



Is There a Robot in Your Future? Helen Greiner Thinks So

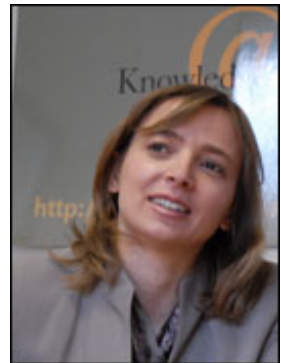
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Had you met Helen Greiner when she was a student at MIT in the late 1980s, you might not have pegged her as the future head of a consumer and military products company. She was quiet, a bit shy, and, as even she would agree, something of a nerd. But she shares a key trait with many successful business leaders -- a passion for something. In her case, it happens to be robots.

That passion led Greiner -- along with Colin Angle and Rodney Brooks -- to found what would become iRobot in 1990. Over the past four years, iRobot has sold more than 1.5 million robots for cleaning people's floors and has deployed more than 300 tactical military robots in Iraq. The company completed its initial public offering on November 15, 2005.

Greiner recently gave a presentation at Wharton sponsored by the School's entrepreneurship and technology clubs, after which she sat down with Knowledge@Wharton to talk about her fascination with robots and what impact robots have, and will have, on our everyday lives.

An edited version of that interview follows. Excerpts from the interview are available as a [Knowledge@Wharton audio podcast](#) and can be downloaded from Apple's iTunes.



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Knowledge@Wharton: How did you first become interested in robots?

Greiner: I saw *Star Wars* when I was 11 -- in the theater -- and I was enthralled by R2D2 because he was more than a machine. He was a character, he had a personality, and he was really one of the stars of the show.

Knowledge@Wharton: Is it true that, at the time, you didn't know that R2D2 was played by an actor in a costume?

Greiner: Yes. My big brother told me that Kenny Baker actually played R2D2, and that burst my bubble a slight amount. But, at the time, I was hacking on a computer, a [Radio Shack] TRS-80 that my parents had bought for the family. I could see the connection between what was shown in science fiction, in *Star Wars*, and what could be built in the future with technologies that were just emerging for the computer industry at the time.

Knowledge@Wharton: What's the goal of iRobot as a company?

Greiner: Our goal at iRobot is to build practical and affordable robot systems. We are not there to do demonstrations of technology. We are not there to talk about stuff that's going to happen 50 years from now in robots -- although that's going to be extremely exciting. We really concentrate on practical and affordable systems for today.

For example, we have 1.5 million Roombas helping people clean their homes everyday. You push a button, it comes out and does the sweeping and vacuuming. When you get back [home], it's on its charging station charging itself. Our Roombas run between \$150 and \$330 -- practical and affordable.

Knowledge@Wharton: You have just talked about one of your consumer products, the Roomba, and you have another consumer product, the Scooba. But your earlier products were government and industrial robots. Tell us about those.

Greiner: Our first products were designed for research labs. [After people started] calling MIT and saying, "Can we buy what was created there?" we thought, "Hey, there must be a commercial application here." We now have military products in combat, [including] more than 300 Packbots helping our troops in Iraq. Terrorists are littering the country with thousands of bombs. The [military] used to send soldiers, wearing bomb suits, to [try and safely detonate] them. Now they send our robots [instead]. So the soldiers get to stay at a safe distance. The robots today have been credited with saving the lives of dozens of U.S. soldiers. We're really proud of that work.

Knowledge@Wharton: I don't think anyone would object to having a robot vacuum the floor, but do you find resistance to robots as a concept -- doing tasks that humans have been doing? Is there a science fiction element of this that makes people nervous?

Greiner: I don't really think so. When computers first came out, you had a lot of people worried that computers were going to obsolete humans and that they were going to take over everything. So you had everything from [the movie] *The Colossus Project* to Hal in *2001*. I think it's a way for society to work through their fears. Once people have a computer on their desk and they see what it's good at doing and, more especially, what it's not good at doing, they don't have the same fear anymore. It's the same with robots. Once people have a Roomba in their home and it's doing the sweeping and vacuuming for them, but they see the things it can't do yet, they really don't fear robots taking over the world.

