the consumers.

Although environments like the U.S. or Europe have higher labor costs, automation can benefit from stronger institutions and infrastructure, high-quality talent, and great innovation ecosystems. These countries and regions need manufacturing jobs and a sustainable manufacturing industry for a stronger and more balanced economic future. Many are talking about a renaissance of manufacturing in North America and Europe, with countries like the U.K., France, and Germany starting to stand out. This is reflected not just within manufacturing circles, but also within the corridors of power where policies are developed and incentives are created.

Meanwhile, over the past decade, we've started to see a democratization of innovation, similar to how YouTube and its peers democratized the production of content, creating an explosion of content providers. The shock of the pandemic, combined with the availability of digital manufacturing ecosystems, could help create a boom for innovation.

An autonomous future

Yoav Zinger, CEO of Launchpad, build the world of product innovation and fulfilment can be broadly divided into three processes: design a product, make or buy the parts, and then assemble those parts. CloudNC has chosen to start with CNC-manufactured parts because that industry is ripe for disruption. Although the machine is complex



*Yoav Zinger,
CEO of Launchpad.build*

and sophisticated, the way it is managed and utilized is not, providing real opportunity to derive tangible performance improvements.

Launchpad operates in an adjacent world, assembling parts and connecting the whole ecosystem starting with DfM (Design for Manufacturing) on the fly, the automated development of work and build instructions, the procurement of parts and then the assembly using robotics where possible. Launchpad has also developed and built a flexible robotic manufacturing solution that learns in a simulation and doesn't need expensive programming.

The ideal is like an Amazon warehouse—software is making all the decisions, but humans are working side by side with robots and autonomous systems. The mix of manual and automated labor will change and develop over the years as solutions change and develop. The future depends on the first stage, the current stage, working well.

Ingredient technologies enabling autonomy

Artificial intelligence is one of the key enabling ingredient technologies, but it is not the only one. In the past few years, machine learning, computer vision, and deep learning have enabled some amazing capabilities and tasks. However, AI often needs more data than is practical to collect. Launchpad's key insight is that there is an alternative to real-world data collection, which is to learn inside a simulation. This requires sophisticated modeling and algorithms, but it is dramatically cheaper than collecting data from physical machines.

Meanwhile computing resources have become cheap, scalable, and accessible, thanks to the likes of Amazon Web Services. This availability of high-performance compute on-demand is hugely important to CloudNC. Autonomously managing factories, and programming and controlling CNC machines is a phenomenally complex computer science problem, which would be intractable without the power of the cloud.



sector in recent years. We've seen investment funds that specifically focus on manufacturing technology and particularly on automation and autonomy. We've also seen some technology-focused funds investing hundreds of millions of dollars into startups that share the same vision of autonomous,

Is this Industry 5.0?

Labels like "Industry 4.0" have little to no value; we're probably barely past Industry 3.0. Industrial revolutions normally take around 100 years, deliver a multi-order-of-magnitude improvement in performance, and change the way we live. This was true of the first three, and we're probably still in the "compute and digital" revolution, the third industrial revolution that started to change the way production occurs some decades ago. Manufacturing is really just catching up with e-commerce and logistics. The real fourth industrial revolution will be autonomy, not digitization.

Getting there requires will, cash, and time. There are numerous technical issues to solve, and we're working on these right now, along with numerous other startups who see the potential, as well as early adopter OEMs that want to buy their technology differently.

And the money is following, with real investment starting to come into the manufacturing

adaptable robots.

We're building a blueprint for the future of manufacturing, one that we believe will bring benefits to all the stakeholders, from the innovators through the brand and the manufacturing partners to the end user or consumer. And this can only benefit the rest of the world, as supply chains get shorter and sustainable manufacturing ecosystems and sustainable manufacturing jobs are created in both low- and high-cost geographies.



Theo Saville, CEO of CloudNC

There is an end state, way beyond where we are now, and beyond even where we are going in the short term. It is what we call "exponential manufacturing," where we can expect the supply chain and manufacturing ecosystem to expand and adapt to suit the needs of the market. That is a really exciting prospect. But in the meantime, we are creating something that really leverages the value of human and automated capital to deliver products efficiently and economically. ■