The Dawn of the Invisible Robot

Miniscule machines with big-data capabilities at the heart of the smart tech revolution

By Matt Kwong

Bill Gates, the architect of the PC revolution, made a bold declaration not long ago forecasting another disruptive technology.
"A Robot in Every Home," his 2006 op-ed for *Scientific American*, described the kind of future in which bionic nurses care for the bedridden, wireless automatons do the yard work and service robots tidy up the household à la Rosie, the Jetsons' humanoid maid.
But in an age of WiFi and the ever-diminishing scale of microchips, personal automation doesn't have to look like a robot with a feather duster.

It may not, in fact, look like anything at all.

"It could become invisible," said John Horn, president of RACO Wireless, a company specializing in M2M (machine-to-machine) communications.
"You'll be able to embed this connectivity into just about anything in our lives. We're seeing thousands of products communicating in real time, with modules so small they can fit on dog collars or wrist watches."

Horn cites the autonomous car as an example, but tiny computers inside many conventional goods — kitchen appliances, light bulbs, the drapes, even clothing — empowers them to "think" and communicate on the cloud with pocket electronics.

Mobile apps can remotely command a coffee maker to start brewing. Intelligent homes have digital nerve centers that control lighting, alarms and whether the toilet seats go down.

"There might be a device that knows, once you enter the home, to turn on the lights, lower the thermostat, maybe start the dinner you have in your microwave," Horn said. "The technology is right there today."

Tech analysts call it the Internet of Things — a constellation of

interconnected items capable of parsing oceans of online data.
Take the infant care company Owlet. It sells biosensor-wired baby socks that monitor the child's vital signs, and then transmit that data to parents' mobile devices to prevent Sudden Infant Death Syndrome. This apparel is known in child-care circles as "smart baby wear."

And these smart products are often made in smart factories.

Just as steam power set the Industrial Revolution into motion, tech analysts call this transition "Industry 4.0" — a technological sea change driven by processing power and wireless networks.

Ken Goldberg, a cloud robotics expert with UC Berkley, put it another way. "Machines are finally discovering the Internet," he said. "The way the web and online information changed the way humans interact is now occurring in the realm of machines and industry."

Corporations such as General Electric are embracing the digitalization of operations. GE is investing $1 billion into a system of web-based analytics called the "Industrial Internet" project. If GE senses a mechanical fault with a gas-powered turbine or if output is dipping below a baseline, performance-monitoring systems can flag stress issues before a breakdown.

Goldberg said these big data analytics are central in "predictive maintenance" — a way to let companies detect when a machine is reaching point of failure. "Imagine every turbine engine on an airplane has sensors collecting data about every route that gets uploaded and shared," he said. "Once you have large amounts of data, you can start looking at patterns of wear and tear and anticipate problems before an inspection."

Sensors and actuators built into production lines also improve the track-and-trace abilities of merchandise down to the lot, batch, operator or individual unit. Scanned bar codes can beam back information about when and where a shipment was sent in case of a recall.

That's a big deal for the pharmaceutical and food and beverage industries,

with radio-frequency identification tags becoming more commonplace. “Think of thousands of cans of soda going by minute by minute under the inspection of these vision-guided robotics and automation systems,” said Bob Doyle, with the Association for Advancing Automation in Michigan. “If they come back and need to do a recall, they can go back and look to see in that vision system where the contamination happened, to see exactly what time a material went through based on their unit-level verification.”

That traceability is a tenet of PLM, or product lifecycle management — literally space-aged software that allowed NASA to virtually test-run its Mars rover without once ever sending a vessel to the Red Planet.

“It’s the idea of creating, developing, producing and managing a product digitally from the time it’s conceived until the time it’s retired,” explained Bill Carrelli, vice-president of strategic marketing for Siemens, which developed the tools.

With PLM, most of the work is completed by computers before a physical factory or product even exists. That means product data records are managed from the recipe stage to production lines, supply chains and store shelves.

Carmakers use it for crash-test simulations without needing a prototype, or to “validate” a production line’s efficiency pre-construction. “You have full access to all that data just as if it were physically in front of you,” Carrelli said. “And that information can be easily shared.”

Minimizing corrective measures saves money, and products can get to a manufacturing stage 30-50 percent faster, he said.

On a more intimate level, machines are also being equipped to communicate with each other to improve efficiency and safety on the factory floor. Roboticists believe these “cobots” — collaborative robots — will transform assembly line workflow.

Manufacturing robots have long been confined to cages or behind light

curtains to protect humans from their mechanized arms, but high-performance computing is bringing the bots out of their enclosures.

At distribution centers for companies such as Staples and Walgreens, orange bots developed by Kiva Systems do the heavy lifting and ferry goods around the warehouse.

Each 330-pound “drive unit” can lift three times its weight and is equipped with camera sensors. As the machines cart around, they scan matrix barcodes embedded on the floor, which guide them to the next inventory order and where to move the goods.

“Kiva robots avoid running into each other, they understand motion co-ordination, splitting up an order. Three robots can go off and fulfill different parts of the same order, then arrange to come back together at the exact same time,” said Alan Mackworth, an AI researcher and computer science professor at the University of British Columbia.

And then there’s the Baxter, a $22,000 humanoid bot with dual arms, a torso and a tablet screen displaying a friendly default smile. Baxter can learn repetitive tasks, mimic them and adjust its work speed accordingly. Sonar sensors detect when a human is nearby so its joints can mitigate their force of impact. Baxter is now being touted as a game-changer for its low price point and its operational simplicity.

Traditionally, custom programming was the only way to get manufacturing machines to perform their tasks. Not so with Baxter, which can be trained by demonstration.

“As sensors improved, it became possible to communicate with robots in ways like visual recognition,” noted George Bekey, a University of Southern California computer science professor. “These robots understand human gestures.”

“On an assembly line, the person still does the smart stuff. You need a special tool? The robot can fetch it," said Elizabeth Croft, director of the

General Motors-funded Collaborative Advanced Robotics and Intelligent Systems Lab at the University of British Columbia.

And will embedded control be the new normal in the business ecosystem? "It’s like the Industrial Revolution," Croft said. "You can’t stop it when it's happening. The genie's out of the bottle, and the industry is pretty stoked."