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Trend topic: **Artificial Integrity**

By

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Robots: the most meaningful form of human/AI integration?

Most of us use keyboards and screens to access large language models and other forms of AI. But AI is on the move – literally.

Robots represent the physical embodiment of AI and as they continue to become more visible and widespread in the workplace and everyday life, they will herald a new era of human and AI integration. This has profound consequences for how we live and work, creating fascinating new possibilities but also raising ethical dilemmas. If we get this right, robots can bring an entirely new kind of value – for enterprises and society at large.

The beginning of embodied AI: Industrial robots

Long valued as tools for automation, robots are increasingly being deployed as teammates with very specific skills. Robots extend human reach – and artificial intelligence – into places and tasks that are too dangerous, remote, or labor-constrained for human workers. They bring AI to critical infrastructure, moving through the physical environment to collect data, identify anomalies, support decision-making, and, increasingly, trigger workflows before humans are exposed to risk. Able to consistently perform repetitive tasks, robots can offer relief in labor

intensive sectors that face fewer available workers due to aging workforces and the difficulty of retaining people in physically demanding roles.

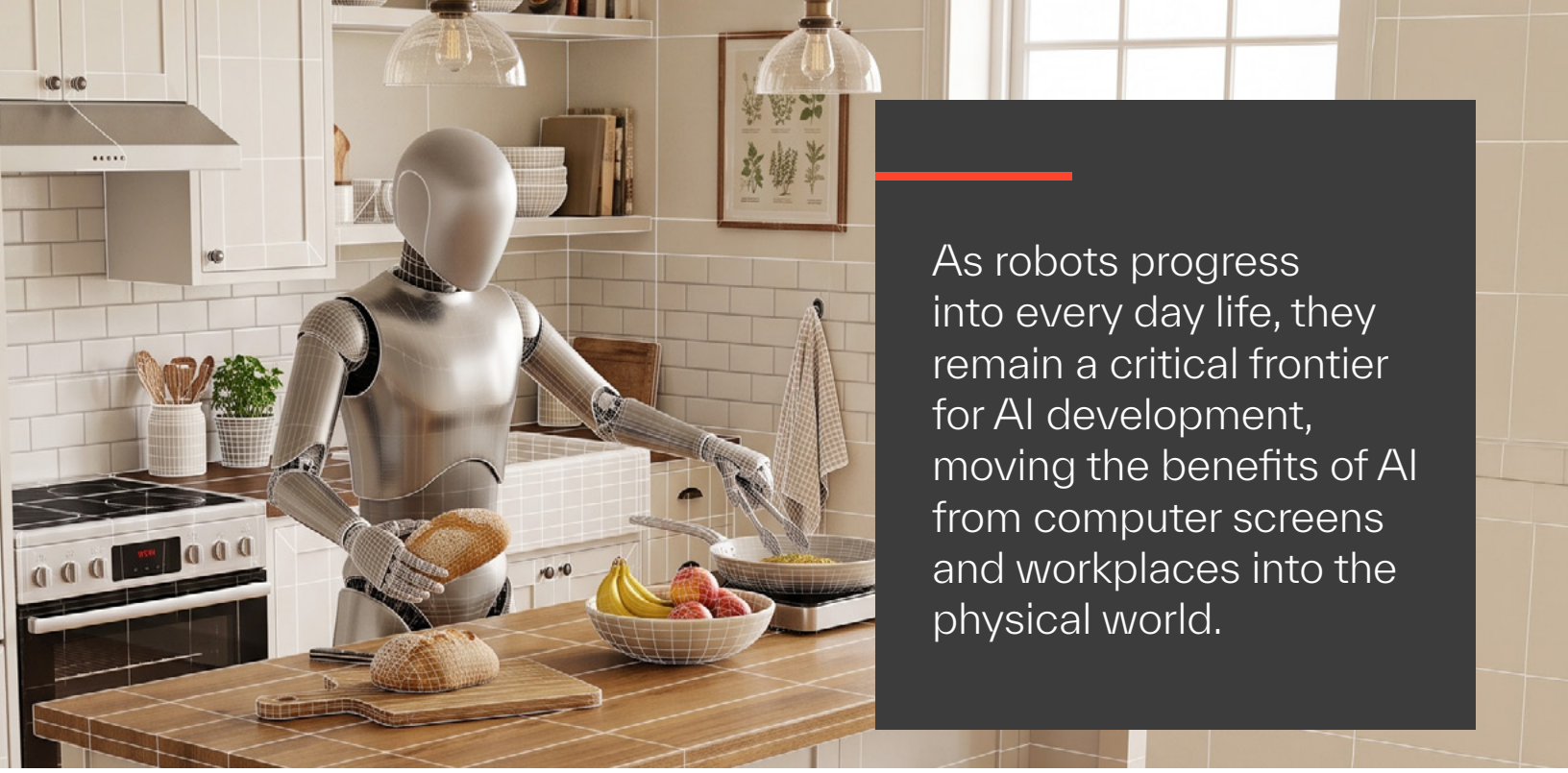
About 80% of robots currently in use are deployed in industrial settings.[1] The most capable of these can tolerate radiation, uncertainty, debris, poor communications, and constrained spaces, providing a reliable remote presence where humans cannot go. As such, they are used in hostage situations, industrial cleanup, to defuse bombs, and to conduct post-fire structural surveys. At the Fukushima nuclear reactor, for example, robots have been a critical part of the planning process for decommissioning the site, taking measurements, photographs, and even samples in areas too radioactive for humans to enter.