Knowledge@Wharton: What about the opposite situation: Once they get one, do they start to treat it like a pet?

Greiner: Our customer base -- homemakers, people who just want to get the vacuuming job done, people who are used to doing it themselves -- buy the Roomba as an appliance, but once they get it home, it's going around, it's following the wall, it's getting around the furniture, it doesn't fall down the stairs, it has bleeps and bloops to communicate. The only thing in their experience that has acted that way has been a pet. So people actually start to name it. You don't see anyone name their toasters but a lot of people tell me they have named their Roomba.

Knowledge@Wharton: What is yours named?

Greiner: That's a really good question! Mine is named "Arnold". One of them. [There are] a few others that all have names, too.

Knowledge@Wharton: What's next in the area of domestic robots?

Greiner: We just announced Scooba, a floor-washing robot. It's really cool because it takes the place of mopping or scrubbing the floors. It cleans up the debris and then it puts down a fluid that we have developed with Clorox. It scrubs it in and then it picks it up on the back end. It's a whole new process for getting the floors clean. And you don't have to push it around because, like the Roomba, it's an autonomous robot. It entirely takes the place of doing the job by hand.

Knowledge@Wharton: When did you first get the idea that you could build a practical consumer robot?

Greiner: We started the company in 1990, and it's always been centered on robots. But it wasn't until about 1999 that we began working on the Roomba development. We first put it on the market in the fall of 2002, and it's been going strong ever since.

Knowledge@Wharton: What's the biggest setback you have had as a company?

Greiner: We call them "learning experiences." They come in stages. One [event], early on, was [when] we absolutely had to ship a robot. We had built it ourselves and if it didn't ship that day everything was going to end, we couldn't pay our bills. It burst into flames at 3 a.m. in the morning while we were working on it.

What that told me is that I have two wonderful business partners -- Colin Angle and Rod Brooks -- because we all burst out laughing and went to Burger King. We began rebuilding it the next day.

When we started the company we were unfundable from a venture capital point of view. It was really not until eight years in that we even tried to get venture capital funding. I can say that I have been turned down by almost every major VC in the country, except for the five really visionary, farsighted ones who joined us. Today, one of the things that really makes me happy is I have had a lot of venture capitalists come up and say to me, "Helen, I was wrong. Robots *are* the next big thing."

Knowledge@Wharton: Like any product company, you face liability issues if your product doesn't do what it was intended to do. But, in the space you are in, where you are building intelligent products, is there a greater peril of them not doing what they're supposed to?

Greiner: Not really. The story about the fire was early on in the company, before we had the understanding and the processes in place to really look at safety. As we were starting the Roomba project, we looked at all the things that could happen in the home and we designed around them.

For example, the Roomba is very lightweight, so it's not heavy enough to cause damage. Safety is built in from the ground up. It has a redundant system to not fall down the stairs, which could be a dangerous thing to do. It first protects itself with its downward-pointing infrareds. If that doesn't work, one of the wheel-drop sensors will detect the edge. And if that doesn't work, it's got a high-friction pad on the back that keeps it from going over.

Building in a lot of redundancy, keeping it lightweight, and keeping it very safe from the beginning of the project have been important.

Knowledge@Wharton: Your consumer products started off being dedicated to a single task, but you have recently opened up those products so people can make them do other things. Can you talk about what you did, why you did it, and how people have responded?

Greiner: iRobot has been concentrating on practical, affordable systems to do chores around the home in the consumer domain. In price per robot capability, the Roomba is an incredible robot. We have gotten it into mass market manufacture and we have designed it from the ground up to be low cost. People were coming to me all the time saying, "Can I use it for this?" and "When are you going to come out with this?" Some of the applications are not in our projected business space, or they don't have the return on investment that we would like to see, or they are just in markets that could be good for a smaller company but are not ones that we are choosing at this present moment.

