



**Professor emeritus Rodney Brooks refines the sequel to iRobot.
Rodney Brooks' startup, Rethink Robotics, is producing robots that can adapt to
manufacturing tasks and the factory environment.**

By Rob Matheson, August 9, 2013

- 1 Professor emeritus Rodney Brooks gained fame in the 1990s for co-founding iRobot, an MIT spinoff that brought the world the Roomba and other innovative, helpful robots. He's since moved on to robots that are bigger, but no less revolutionary.
- 2 Brooks' newest startup, Rethink Robotics, headquartered in Boston, is producing robots that can work safely in factories alongside humans and demonstrate "common sense," adapting to their tasks and environment.
- 3 Rethink's first commercial model, Baxter, released in January, is a human-sized, two-armed robot that can be programmed to learn repetitive production tasks: material handling, testing and sorting, light assembly, and packing and unpacking. Any worker, tech-savvy or not, can program Baxter by moving the robot's arms — demonstrating the desired tasks and locations — and pressing buttons on a control panel.

A ROBOT'S EMOTIONS

Brooks didn't set out to build a humanoid robot, but he found that giving Baxter a face was the most intuitive way to communicate information.



NEUTRAL
Ready for training



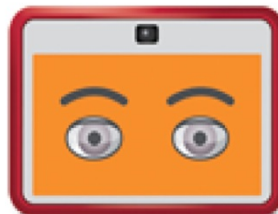
ASLEEP
On standby



CONCENTRATING
Learning a task



FOCUSED
Working away without a problem



SURPRISED
A human has approached



CONFUSED
Having trouble finding an object or otherwise completing a task



SAD
Given up trying to complete a task; there's a problem

- 4 The robot's "face" — eyes and eyebrows displayed on an LCD screen — indicates its status and where its attention is focused. **Sensors** on the robot's "head" allow it to recognize when people are nearby, and sensors on its joints allow it to reduce the force of impact should it detect a collision — valuable, and novel, safety features.
- 5 "Baxter changes its movements to **accommodate** the world. That's a revolution in robots for manufacturing by itself," says Brooks, a former director of MIT's Computer Science and



6 Artificial Intelligence Lab and now Rethink’s chief technology officer. “And the fact that it’s aware of people and safe to be around people is another revolution in the manufacturing environment.”

As importantly, Brooks says, Baxter is built from parts manufactured in the United States. The product’s domestic roots are contributing to the company’s popularity, Brooks says: “Our customers have a lot of emotional investment in that.”

7 Hundreds of Baxters have sold nationwide, and the robot has been praised for its safety and affordability, among other things. *Technology Review* listed Baxter as one of 10 breakthrough technologies of 2013; Time named the robot a top invention of 2012. Rethink itself — named to Technology Review’s most recent list of “disruptive companies” — has raised more than \$62 million in funding.

Making U.S. manufacturing more attractive

8 A Baxter-type robot first appealed to Brooks as a means of helping America compete with low-cost overseas labor and making its factories competitive globally. “I decided maybe I could do something with robots to make manufacturing more attractive in the United States,” he says.

9 Five years of **prototyping** and field research at U.S. factories followed Rethink’s 2008 founding. This field experience led Brooks and his colleagues to **jettison** many features, such as a speech interface (because factories are noisy) and touchscreens (because workers commonly wear gloves). “It’s all this obvious little stuff that, as an academic, doesn’t register when you’re starting to commercialize something like this. So you have to go into the field to find it out,” Brooks says.

10 Once it had the design, rethink began reducing Baxter’s development costs by replacing costly mechanical components. Advanced software allows the robot to fix mechanical irregularities, such as troubles with gears. Features like cameras help the robot detect objects without requiring **precision accuracy**.

11 But the robot is designed with some impressive hardware. One key feature (which allows the robot to sense and soften collisions) was invented and patented at MIT: Baxter’s arms contain a mechanism called a series elastic actuator that was invented by Gill Pratt, a former MIT faculty member, and Matt Williamson, Brooks’ former PhD student.

12 Traditional **actuators** involve a motor driving a gearbox, which in turn drives a joint. All are rigidly attached to one another, making a device fast and accurate, but rendering it unable to sense force, which can be dangerous. Elastic actuators, on the other hand, are spring-based and allow the device to sense force — slowing when a human touches it — as well as absorbing friction and shocks.



13

Williamson now directs Rethink's technology development. A number of other Rethink employees hail from MIT, as well as from Northeastern and Tufts universities, Worcester Polytechnic Institute, and other institutions in and around Boston — which Brooks calls “the world's epicenter for robotics.”

“You can't have a robotics company in Boston without employing people from MIT,” he says.

14

Brooks, who left MIT in 2008, adds that the Institute's entrepreneurial ecosystem has grown dramatically since he co-founded iRobot with then-graduate students Helen Greiner '89, SM '90 and Colin Angle '89, SM '91. “It has a lot for students,” he says. “Everyone's doing something with entrepreneurship there now.”

A tool for factories, and the lab

15

While Baxter has received its share of praise, some media coverage has asked whether the robot could eventually take jobs from humans. But Brooks sees Baxter as a tool, comparing the robot to another useful invention, the electric drill.

16

“Electric drills increase the **productivity** of workers, but do they take jobs away? I view Baxter as a tool — like the electric drill — that increases productivity,” he says. “Baxter is not technology separate from average workers; it's a tool *for* factory workers.”

17

For instance, Baxter may help aging factory workers do their jobs more **efficiently**. But humans still do better at tasks like quality assurance or small assembly, Brooks says.

18

In May, Rethink began selling a Baxter Research Robot. It's exactly the same, mechanically and electronically, as the manufacturing robot, but is geared toward research tasks — which Brooks hopes may lead to research advances.

19

“I don't know what the research will be,” he says. “All I know is once the tools are there, and are cheap enough that lots of universities can have them, there will be major innovation. I think that's worthwhile for the world.”