Robots are learning to think like humans. Can they meet Amazon's demands for speed?

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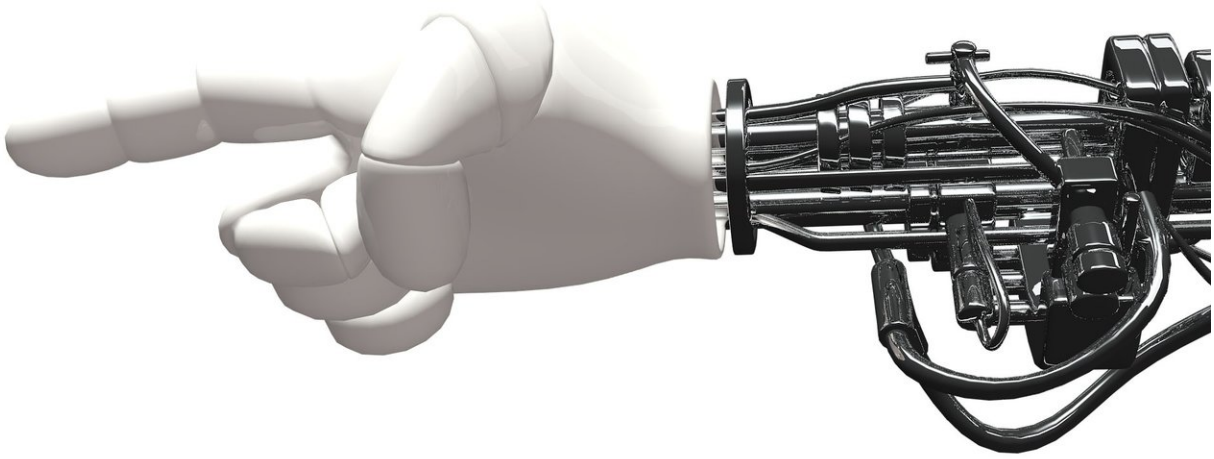

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In a lab at the University of Washington, robots are playing air hockey.

Or they're solving Rubik's Cubes, mastering chess or painting the next Mona Lisa with a single laser beam.

As the robots play, the researchers who built them are learning more

about how they work, how they think and where they have room to grow, said Xu Chen, one of those researchers and an associate professor of mechanical engineering at UW.

"From a robot's viewpoint, artificial intelligence is getting more and more mature," Chen said, referring to the software and algorithms that help a robot take in its surroundings and make decisions. "But if we want a full-scale robot to be able to think very quickly and cleverly, and then be able to do things in the physical space, I don't think we're there yet."

The games are a way to get one step closer to taking the robots out of the air hockey arena and into the workforce, asking machines to shoulder tasks like lifting and moving heavy boxes for hours at a time. Robots are already working in warehouses, helping Amazon and Walmart customers get their orders faster, but e-commerce and retail leaders want them to do more. The jobs have already been assigned but some of the technology still needs to catch up.

In Chen's lab, the games can fill in some of those gaps, mirroring how a robot might operate in an ever-changing workplace. The laser painting is a scaled-down version of a 3D printer, which can be used to test and manufacture parts for the aerospace industry. Watching an air hockey puck fly down the table helps researchers understand how to "clean" the data the machine is processing from the environment around it.

Already, there's growing demand for that type of technology. The market for automated solutions for warehouses—solutions that range from conveyor belts to robotic arms to autonomous carts that ferry packages around a facility without direction from a human—could reach $51 billion by 2030, based on an estimate from ABI Research, a New York-based firm that studies technology.

In a warehouse, automation and robotics can help businesses speed up

operations. That can be good for a company's bottom line but hard for workers, who push to keep pace with the machines. Concerns about that desire for speed are, in part, driving a growing union swell, particularly at Amazon warehouses, seen as one of the fastest e-commerce leaders.

"The acceleration of technology in all kinds of workplaces in new ways is actually a whole new set of reasons for people to get together and form a union," said Jim Stanford, an economist and director of the Center for Future Work, a progressive economic research firm.

"I'm not surprised that technology is a factor in what would motivate workers to want a union," added Lisa Kresge, who studies the intersection of tech and work at the University of California, Berkeley. "Because it's increasingly a factor that's affecting their lives."

Automated solutions

Venture capital interest in automation saw a spike starting in 2016, when investors handed off more than $2 billion to companies working on automated solutions. In the first half of last year, investors had pledged $1.4 billion to the industry, according to data from research firm Crunchbase.

"There's a lot of tasks that need to be solved," said Jeff Burnstein, president of the Association for Advancing Automation. "One of the exciting things now is companies are popping up who are only focusing on specific areas."

Autonomous robots at Amazon sites covered more than 1 billion miles last year, moving packages alongside human co-workers. When a bin arrives at a worker's stowing station, a software system will shine a light on spots to avoid, helping to calculate the most efficient way to fit items in and around one another. An algorithm later determines—and

delivers—the right amount of tape needed to seal up each order.

