HOME IS WHERE THE HARDWARE IS

BY MICHAEL Q. BULLERDICK

Breakfast served by butler bots? Not yet. Clean rugs or windows, though, is another story.

A ROBOT IN EVERY KITCHEN? SALES OF DOMESTIC BOTS REACHED 12 million in 2012, but if your Mr. Coffee isn't buying the beans and cleaning up after itself—let alone walking the dog and doing the wash—don't fret. According to clever marketers, at least, "robot" covers any device that can be programmed to perform a mechanical task. By that measure, most appliances, including coffeemakers, qualify.

Full-service butler bots, on the other hand, are a long way from joining the workforce. Blame their salary demands. The U.S. Defense Department spent $26.3 million to develop just the legs of its Petman robot, legs that any domestic machine worth its servo would need to climb the stairs to the master bedroom. Compare that with $15,000, the most that consumers are willing to spring for a servant bot, or $25,000, the average salary of a maid in the U.S.

Still, the domestic-robot revolution forges ahead, thanks to economies of scale in manufacturing, the development of smart mobile devices and cloud computing, and the race to establish a toehold in the burgeoning elder-care market. It hasn't hurt that the industry lost its obsession with producing humanoid helpers. In imagining a vacuuming robot, engineers at the iRobot Corp. rejected a focus-group consensus that demanded "the Terminator pushing a vacuum cleaner," as company cofounder Helen Greiner put it in an article in *New Scientist*. Instead, the team conjured a small, single-purpose bot that could glide under furniture and navigate rooms with a minimal amount of sensors to keep it affordable.

The result, Roomba, hit the malls in 2002—and it was a game changer. Approximately 8 million Roombas have been sold globally, making them the most popu-

YOUR HUMBLE SERVANT
Mahru, developed in South Korea, can clean up, put clothes in the wash, and heat food in a microwave.

THOSE CHORES YOU HATE
From top: Roomba vacuum cleaner, the most popular household robot ever; self-propelled window washer E.zicom Windoro; Litter Robot, a cat box that cleans itself; Robomow lawn mower.

lar household robot ever. The Roomba begat a service-industry boom that includes the likes of the V-R4000 (LG), the Trilobite (Electrolux), the Neato XV-21 (Neato Robotics), and Mint Plus (Evolution Robotics). And iRobot expanded its product line with the Scooba, a floor washer; Verro, a pool cleaner; and Looj, a gutter cleaner. Other bestselling devices include the E.zicom Windoro (E.zicom Robotics), a self-propelled window cleaner; the Litter Robot LRII (Litter Robot), a self-cleaning cat box; and robotic lawn mowers such as Robomow (Friendly Robotics), Ambrogio Lawnbott (Zucchetti), and the Automower 230 ACX (Husqvarna).

Creating a data-sharing network that allows robots to get "smarter" is the mission of Rapyuta, the RoboEarth Cloud Engine. The "Internet for robots" is a new open-source, cloud-based information repository. Rapyuta virtually stores a robot's costly bits—sensors and processors—so they can be divvied up among the global legions, thus making each more adaptive and affordable. Robots can also access an online database through which they can, as the literature says, "benefit from the experience of other robots."

What might those experiences be? Anything from navigating the floor plan of a multistoried house to distinguishing among every furnishing in every room. Unlike their industrial counterparts, whose environment was specifically designed to accommodate them, domestic bots must contend with the hazards of a less-functional human aesthetic. Imagine that after absorbing all there is to know about your home's layout and contents, your dutiful robot encounters a ladder where the coffee table once stood. Where does that plate of cookies it's holding go now? Rapyuta can teach the bot about ladders so that it can recalibrate itself and achieve the original task.

