



LENDING A HAND

Ease of use, flexibility spur interest in cobots

By Karen Hanna

IN DIVERSE settings around the world, robots now are cooking food, assisting on surgeries, polishing molds, boxing goods, hanging dry-wall, even operating drills on construction sites.

All without guarding.

And their communication skills also are getting better, according to experts on collaborative robots (cobots), with advances in automation and vision technologies coming at a critical time, as companies look for ways to offset labor shortages. At least one expert says, despite restrictions imposed by safety concerns, cobots will continue to push past barriers regarding speeds and payloads. According to at least one study, prices are coming down, too.

"Machine learning and robots are becoming more accessible thanks to new technology and processor generations. Robots are now being changed from science fiction to science through machine learning," states an academic paper surveying research involving cobots from 2018 to 2022. It cites cases of cobot use that conjure images closer to R2D2 than Roomba, saying at one point, "The current research on cobots aims to enable cobots to emulate mankind in learning, adapting, manipulating capabilities, vision and cognizance."



Borboni

Alberto Borboni is one of the writers of the paper, "The Expanding Role of Artificial Intelligence in Collaborative Robots for Industrial Applications: A Systematic Review of Recent Works." An associate professor of engineering at the University of Brescia in Italy, he sees a very bright future for cobots, especially over the next five years.

"Because there are no barriers and cobots are simple to program and reprogram, this maintains production rates, reduces the risk of downtime, and allows for more flexible production layouts. It is highly likely that the number of cobot installations will be significantly higher than that of standard traditional robots," he said.

EASY DOES IT

With a career in robots that spans more than 40 years, Joe Campbell has seen a lot of automation trends. He has advice for anyone who last considered cobots a few years ago: It's time to look again.

"A lot of the customers that we talk to perhaps looked at traditional automation five or 10 years ago, and they said, 'Well, it's too expensive, it takes up too much floor space. ... I don't have a robot engineer on staff, I don't have anybody who can program it.' And those were all fair objections 10 years ago, but that's not the case with collaborative technology, particularly UR's. It is really, truly easy to use," said Campbell, senior manager of strategic marketing and applications development for Universal Robots (UR) USA.

Cobots have come a long way, agreed Kristian Hulgard, GM of the Americas for OnRobot.

When he entered the field a little more than a decade ago, just as cobots began generating a stir, Hulgard said people were excited by the mere notion of having robots that could work safely alongside humans.

"Back when it all started, nobody really paid much attention to the ease of use. Everybody was talking about safety, 'Hey, we can save time and money and space by not installing these robots with a safety guarding around them, and we don't have to take that much space in manufacturing floor and so on and so forth.' Now, fast forwarding to the safety part is something that everybody has accepted, and everybody has figured out. Now, it's all about ease of use," he said.

Thanks to cobots, expectations of how automation should work could be changing, said Chris Caldwell, product manager for Yaskawa Motoman.

"One of the fundamental shifts that cobots drove was an increased awareness of the importance of ease of use. With technology advancing, there is getting to be less and less of an acceptance for things being difficult," he said.

GET SMART

For an explanation of how cobots have improved, look to the innovations and add-ons that make up their eyes and brains.

"Vision and artificial intelligence (AI) are mutually beneficial technologies and, actually, are the key of cobot evolution in manufacturing," Borboni said. "If we mean artificial intelligence as machine learning algorithms, they will benefit greatly from the widespread use of parallel hardware by enabling higher throughput rates while maintaining safety levels. The ability to perform multiple calculations at the same time will enable the integration of teams comprised of numerous human and robotic agents."

Continued

Relevant technologies include: inbuilt sensors that detect proximity, motion and torque; LiDAR — or light detection and ranging — sensors; and 2D vision sensors. “Systems that employ 3D depth cameras and computer vision algorithms enable cobots to operate alongside people and have complete knowledge of their environment,” states the report Borboni co-authored.

Over the past years, cobots have entered the market that have sensing elements all over them, so their joints are independently controlled, says the report, which notes collision rates are down.

Machine learning — a subset in AI — allows cobots to improve at their tasks over time, according to the study.