So we put an open interface on the Roomba [allowing] other people to make it into the robot that they

envision.

Knowledge@Wharton: Have you heard stories of what people have done with this?

Greiner: Well, a few stories. One [involved] making a webcam on wheels so you can control your robot through the Internet and see what the robot sees and hear what the robot hears as you drive it around. Somebody made a robotic plant-moving system, so plants can always be in the sun. Someone was talking about making a swimming pool-skimming robot. And most recently, just this past week, some hackers did a physical instantiation of the video game Frogger. Now we don't condone this type of activity [*laughs*], but it shows you just where creativity can go when you make a system open.

Knowledge@Wharton: You have also used robots in the field of archeology. How does that work?

Greiner: We were asked by *National Geographic* if we could apply some of our robot technology to help with a problem in the Great Pyramids [in Giza, Egypt]. There are shafts that people had never explored, that they hadn't seen in the 5,000 years since they were built. Robots were the only way to move camera systems and sensors up to places where the archeologists wanted to get more information.

In the summer of 2002, we had our robots exploring shafts coming out of the Queen's Chamber in the Great Pyramid. The archeologists learned a lot about why the shafts were built. They had information to create new hypotheses about the architecture that was used in the Great Pyramids.

Knowledge@Wharton: Did you have to adapt these robots to handle the terrain in those shafts?

Greiner: We took some of the technologies from our military robots and adapted them to go through these 4-inch square shafts. We added camera systems and ultrasonic sensors so they could look through an obstruction that was blocking the way.

One of the most difficult things in that project was that the Egyptian authorities and *National Geographic* wanted to look through what they thought was a door. They asked us to do it. So we brought in a drill and attached it to the robot. They said: "You want to *drill* through the Great Pyramid?" After about 50 trials down in the Queen's Chamber showing how the robot would just make a small hole that we could put a camera through, they did actually let us drill the hole.

Unfortunately, what they found on the other side was another blockage, so it's still a great mystery for somebody else to take on and solve with *National Geographic* and the Egyptian authorities.

Knowledge@Wharton: You have talked about having robots work in industry, in the consumer area, in the military -- what about for academia?

Greiner: There are robot labs in every major university across the country. I now see this moving down into high schools. Robots are a great way to have kids learn because they can get excited about it; it's new, it takes a lot of innovation, and there are so many applications that haven't been addressed yet. It's a great place to teach kids because they can learn while they are actually doing something that's state of the art. The University of Southern California is looking at our Roombas [as a way to help] develop a curriculum in robotics. With the Roomba's open interface, you can make it into a teaching tool.

Knowledge@Wharton: Are these robots used to actually teach young people how to build something like this? Can they be taken apart to see how they work?

Greiner: When I was in junior high school, I was hacking on a computer system. Kids don't hack

computers now because they come as turn-key products and they already have all this great software running on them. But kids are hacking robots and learning about technology by opening up and tinkering with robot systems. That's another reason we put an open interface on the Roomba.

Knowledge@Wharton: Do you see ever getting into the medical field or health care?

Greiner: There are just so many great applications for robots. We look at some of the big ones [such] as law enforcement -- the robots that are helping our troops today could also help our police officers and early responders.

There's elder care, which is related to health care. There's an aging demographic, and people want to stay more independent in their own homes. They want to live where they have always lived. They have physical needs. They are adopting technology, but it's mostly information technology. With those physical needs there is an application for robots to help people remain more independent in their own homes.

Then there are things like commercial cleaning. We have already shown autonomous cleaning in over a million homes. Imagine all the buildings -- schools, offices, retail outlets -- that get cleaned almost every night. That's a tremendous application for robots.

Knowledge@Wharton: Since you have proven the value of robots and their ability to be adapted to people's individual needs, are you concerned that other, more established companies are going to be able to compete with you and take away your competitive advantage?