Amazon says its robots allowed the company to store 40% more inventory in its fulfillment centers. With the product easily on hand, it can shorten the time between when a customer orders, and when the package arrives at their doorstep.

Walmart estimates the same cost and efficiency savings, citing a high-tech distribution center that moves 40% more product than a traditional facility. In its high-tech grocery distribution center in Shafter, California, Walmart uses an algorithm to determine how to arrange cases of fruits and vegetables to maximize the space on a pallet or trailer. To avoid any crushed strawberries, the software accounts for each item's density when making its calculation.

Last year, Walmart announced it was planning to implement high-tech solutions in 25 of its 42 regional distribution centers. "In short, this is a game changer," it wrote in a July 2021 blog post. "This first-of-its kind tech when applied at our scale is revolutionary."

Where tech falls short

Automation isn't for everyone—particularly businesses that operate on a small scale, said Rich O'Connor, vice president of storage and automation with Raymond West, a company with operations in Auburn that makes forklifts and other warehouse equipment, and helps customers integrate automated technologies into their operations. Raymond West, a subsidiary of Toyota, provides conveyors for Amazon's last-mile delivery service.

Before turning to new tech, O'Connor said companies should look at how they operate and find parts of the process that could work better. A large pile of products sitting in a corner of the warehouses is usually a

good place to start, he said.

Introducing automation can take anywhere from six months to two years.

"If we simply automate a bad process, then typically the same issues are only going to become expanded," O'Connor said.

Warehouse robots like the ones Amazon and Walmart use have one major blind spot: picking through items of different shapes and sizes.

That's where the human brain is still needed.

"We can do so many diverse kinds of processing that it's nearly impossible—if not actually impossible—to replicate," said Ashish Banerjee, an engineering professor at the University of Washington. "A lot of what we do comes from years of experience and intuition, so getting any robot to be that knowledgeable, that diverse in its processing and distribution capabilities, is extremely challenging."

A robot can perform well in a warehouse that has consistency, Banerjee said. The types of products coming in are the same, the layout of the building is the same, and its tasks are usually the same. Seasonal spikes—like lawn chairs in the summer and snowblowers in the winter—can get tricky.

Technologists are working on ways to use AI and other software to help robots determine what an item is and decide what action it should take, Banerjee said. In the meantime, humans are still needed, if only to supervise.

For the human workers in a warehouse, that task—"picking," in industry lingo—takes up a majority of their time, said O'Connor from Raymond West.

One worker might spend 50-60% of their day walking to the items they are meant to pick. Automated solutions, like mobile robots, that bring goods to a human worker, can reduce travel time to just 10-15% of the workers day, O'Connor said, freeing up those minutes for more picking.

Working with the machines

Jason Anthony doesn't normally notice the robots moving packages around him.

A picker at the JFK8 Amazon warehouse in Staten Island, New York, Anthony estimates he is expected to move an item every nine seconds.

He's the fourth stop in the streamlined warehouse process. A truck drops the merchandise off, a stower puts the item in a bin, a network of conveyor belts and autonomous robots move that bin around the warehouse, and then it gets to Anthony, who grabs the correct item to fill an order, scans it and sends it to a packer, before it heads back out the warehouse.

An algorithm determines which packages get to Anthony at one time. They range in size from a bottle of hand sanitizer to a 50-pound item, with little warning of what's to come.

In Charlotte, North Carolina, Jonathan Schenkel noticed the robots he worked with had a uniquely human problem: They have slow days.

Schenkel, who used to work as a picker at an Amazon fulfillment center, would wait for a robot to arrive at his station with items to pick and send along. There were days when the robots would scoot around quickly; as soon as he picked the right items from one robot, another would slide in to take its place. But other days, the robots could be sluggish.

If a robot was running behind, Schenkel would look at a screen at his workstation that alerted him when another one was on its way.

At a warehouse that measures productivity by the second, five to 10 minutes of lag time for one robot could have a big impact on Schenkel's average pace of work for the day.

Amazon has been criticized for using robots and other automated solutions to increase the pace of work for its employees, sometimes to an unsustainable rate, but Schenkel said he liked to work with the machines.

Before starting at the fulfillment center, he had worked at an Amazon sortation center, where associates sort customer orders by final destination and get them on trucks for delivery. There, instead of teaming up with robots, he would have to sort through the packages as they arrived on a conveyor belt.

He transferred from one center to the other in search of more hours. But after seven months at the fulfillment center, Amazon let him go.

Managers told him he wasn't keeping up with the pace of work and had too many errors as he filled orders. Schenkel said the company increased the expected pace of work, up more than 100 items per hour, and as he pushed himself to work faster, he knew the number of mistakes would also increase.

Schenkel said he asked repeatedly to switch to a different role in the warehouse, recognizing he wasn't matching the pace of work. The company said no.