Robots can also bring super-human capabilities to tasks that might seem mundane but are business-critical. An intern may complete a factory inspection by taking notes, but that information may not be aggregated and accessible. A plant manager making an inspection knows which noises can be ignored and which indicate an issue – but when the plant manager retires, that knowledge is likely to be lost. Now consider a robot making that same inspection: It traverses the factory floor seeing and hearing things that humans cannot see or hear. It collects the same data from the same vantage point every day, creating a clean, historical data set that can both accurately feed AI and be used to make predictions. It is now widely acknowledged that having a foundation of clean, accurate data is a non-negotiable in building effective AI systems – robots offer a method that is free from human error and subjectivity for doing this.

From factory floor to every day life

Until about two years ago, most robots were model-driven. It could take millions of lines of code, and months or years of trial-and-error, to train a robot to perform a particular task. Even after all that work, the robot would be good at only one task in one environment, which is why many industrial robots are literally bolted to the floor and do exactly one thing. Take the robot out of that environment, and it was suddenly useless.

Now, robots are data-driven. With the use of AI – specifically reinforcement learning – robots can conduct that trial-and-error on their own, essentially training themselves and supercharging their ability to work in unfamiliar surroundings. The availability of massive computing power means that we can take an animation of a human performing a particular action, feed it into a physics-based simulator, and then ask the simulator to run it millions of times. When the results are uploaded to the robot, the robot often moves in a surprisingly organic way, with a stability and agility that was not previously possible. Quicker and cost-effective training of robots that are more adaptive and better at managing unknown environments means they are becoming



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capable of moving off the factory floor and into other workplaces and even homes.

This will lead in the next few years to a new wave of service robots, which will be more flexible and general-purpose than today's industrial robots. Industrial robots often need to work behind a virtual fence; service robots will have closer contact with humans, although there will still be a human operator nearby. Hotels, cruise ships and resorts provide a useful middle ground for service robots, allowing them to work more closely with humans while also benefiting from a bit more structure. An estimated 199,000 new professional service robots were introduced in 2024[2]; If you step off a plane in Seoul, you'll be greeted by two robots ready to carry your bags and another will wash your dishes after you finish your ramen. As a result, the critical labor shortages in the service industry, which were amplified in the post-COVID era, can be effectively addressed by robotic workers.

Operationalizing robots at the frontier of physical AI

As robots progress into every day life, they remain a critical frontier for AI development, moving the benefits of AI from computer screens and workplaces into the physical world. While generative AI and language interfaces allow robots to answer questions such as "What has changed since yesterday?" or, (perhaps in a power plant) "What are the thermal anomalies near pump 14?" robots use multiple layers of AI to sense the world and move through it autonomously. This includes:

- Perception AI: seeing, hearing, sensing, detecting objects, reading gauges, recognizing hazards.
- Navigation and autonomy: mapping spaces, avoiding obstacles, planning paths, returning to docks, repeating missions.
- Manipulation intelligence: understanding how to grasp, open, carry, place, or interact with objects.
- Predictive analytics: turning inspection data into alerts, trends, and maintenance recommendations.

