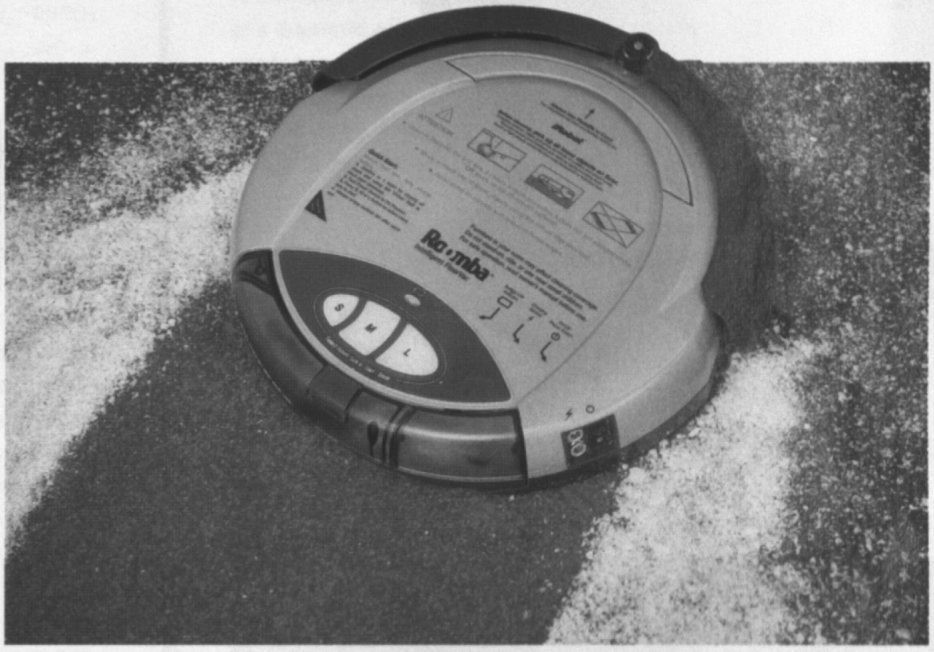
Robots That Suck

HAVE THEY FINALLY COME OUT WITH A ROBOT FOR THE REST OF US? BY GEORGE MUSSER

For generations, tinkerers have been pointing out how much their projects will lighten the load of housework. For generations, spouses and parents have failed to be impressed by these claims. When I built my first robot seven years ago, people kept asking, "So what does it do?" I explained that it would eventually vacuum the floor. I should have just been honest: "Not much, but it sure is cool, isn't it?" All these years later I still have trouble getting my creations to do the most basic things, like move in a straight line. My professions of usefulness don't carry much weight around the house anymore.

At least I am not alone. Seldom in the history of technology has an industry been so eagerly anticipated, and so slow to emerge, as the consumer robot industry. Back in the early 1980s, when computers were turning from hobbyist playthings into mass-market appliances, it looked as though robots would soon follow. Heathkit's famous Hero I robot kit came out in 1982, not long after the original IBM PC. *Entrepreneur* magazine predicted a $2-billion home robot market by 1990. Today the original PC is a museum piece, and Hero I is still the state of the art.

Anyone who builds a robot appreciates what happened. When humans use a personal computer, we enter into the computer's world. If it can't do something, or if it crashes, too bad; we have to deal. But a robot enters into our world. If floors are uneven, if legs get in the way, if lighting conditions change, the robot has to deal. Extra computing power doesn't necessarily help; on the contrary, more sophistication typically means less resilience.



DON'T CRY OVER SPILLED DETERGENT **if you have the Roomba floor cleaner, the first home robot that is both genuinely useful and reasonably priced. It won't completely relieve you of vacuuming duties, though. The robot is about 10 inches (25 centimeters) in diameter.**

Through the school of hard knocks (lots of them), robot experimenters have learned to keep things simple. Massachusetts Institute of Technology professor and robo-guru Rodney A. Brooks led the way in the mid-1980s with a new style of robot programming, in which cheap sensors directly trigger elementary behaviors. Most robot kits these days, such as Lego Mindstorms, embrace this approach. And a similar design philosophy is reviving the fortunes of the home robot industry.

Some products, admittedly, achieve simplicity by giving up the pretense of doing anything useful at all. Robot dogs such as Sony's Aibo are the classic example. Others, such as robotic lawnmowers and pool cleaners, aim to do a single task in a highly controlled environment. The next step up is to do a single task in a highly uncontrolled environment, and the most obvious candidate for that is vacuuming. Over the past several years, a number of companies have promised to roll out floor-cleaning robots. A few of them have even delivered.

Apart from DustBot, a cheap but clever toy made by the Japanese company Tomy, the first consumer robot that could vacuum was Cye. Released in 1999 by Pittsburgh-based Probotics, Cye is the Apple II of robots: just pull it out of the box and plug it in. I tested one back in the fall of 2000. It's about the size of a toaster oven, with two wheels, a pair of wheel odometers to measure its movement, and

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a bump switch to sense when it hits something. To prove its usefulness, it can tow a small upright vacuum cleaner.