That gives them an edge over industrial robots.

“Cobots benefit from faster learning and easier programming due to AI,” the study states. “Industrial robots need intricate reprogramming, which calls for a knowledgeable engineer or programmer. A cobot’s real-time interface allows for interactive human input during communication, whereas robots require remote interaction.”

With improvements in machine learning, cobots are able to learn more quickly, even by example, said Ken Fordyce, a retired IBM engineer who has expertise in a diverse set of analytics methods.

Cobots also can recover from failure more gracefully, unlike other machines or computers that might require a full reset to restart. With AI, they can “learn basic tasks quickly through demonstration and basic instruction,” as well as “sense and respond to execute tasks and avoid collisions,” Fordyce said.

The study Borboni co-authored hints at both how far cobots have come, as well as what strides might remain to be made.

“End-to-end autonomy in learning-based robots commonly includes three primary elements, such as perception, cognition and control. Due to the complementary nature of these elements, autonomous control is made possible by sophisticated sensing and cognitive techniques,” the report states.

As of now, though, “cobots remain unable to discern an individual’s emotional condition.”

But they will continue to get better, automation experts said.

“As far as the technology goes, it’s really opened to see what somebody can do with it,” said Tim Pelesky, who heads up marketing and sales enablement for integrator Onexia. “Every year, it seems like it’s getting more advanced, more flexible, more versatile, more easy to use and more widely adopted. So, I tell everybody that we’re in the infancy right now; this is all just kind of getting started, and people are finally starting to understand what this technology can really do.”

APPLICATION MULTIPLICATION

Compared with industrial robots, cobots’ ease of use and smaller sizes make them accessible, even for employers that previously might have rejected automation due to concerns over cost or the perceived hassle of handling high-mix, low-volume work that would require constant reprogramming.

What’s a cobot?

CALLED “A NEW breed of robots” by the International Federation of Robotics, collaborative robots, or cobots, can operate safely alongside humans without fencing. In a 2020 report, the IFR defines four stages of collaboration. The stages are:

- Coexistence: No fencing, but no shared workspace
- Sequential cooperation: Robot and worker both active in the workspace, but movements are sequential
- Cooperation: Robot and worker work on the same part at the same time — both in motion
- Responsive collaboration: Robot responds in real-time to movement of worker

The most common interactions between humans and cobots involve the first two scenarios — in which machines and humans work separately or carry out consecutive duties, according to a 2022 academic paper, “The Expanding Role of Artificial Intelligence in Collaborative Robots for Industrial Applications: A Systematic Review of Recent Works.”

The academic report suggests that greater interactions might be possible in

the future, as artificial intelligence (AI) develops. For example, it says, “There is growing interest in creating a collaborative workspace where people and robots can work cooperatively because of the supportive nature of their abilities. These diverse elements of the industrial sector’s dynamic nature and the existing deficiencies in analyses serve as a high impetus for the development of AI-based HRC.” HRC stands for human-robot collaboration.

Experts also use more general definitions for cobots. For example, the academic paper makes the distinction that “cobots help employees, whereas robots take their place.” Meanwhile, Ken Fordyce, an AI specialist who’s retired from IBM, said a cobot is “a robot that can learn multiple tasks so it can assist human beings. In contrast, autonomous robots are hard-coded to repeatedly perform one task, work independently and remain stationary. [Cobots] are designed to work alongside and assist human employees, all the while making sure they don’t cause any harm to us carbon-based lifeforms.”

“There’s need for all the applications as we’ve always been doing, just at a much higher level, because now we have more affordable automation, we have easier-to-integrate automation, we have faster automation,” OnRobot’s Hulgard said. “The technology is there to support any type of business case.”

Caldwell, of Yaskawa Motoman, listed a raft of possible applications: plastic degating, deburring and finishing, as well as “machine tending or pick-and-place applications ... palletizing applications, assembly, fastening or screw tightening, adhesive/tape application.”

He predicted an increase in cobot utilization in post-demolding secondary operations.