In this sense it is clear robots are at the forefront of how we can use AI in the physical world, and as we develop them further this continues to give us opportunities to test and innovate. However, as with other forms of AI, the technology itself – in this case the robot – is only half the product. The real value comes from ensuring the AI can be operationalized effectively. We know this has been one of the biggest

challenges to successfully deploying AI in the workplace to date[3]. For leaders to avoid the same delays when it comes to deploying robots, they need to prioritize the following:

Customize workflows – first of all, the right workflow needs to be created and that means designing for autonomy, repeatable routes, tailored payloads, data capture, analytics, alerting, and integration into systems such as computerized maintenance management systems, supervisory control and acquisition systems, asset management, or security operations. It is thought that about $2.9 trillion of economic value could be created by 2030 in the US alone if organizations redesign entire workflows, rather than tasks, for collaboration between humans, agents, and robots.[4]

Build the right infrastructure – for robots to work effectively, they also need supporting infrastructure, notably a high-speed internet connection that lets them ask questions, get commands, and process images in the cloud. If a robot sees an unfamiliar object blocking its path, it could take a picture of the object, upload it to the cloud, and ask what it is. A foundation model could tell the robot that the object is a table and tell it to go around the table rather than attempt to climb over it. Unfortunately, many manufacturing environments don't have access to fast internet connections, or don't have those connections in all parts of the workplace. Other manufacturers may have fast wifi, but don't allow widespread access. Robots in other workplaces, such as those in the hospitality industry, will need similar connectivity.

Prioritize employee education and change management – successfully introducing robots to the workplace requires a thorough education effort. Many of these strategies will be familiar to leaders who are introducing other forms of AI in the workplace. Education about robots starts with the basics. Many workplaces put up posters explaining what a robot will do, what it can't do, and how it works with humans. One company paraded their new robot through the company cafeteria at peak hours; when folks stopped taking selfies with the robot, the company knew it was time for the robot to go to work.

Employees may have other concerns about robots. Surveillance is one – is the robot watching them? Others are worried that eventually, the robot will take their job. Generally, robots do tasks, not jobs. Employees' willingness to welcome a robot is, not surprisingly, tightly related to their feelings about the task a robot is trained to do. Unloading a container is one of the most hated jobs in logistics, and most employees are happy to have a robot do it. In

other cases, a robot is doing a task that an employee doesn't mind doing, and the employee is anxious that their job will change or vanish in the long run. The best remedies are similar to those that are often offered with other AI tools: training, upskilling, and certifications. A warehouse employee, for instance, could be offered the opportunity to earn a certification as a robot operator. Ideally, robots take on the dull, dirty, dangerous, and difficult work, allowing people to move up the stack — supervising fleets, interpreting data, designing interventions, and making higher-quality decisions.

The robotics industry needs to make some changes as well. It needs to be more realistic about their robots' capabilities and stop producing videos of robots pretending to do tasks they can't yet do. There needs to be agreement that general purpose robots must not be weaponized or allowed to harm or intimidate humans or animals in any way. Finally, there are still many improvements to be made in safety, especially in robots that will have close interactions with humans.

Companion robots: the ultimate app

As industrial and service robots become more widespread and visible – think of sidewalk delivery robots, or Waymo – robots and people get better at interacting with each other. At the same time, robots become more capable and adaptable in unfamiliar environments. This will lead to the emergence of general-purpose robots that will live in our homes. It's also where I believe we'll find an amazing application for robots: fighting loneliness.

The World Health Organization has decreed loneliness a global health concern, affecting 1 in 6 people globally[5] and causing mortality effects similar to smoking up to 15 cigarettes a day.[6] An approachable, intelligent, and even cuddly companion robot could be a great benefit to those who are socially isolated or lonely, especially if they're unable to live with or care for a pet. In addition to providing emotional support, a companion robot could remind someone to take their medicine, return a call from a family member, or order groceries. If someone is usually awake by 7am but is still in bed at noon, a companion robot could check on them.

What if, in addition to helping fight loneliness at home, a robot could help bring people closer together too? Academic research has linked improved life satisfaction with even minimal social interactions, such as thanking a cashier or placing an order with a barista.[7] So imagine a robot companion that says, "I need some fresh air. Could we go outside?" Or "When we were outside yesterday, I noticed another companion walking one street over. Could we go meet them at the park?"

In this way, robots aren't just advancing embodied AI. They are advancing AI that helps humans in perhaps the most meaningful way: to help them feel less lonely and more connected. And surely that's the best form of AI and human integration.

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