You control Cye from a PC via a wireless link, and the desktop software is where Cye really shines. As the bot blunders around, it relays back odometry readings, and the software estimates its position by dead reckoning. Crucially, the software keeps track of the uncertainty in its position; periodically the robot can reduce the error by reorienting against an object of known position, such as a wall. You can map a room, automatically calculate paths from A to B, and designate no-Cye zones—very handy in a home or office where not everyone shares your robotic enthusiasm.

For all its dummy-proofing, though, Cye still appeals mainly to gadget freaks. The price, which used to be $700 until the company lost its senses and raised it to $2,700, puts off the practical-minded. The mapping software tends to crash, and the vacuuming mode is primitive—the bot sweeps back and forth in a rectangular area and doesn't suffer obstacles gladly. Even I got bored. Lacking other sensors or the provision to run your own programs, Cye isn't capable of the richness of behavior that even entry-level kits can provide.

Last October, Brooks's own firm, iRobot, based in Somerville, Mass., brought out Roomba, a robot tailor-made for vacuuming. The lead designer, Joseph L. Jones, is co-author of the 1993 book *Mobile Robots: Inspiration to Implementation*, which remains the single best guide for beginning hobbyists (it got me started). The main subject of the book, the Rug Warrior project, grew out of a floor-cleaning bot that Jones had built for a contest at M.I.T. Four years ago he and mechanical engineer Paul Sandin finally got company backing to turn it into a product.

Roomba is roughly the size of a car hubcap and weighs about six pounds. The main cleaning mechanism is basically a Bissell carpet sweeper—one of those rug cleaners that is often found (and sometimes used) in college dorm rooms. A zigzagging wire forms a cage to keep the rotating brush from choking on the corners of rugs. A miniature weed whacker on the side flicks dust away from the base of walls. Behind the sweeper are two squeegee blades with a narrow slot between them—a "microvacuum" designed to suck up dust and hair. (Jones says the battery couldn't power a full-size vacuum.) The dirt ends up in a plastic cartridge.

The only controls are an "on" switch and three buttons to specify whether the room is small, medium or large. When you press one, Roomba starts moving in a spiral; after a while, it goes straight until it hits something, then turns, sometimes heading back toward the center of the room, other times executing a scallop-shaped path to try to follow a wall. The overall effect is a random walk. Half an hour later, give or take 10 minutes depending on room size, it declares victory and stops. You can also stop it by picking it up using the built-in handle. A battery charge lasts about an hour and a half.

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I tried Roomba on low-pile carpets and hardwood floors in rooms both empty and full. It didn't damage or topple anything, and it did remarkably well at extricating itself from power and phone cords, either by shifting direction or temporarily shutting off the brush. The edge detector—downward-pointing infrared sensors that watch for drop-offs—worked perfectly. Much as I tried, I couldn't entice Roomba to fall down a flight of stairs. I even put it on a table and let it clear off the crumbs.

Roomba slurped up most of the filth, but it didn't replace the need for manual vacuuming or sweeping, and iRobot is wise not to claim that it does. The real Achilles' heel of the robot, though, is the

wire that is supposed to keep rug corners from jamming the brush. It got yanked off within a couple runs, and the company had to send me a new one. Even with the wire, the bot didn't like the kilim in our living room one bit. And although it was usually able to free itself from cords, "usually" wasn't good enough: it got hung up at least once per run. You don't have to watch Roomba continuously, but you had better be nearby to help it. I think it's fair to say that Roomba rises above the level of mere gadget—but not by much. What makes it a breakthrough is the price, $200, which approaches the don't-need-spousal-preapproval range.

Roomba closely resembles a vacuum robot, Trilobite, that was introduced by Swedish appliance maker Electrolux in November 2001. Electrolux didn't respond to repeated requests for a demo model and doesn't sell Trilobite outside Sweden, but I tried it out in a shop on a visit there this past fall. Trilobite features a more powerful and rug-friendly vacuum; a sonar to detect obstacles, so it seldom actually makes contact with anything; and a position tracker, so it can return to its home base and plug itself in when it needs a charge. On the minus side, it lacks an edge detector, relying instead on magnetic strips that you lay around danger spots. Worse, its price, 14,000 kroner (about $1,500), is not likely to pass the spouse test.

Watching these robots bumble around gives you a new appreciation for how difficult housework really is. It takes agility, a tolerance for imprecision, and advanced pattern-matching skills—just the abilities with which evolution on the savanna endowed us. Rather than ever making a robot do all that, humans might, I suspect, find the tables turned on them: a future cyborg species could simply hire people to clean their homes for them. SA

For a review of another recently introduced robot, the ER1, see the online version of this article at www.sciam.com under "Technicalities."