Adaptation, says Alper Aydemir, an engineer at Sweden's Royal Institute of Technology, is what will one day make live-in robots ubiquitous. Partnering with the makers of Xbox and the general public, Aydemir has developed project Kinect@home, another open-source cloud-based warehouse, through which robots can share practical information and hone the sensory algorithms that command their spatial awareness. Kinect@home uses crowdsourcing to build its database; since 2012, users have scanned their environments with their Xbox's Kinect sensor. Each uploaded image adds to the plugged-in roboworld's understanding of living spaces. Think of Kinect@home as a library of everyday objects and architectural arrangements. Experts say it won't be long—two years, maybe—before your basic out-of-the-box bot will be able to tell the difference between a four-legged family pet and a four-legged coffee table, or even one carved to look like the family pet, not to mention tell a microwave from a stove or Grandma from Grandpa.

That last distinction is good news for the "sandwich generation," whose members are simultaneously caring for kids and parents. Their search for safe, efficient, affordable elder care is an urgent driver of the robotics industry. Every month some 875,000 people join the ranks of seniors, making them the world's fastest-growing demographic. And each year, 13% of those 65 and older are diagnosed with Alzheimer's disease that requires assistance; the number jumps to 50% at 85. Meanwhile, the available army of caregivers continues to shrink and costs for assisted-living facilities skyrocket.

NOT SO SURE *A mechanized helper (here in a test situation) would seem a natural fit for rapidly aging, high-tech Japan, but the public has expressed discomfort with the idea.*

"Is it a perfect storm or is it a perfect opportunity to launch robotics from just a technology into being a useful tool?" asked Tandy Trower, the CEO of Hoaloha Robotics, in the British edition of *Wired*.

With global sales of elder-care robots estimated to reach $6.5 billion by 2017, universities, robot makers, even auto manufacturers are adapting existing multipurpose models and developing new ones. Not only can their latest assistive robots perform housework that seniors find increasingly difficult, but they also provide routine personal care: helping users in and out of beds, chairs, and showers; reminding them when to take their medication (and how much to take); encouraging them to eat; keeping them alert with memory games. The robots are also being programmed to monitor vital signs and to call for help should they detect a problem.

But despite such life-improving and lifesaving benefits, seniors have yet to be sold on mechanical buddies. Studies show that the elderly—even technologically savvy ones—prefer human aides to robots for most personal needs. Research at the Georgia Institute of Technology actually found subjects expressing concern about growing robot-dependent.

In theory, Japan would seem a more satisfying proving ground for entrepreneurial roboticists: its population is accustomed to smart devices and industrial bots, and its health insurance picks up most of the cost for assistive machines. At the same time, Japanese birthrates have declined dramatically over the past two decades, guaranteeing a shortage of doctors and caregivers in a country where 22% of the populace is already over 65. Yet when the country's largest robotics company, Tmsuk, entered the home-care market a few years ago, its executives were stunned by the lack of demand, and they soon halted the program. Subsequent research revealed a deep-rooted discomfort with caregiver bots in general, stemming from traditional values that hold that adults best honor their elders by caring for them.

Roboticists at Toyota hope to pave over that cultural speed bump. They are in the final stages of refining a human support robot (HSR), a docile-looking, 70-pound humanoid design that can open and close doors and retrieve items from either the floor or a high shelf with two finger grips on a single arm. Its face is a smart tablet with which users can activate Skype or launch other apps by voice command.

University of Toronto engineers are focusing on a "soft" approach, betting that seniors are more likely to engage with robots—like the one they call Brian—that are what project leader Goldie Nejat labels "social motivators." These bots are meant not for physical tasks but for social interaction. Brian features speech-recognition capabilities and can interpret body language and facial expressions, responding with facial expressions and verbal motivations of its own. The 150-pound charmer encourages seniors to exercise with exclamations like "I know you can do it!" But it isn't above guilt-tripping. To those who won't take their medicine, it moans, "You're making me sad."

While their elders try to come to grips with robot companions, younger generations can't wait to welcome them into their homes. Market studies, like those by Persuadable Research Corp., indicate that nearly half of this consumer cohort (41%) would be willing to up their spending cap—to as much as $25,000—if financing like that offered to car buyers were made available. Manufacturers hope their service bots might follow cars in one other respect too: as the next status symbol. Someday soon, keeping up with the Joneses will mean hiring a mechanical Jeeves.