Now, he's looking for other jobs. He's open to another warehouse role but said his search won't include Amazon.

The labor equation

In Staten Island, Anthony moves quickly during his shifts and while he doesn't notice the robots that are working alongside him, he says he does feel the digital eyes of the software systems Amazon has set up to keep tabs on workers.

That system has offered him some clarity on how fast he's moving—he can check his own pace on a machine in the break room—but it has also led to a tense work environment where he and his colleagues worry about taking a drink of water or going to the bathroom.

It's one of the reasons Anthony decided to join the effort to unionize.

"We could be tracked by our supervisors from the moment that we log in to our stations to the moment that we leave," Anthony said. Asked if the technology helps ease some of the burden of his job, he said "there's nothing that makes my job easy."

Workers at the Staten Island facility where Anthony works voted April 1 to form the first union at an Amazon facility in the U.S. Amazon is planning to dispute the results of the election but, if the outcome is not overturned, the company and the labor union will now start to negotiate a contract. Workers at the facility are looking for better pay and better working conditions, including around the pace of work.

Unions generally don't want to stop technology, said Stanford from the Center for Future Work. Instead, they want to have "bargaining power to get some benefits."

Benefits like guaranteed notice of changes to come. A requirement that local workforces should be included in discussions around new types of technology. Access to training and retraining. Assurances that workers

will know how to use the machines safely. Severance packages if they are automated out of a job.

"All of the bread-and-butter issues that unions are trying to negotiate around technology are all about ensuring that it is applied fairly and safely, and the costs and benefits are shared," Stanford said.

The Culinary Workers Union Local 226 in Las Vegas recently negotiated contract language requiring employers to provide up to six months' notice before the implementation of new technology, free training and a bonus package that includes six months of health benefits if a worker's job is displaced by automation.

The Transportation Trades Department, AFL-CIO, which represents 37 unions, is pushing federal lawmakers to start preparing for the introduction of fully autonomous vehicles. It wants to ensure that if workers are displaced, they're offered jobs at the same pay scale at their prior position, department President Greg Regan said.

The United Food and Commercial Workers International Union, which represents workers in grocery, meat packing and other front-line industries, condemned Amazon recently for investing in contactless checkout technology, a step toward eliminating the need for checkers.

Stanford from the Centre for Future Work doesn't think Amazon would make concessions around new technology on its own. It "will only do that if they are pushed."

All eyes on Amazon

Washington labor officials have also been paying attention to Amazon's warehouse operations. The state Department of Labor and Industries has filed four citations related to unsafe working conditions at Amazon

facilities in the state. The most recent citation, from a warehouse in Kent, found 10 of the 12 work processes evaluated "create a serious hazard for work-related back, shoulder, wrist and knee injuries."

The department connects the risk of injury to the pace of work. Beth Gutelius, research director of the Center for Urban Economic Development at the University of Illinois Chicago, connects the pace of work to the use of robots.

It's not that robots inherently make work more dangerous, she said. It's how Amazon and similar companies use them to set expectations for its workers.

"There are many technologies that could take out some of those risks, lower the risks (and) the hazards of being a warehouse worker," she said. "The problem is the choices the employers are making ... are canceling out all those opportunities."

Amazon has committed to reducing incident rates by 50% by 2025, Amazon spokesperson Kent Hollenbeck said. And it's going to use technology to get there, Jeff Bezos told shareholders in his last letter as CEO before stepping down.

It agreed to spend $66 million to create technology that will prevent collisions of forklifts and other industrial vehicles and is working to "invent solutions" to reduce musculoskeletal injuries for new employees. In a nod to software, it is using algorithms to automate staffing schedules in a way that rotates employees among jobs, reducing stress from repetitive motion.

"We have never failed when we set our minds to something, and we're not going to fail at this either," Bezos told shareholders.

Setting the standard

Amazon's business model, multiple revenue streams and high-profile status makes the company an "outlier" compared with other warehouses—and that could be pushing the narrative of automation along faster than the tech itself, said Gutelius, from the Center for Urban Economic Development.

"For all of the talk about how technology is changing warehousing ... it's at a much earlier phase overall in the industry than I think a lot of people assume given the news, especially about Amazon," she said.

Amazon has room to experiment with new technologies and invest in automated solutions that could cut into immediate revenues for the promise of long-term gain, she said. It has the flexibility to choose a "loss leader," or part of their business that could afford to lose money in order to build up those technologies.

O'Connor from Raymond West is starting to see more companies come on board to try to keep up.

Companies used to invest in automation only when they'd see a return on their investment in two years, he said. Now, they're willing to wait three to five.

O'Connor pins the change to Amazon's success.

"Companies like Amazon have set the bar very high for service," he said. "If you're going to compete with Amazon or sell with Amazon, then you have to have the same type of service, and the only way you can do that is if you add some automation to the process."

"If you don't invest in change," he said, "then you're going to be left in

the dust."