Greiner: On the consumer side, Electrolux and Kärcher, two large vacuum companies, already have products out, but they are more than \$1,000. When *Consumer Reports* did a recent comparison of robotic vacuums, our Roomba, which is \$150 to \$330, measured equal to, or better than, any of the higher-priced ones from the traditional vacuuming manufacturers.

We've had some knock-offs come in on the low end -- people who say, "Hey, these guys are selling a lot of robots, we'll just copy what they're doing." So far, none of them has been successful on the market because they haven't been very functional and they don't have the brand that we have. People go to the stores and ask for a "Roomba," not a "vacuuming robot."

Knowledge@Wharton: To what extent do you feel that the Roomba and other domestic robots will have a market in low-income countries [such as] India, where a robot that sells for \$150 in the U.S. might be quite expensive compared to the domestic labor that you can engage.

Greiner: That's a very good question. Many people in the Western world don't have the option of getting a maid service and, if they do, the maids only come in once a week or once every two weeks. The Roomba allows you to keep your floors clean. And [with] the Scooba -- people hate to vacuum, but they absolutely loathe mopping. That's what our market surveys show. So it's one of those jobs that doesn't get done as often as the person in charge of the home would like it to get done. It's something that, even if you have a maid service, you would still want to have for the in between times.

In the lower-income countries, I'm not sure we see a near-term market opportunity because there are other low cost solutions. However, a country like Japan started out doing manufacturing and now it's a high-income country. Korea is following suit. And I would imagine China will be following suit in the short timeframe. Countries progress. They start out taking on the low-cost jobs and then move up. India's doing a lot of software development for the United States now. Just because it's a low-income country today doesn't mean it won't be a target for robot sales in the future.

Korea has been a great market for us. We have almost as deep penetration in Korea as we have in the United States for the Roomba.

Knowledge@Wharton: What would you like your robots to be able to do that they can't do right now?

Greiner: Everything!

Knowledge@Wharton: For instance?

Greiner: At iRobot we started building walking robots with the idea that biological systems get over more terrain with more agility than wheeled or track systems. [But] practicality dictated that, in the short term, we move to wheeled and track systems. I think, in the future, walking robots will be extremely important, but the technology's just not quite there yet. The strength-to-weight ratio in the motors doesn't allow the output to be as effective as the track systems we already have on the market today. So you really have to get to a point where you're doing something that the older technology can't do before you displace it.

Knowledge@Wharton: In general, what's harder to do -- the mechanics of making an autonomous robot or programming the "intelligence" to make it do the right thing?

Greiner: That's a tough question, because they are so tightly coupled. The type of intelligence you put on board depends on the types of sensory systems you have. And you can make things a heck of a lot easier if you have a great mechanical system.

So, for example, you can have a very complex program that makes a walking robot climb stairs, but the Packbot with its track system just gets on the stairs and can run straight up. Through intelligent mechanics we often make our programming tasks really easy. And through very good low-level software, we can take less expensive sensors and get more information out of them. So designing the system as a whole is what has pushed our robots ahead.

Knowledge@Wharton: You went public in November 2005. How has that changed the way you conduct business? What are the challenges that being a public company now presents?

Greiner: Being a public company hasn't really changed the culture of iRobot. People are still dedicated to bringing practical and affordable robots to market. And we still get the same thrill when a consumer writes to us and says, "Damn, this is a good product," as we do when we receive a letter from the guys in the field saying, "Your robots saved lives."

From a financial processes point of view, we started implementing our SOX [Sarbanes-Oxley] processes a few years ago. And we have more company operating system deadlines. For example, we just turned in our first 10-K last week. It's just more of a drumbeat of business that has to go on when you're publicly traded. But from a cultural and a business point of view, the effect has really been minimal.