One important characteristic of cobots is the ease of reprogramming, which has made them a perfect fit for companies that have frequent changeovers, such as small-batch custom molders Ferriot, Akron, Ohio, which has put a mix of cobots to use to free up labor; and Aim Processing, Longmont, Colo., which uses Flexxbotics’ Flexx-Reference app to reprogram its UR cobots quickly.



Campbell

“In general,” Italian professor Borboni said, “I believe manufacturing systems will increasingly center on two broad categories: standard products with large production batches made with automation and traditional robots, as well as customizations, and small production batches made with collaborative robots and human operators.” Facilitating that level of flexibility is especially important to UR and its customers, Campbell said.

To illustrate how easy the UR cobots are to use, Campbell cited one manufacturer in rural Wisconsin that staged a contest challenging each of its employees to be the first to program a new application.

“A 26-year-old woman, no degree, certainly not a roboticist, she really dug in,” he said, “And she’s now the robot tech for the plant.”

More than 160,000 people have taken UR’s online training classes, he said. The nine core modules take just about two hours. Students who complete the core module are eligible to take five additional modules.

“You come to a trade show, I’ll have you programming in 10 or 15 minutes,” Campbell said.

RIGHT FIT

Matching the machine to the application is a job that requires integrators, some of the automation experts said. Integrators can provide training and insights into what’s possible, and steer processors away from decisions they might come to regret.

“I’ve seen that. It’s not one time; it’s 100 times, I’ve seen. Walking into a manufacturer’s manufacturing floor, and then there’s one or two robots just sitting on a shelf somewhere, and they’re like, ‘Ah, we never really got to it,’ or ‘we couldn’t really figure that out,’ or, you know, ‘we changed some things,’” OnRobot’s Hulgard said.

Yaskawa Motoman’s Caldwell said automation experts can help processors identify the easiest applications to automate, as well as dispel misperceptions they might have about technologies such as cobots.

“I think most integrators and industrial robot manufacturers have varying levels of frustration

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'BOT AND PAID FOR

Tight labor market drives up demand, ROI for cobots

By Karen Hanna

AMID THE labor shortage, one application robots seem poised to take on could be the job of selling themselves. Having employees who don't take time off and never tire after performing the same task over time has its benefits.

Of the the 8.5 million manufacturing jobs in the U.S., 4.6 million could be automated — half with cobots — estimates Joe Campbell, senior manager of strategic marketing and applications development for Universal Robots (UR) USA. In deriving those numbers, the robot veteran has crunched statistics from the U.S. Census Bureau, the U.S. Bureau of Labor Statistics and automation maker Teradyne, along with other sources.

Multiple sources, including Campbell, reported to *Plastics Machinery & Manufacturing* that current demand for automation is hot — in large part because the job market remains competitive. For many plastics processors, collaborative robots (cobots) represent a practical point of entry.

According to a 2022 academic paper, "The Expanding Role of Artificial Intelligence in Collaborative Robots for Industrial Applications: A Systematic Review of Recent Works," the U.S. cobot market was worth \$1.01 billion in 2021, "and is anticipated to increase at a compound annual growth rate of 31.5 percent from 2022 to 2030."

A record 3.5 million robots, worth an estimated \$15.7 billion, were in operation last year, according to the International Federation of Robotics.

Campbell explained the demand with a real-life scenario.

"Let's say you're a contract molder, and you need a certain amount of labor to do the secondary operations and to pack the parts out," Campbell said. "If you can't hire that, you can't run your machines. If you can't run your machines, you've got a half-million-dollar investment that's sitting there idle."

In December 2022, more than three-quarters of employers surveyed by the National Association of Manufacturers reported they were concerned about attracting and retaining workers. That challenge ranked No. 1, higher than issues involving the supply chain, raw material costs and myriad other concerns.

As of January, the U.S. Bureau of Labor Statistics reported 803,000 openings in the manufacturing sector — down from 905,000 at the same time last year, but a moderate increase over the 797,000 openings reported in December 2022. At the same time, unemployment hit a 50-year low, at 3.4 percent.

According to statistics cited by Campbell, 2.1 million manufacturing jobs will go unfilled by 2035. Ten thousand baby boomers retire every day.

"Nobody is buying automation today to put people out of work," Campbell said. "When I started selling robots 40 years ago, that was the model: You sold automation because the company needed to take labor out. Today, nobody can attract enough workers into manufacturing, so, the name of the game today is to put your skilled workforce into the highest-value operations."

In some cases, automation can help manufacturers extend their shift, by finishing up tasks at night that are programmed during the day. For manufacturers that's aren't ready for fully lights-out production, it's a "fairly big win," he said.

According to Campbell, companies can see a return on investment in a year. "In many cases, it's less than that. ... It's a really good payback, especially if you are having trouble hiring manual operators to load and unload machines."

According to the Association for Advancing Automation (A3), North American companies set all-time records last year by ordering 44,196 robots valued at \$2.38 billion.

More than 50 percent of sales came from the automotive industry, which ordered 23,807 robots, up from 16,752 in 2021.

"While the numbers of robots sold to non-automotive companies isn't as staggering as it's been over the last couple of years, it's clear that companies in

every industry see automation as necessary for success," A3 President Jeff Burnstein said. "We look forward to seeing more unique and increasingly easy-to-use robots that all industries can benefit from at Automate 2023 in Detroit this May."

LEVELING UP

Cobots are drawing attention from manufacturers that hadn't previously embraced automation. They're becoming accessible — and essential to them.

"What I've noticed in industry is a lot of the traditional automation has always been there; now, it's more or less trying to automate the positions that they just can't find the labor for anymore," said Tim Pelesky, who heads up marketing and sales enablement for integrator Onexia.

In addition to capabilities that make them easy to use, cobots boast a price that offers an attractive entry to automation, according to the academic report. In 2015, the average cost of a cobot was about \$28,000, but that's supposed to dip to \$17,500 by 2025, the report says.

Cobots are appealing to automation novices.

"One of the primary factors driving growth in collaborative robots is the willingness for first-time adopters to embrace the technology," said Chris Caldwell, product manager for Yaskawa Motoman. "Due to the additional safety considerations, many companies that are hesitant to cross into industrial robotics feel like collaborative robots are right for them."

One market that's largely untapped is among manufacturers with small or mid-sized shops. Those processors have been traditionally ignored as robot suppliers have focused on companies with deeper pockets, Campbell said.

But UR and other companies see potential in that demographic.

"It's a huge market that we're barely scratching the surface on. About 90 percent of the businesses, the manufacturing companies in the U.S., are less than 100 employees. I can tell you having sold automation for decades, that's not a high-priority sales target," Campbell said.

GOOD COLLEAGUES

Rather than replacing people, cobots are making their jobs better, in addition to helping the companies that employ them, automation experts say.

"It opens up the world for the people that are showing up to go to a more value-added position. And also it helps just get product out the door more efficiently," Onexia's Pelesky said.

By doing dirty, dangerous and dull jobs, cobots improve the quality of life for their human counterparts. According to statistics cited by UR's Campbell, 70 percent of workers believe automation will create opportunities for them to do higher-level work.

"Companies may grow exponentially and automate various manufacturing processes with the aid of cobots, which also makes extra space available for working remotely. By taking over undesirable duties, they also increase worker safety," the academic report says.

In a tight job market, both employers and employees see the benefits.

Overall, robot suppliers say, business is brisk. Kristian Hulgard, GM of the Americas for OnRobot, characterizes it as "hot." Demand for palletizing automation, in particular, is at a "fever pitch," Pelesky said.

"When cobots started, everyone was always saying, 'Oh, this is going to take a lot of jobs from us.' The fact is today, there's nobody who wants to take those jobs, and now we're trying to create more jobs by installing more robots," Hulgard said.



A cobot works in a palletizing cell designed by Onexia.

Onexia Inc.

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with the misapplication of cobots based on their name/price rather than capabilities. It's been repeated many times, but how collaborative is a cobot handling a knife?" asked Caldwell, who pointed out that even cobot integration requires careful risk assessment.