Knowledge@Wharton: You are now a public company, but you are also a company driven by technology. Is there a challenge balancing your investment in long-term R&D with the pressure for short-term growth?

Greiner: We made very clear in our prospectus, in our road show and, again, on our first earnings call, that we were really concentrating on top-line revenue growth in the next few years. There's such an incredible potential in the robot field, it would be shortsighted for us to be dropping too much money to the bottom line. We really need to continue to invest that money in growing the business.

Knowledge@Wharton: What keeps you up at night? Is there a business challenge or a risk that really bothers you?

Greiner: At the beginning of last year I would have answered this question with: "We've got a heck of a lot of hiring to do. And we need to make sure that those people we hire are really as passionate about the field as we are." We did get a phenomenal amount of hiring done in the past year, and it's been incredible because we have folks who bring expertise in particular domains that we might not have had at iRobot. At the same time, you can sense that the culture and the passion about robots [has remained]. Our mission statement, which is "Build cool stuff, deliver great product, make money, have fun, and change the world," is still proudly displayed on all the walls and, I think, has been internalized by the new employees at iRobot in the past year.

Knowledge@Wharton: One way of getting new skills is to hire people, as you've done. Another way is to have alliances with companies that have skills you may not. You've had some interesting alliances. For example, you referred to the one with Clorox. Can you talk about your approach to alliances and how you manage them?

Greiner: We teamed with Clorox to make the cleaning fluid for the Scooba because we wanted to [take advantage] of their decades of experience making cleaning solutions and really thinking about cleaning. It's been tremendous. We had some specific requirements. It turns out the soap for a robot floor-washing system has to be high traction. When you put soap on the floor it's slippery, which is exactly the wrong thing. So their engineers and ours worked together to make a high traction soap [that] cleans really well.

Knowledge@Wharton: What is your alliance with John Deere about?

Greiner: It's a strategic alliance, so there might be multiple business opportunities in the future. The first one is a robotic version of their M-Gator system. They have sold thousands of utility vehicles, called M-Gators, to the military. And we are working together to make that the first unmanned ground vehicle that the military gets into usage.

Knowledge@Wharton: Let's step back a bit and look more broadly at some of the major trends in the field of robots. Explain the work you're doing with swarms.

Greiner: Our swarm was a research project to look at [the question]: If one robot can do a job effectively, what can a whole team of hundreds of robots do together? We built a swarm of 128 robots and we were doing core research into distributed algorithms to see how these robots can work together to get a job done more effectively.

Knowledge@Wharton: How big was each of these robots?

Greiner: Each of them was smaller than the Roomba, but with lots of sensors on board and the ability to communicate to their closest neighbors.

Knowledge@Wharton: What can they do?

Greiner: You have to look at the swarm like a hardware simulation. They're not real robots doing real tasks; they are a simulation, but instantiated in hardware. So, [for example,] they could go out and search a building and find objects of interest. In the case of our test, they were orange cones. When they found one, they could call in other members of the team that might have some specific expertise. So, say you want to bring an explosives sniffer close by. You can pass word through the swarm that you need that

capability, calling in folks from the back of the swarm -- not your closest neighbors, because that can split the swarm.

This is really core research into distributed algorithms for robots. Today we have the Packbot out doing individual missions, but you can imagine sending a team of Packbots to search a whole building. You can get the job done quicker.

Knowledge@Wharton: What do you think people would find most surprising about you?

Greiner: Most people who know me know that one of my passions is snow boarding. And I play ice hockey, scuba dive and wind surf. But what they would find surprising is that I just love gardening. I spend a lot of time putting flowers in my house and making an English wildflower garden. Which is why things like the Roomba are so invaluable. If I'm at home, I don't want to spend time vacuuming or washing my kitchen floor. I want to spend time out doing the gardening.

Note: *Helen Greiner will speak in June 2006 at the Tenth Annual Wharton Leadership Conference, titled "[Leading With Resilience: Coming Back from Challenge and Adversity](#)"*

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