Variables that can determine whether a cobot or industrial robot would be better suited to a given application include throughput, cell design, payload, footprint and safety requirements.

Each has its own place, according to Caldwell.

"Have an automation provider tour your facility, and they'll find applications that have existing solutions. Start with the low-hanging fruit and use the ROI to fund some of the more challenging applications. Automation is an iterative process, and you can keep attacking the current bottleneck for your business," he said.

ROBOTS RULE THE FUTURE

Cobots' appeal will continue to grow as manufacturers look to fill roles in a tight labor market, automation experts say. OnRobot's Hulgard predicts robot deployment over the next five years will be at a level 10 times larger than today. He envisions the manufacturing plant of the future staffed by robots — and the people who enjoy working with them.

Both he and fellow automation experts also say they believe the technologies will continue to improve.

"Our younger generation of workers, they like to work with computers; they like to work with technology," Hulgard said. "That's a big driver in how people select their career, and this is a great fit, saying, 'OK, instead of having 10 people standing on a conveyor line and putting things together, now we have 10 robots,' and instead, you're hiring X amount of people to maintain and to optimize and run these robots, and be part of that side of the technology."

Though bound to make cobots that can interact safely with humans, engineers will continue

to find creative ways to push the envelope, UR's Campbell said.

"I've yet to meet a robot engineer who doesn't want a robot that's bigger, stronger and faster," Campbell said.

Onexia's Pelesky is waiting on a specific function to become common and efficient — the ability of automated guided vehicles to taxi cobots from one assignment to the next.

"I want to put an arm on an AGV and make it work effectively," he said.

Brains — in addition to brawn — likely will continue to underscore cobot advances.

Automation is in an evolutionary stage similar to computers in the 1980s, OnRobot's Hulgard observed. As people eventually understood about their computers, the user experience is what matters, not the physical components that facilitate it.

"That's also the direction I think the whole industry will take, just like the IT industry did back from the '80s. ... The hardware, nobody really cares what's inside the computer, what your graphic card's brand is, or what your screen brand is, or whatever. It's all about the software that controls it. That's the big difference, and that's the direction this industry will take," Hulgard said.

He looks ahead to full integration that includes cobots, robots, grippers, sensors, conveyors — "everything in the application, taking all of that into consideration and installing it in one software platform."

That might mean that cobots eventually operate with digital twins, or develop more natural relationships with humans. The strategies — along with avatars, gestures, gazes and even "MindBots" or EEG brain scans — all are studied in research cited by the report Borboni co-authored.

He foresees a more positive environment for humans, facilitated by cobots.

Data captured by the sensors cobots use could have plantwide benefits.



Yaskawa America Inc.

Its high payload — topping 44 pounds — makes Yaskawa Motoman's HC20 cobot ideal for palletizing.

"Supply chain management can be improved by centralized data insights from digital industries fed into machine learning algorithms. This includes optimizing logistical routes, switching from bar-code scans to a vision-based inventory system and making the most of available storage capacity. Additionally, machine learning can forecast demand trends to assist in preventing excessive production," the report states.

As automation and cobots evolve, tolerance for having humans struggle to interact with technologies could continue to decline, Yaskawa Motoman's Caldwell said.

"Smaller companies have been served very well with solutions that are easy to add into their existing operation. In the longer term, as sensors improve and technology is more widely adopted, I think there will be an even more blurred line between what is a cobot and what is an industrial robot." he said. "Ultimately, I don't know that market penetration is as much of the metric as much as market disruption is. Cobots have already driven an ease-of-use arms race."

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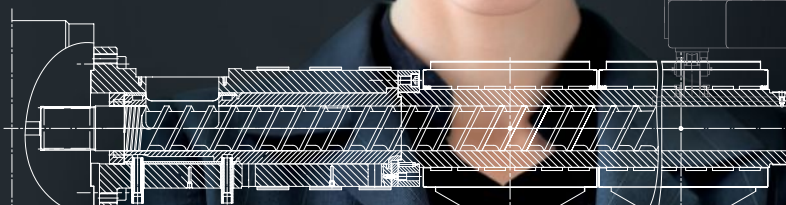
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