KATE DARLING

# The New Breed

## HOW TO THINK ABOUT ROBOTS

'A must read for anyone interested in the emerging ethics of robotics'

**Irene M. Pepperberg**

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THE NEW BREED

'Darling celebrates our ability to bond with those outside our own species . . . But she reminds us that robots, unlike animals, are designed by people, and could be used to exploit our better nature'
Simon Ings, *New Scientist*, Books of the Year

'Man's best friend reimagined . . . What makes Darling's book interesting is its attempt to reframe our thinking about robots in terms of our relationship with animals'
Tim Hornyak, *Literary Review*

'Her book employs current research from a range of disciplines to dispel popular dystopian myths about how superhuman robots are after our jobs'
Michael Marinetto, *THE*

'Well-researched, well-developed, and well-written, Darling's innovative proposal – to use our history of human-animal interactions as a blueprint for the future of human-robot interactions – is a must read for anyone interested in the emerging ethics of robotics. *The New Breed* raises serious questions and provides some intriguing answers'
Irene M. Pepperberg

'In this extraordinary and wide-ranging book, Kate Darling fundamentally reframes how we should understand these new forces within our life. From their effect upon the nature of work, to their critical role in the emotional life of many, robots will matter as much as animals have mattered'
Lawrence Lessig

'Inspired by how humans have partnered with animals throughout history, Darling, a robot nerd who calls her toddler "Babybot", explores the fascinating emotional connection we have with our robots and makes a compelling case for a bright future where robots are our collaborators and companions'
Rana el Kaliouby

‘A riveting and engaging book, full of wit and wisdom. It goes beyond the tired tropes of utopia and dystopia, and presents a nuanced and smart take on our relationships to robots’
Bruce Schneier

‘Endless ink has been spilled on AI and our robot future. Just when it seems there’s nothing left to be said, along comes Kate Darling’s book. For the first time, it seems we’re having the conversation we ought to be having’
Tim O’Reilly

## ABOUT THE AUTHOR

Kate Darling is a researcher at the Massachusetts Institute of Technology (MIT), where she investigates social robotics and conducts experimental studies on human-robot interaction.

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*How to Think About Robots*

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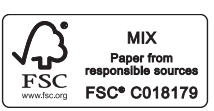


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*To my dad, who always encouraged an open mind.*

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# INTRODUCTION

"Animals are good to think with."

—Claude Lévi-Strauss

I was twelve weeks pregnant and nauseous, but excited. After two days of co-running a workshop in Mountain View, California, I had been handed an opportunity I couldn't resist, so I woke up at the crack of dawn and flew from San Jose to Denver to Boston to Zurich, and took multiple trains to Bavaria, Germany, determined to get to my destination: Ingolstadt.

Ingolstadt is a university town on the banks of the Danube River with beautiful red roofs and cobbled streets. It's famous for its nineteenth-century medical laboratory, where scientists and students performed experiments on dead pigs, inspiring Mary Shelley to situate a large part of her famous 1818 novel, *Frankenstein,* in this Bavarian city. But Frankenstein wasn't the reason I made the 5,800-mile trek. Ingolstadt also happens to be the home of Audi AG, the German luxury car manufacturer.

Audi had recently launched a research initiative to investigate societal questions around AI, autonomous vehicles, and the future of work, and I jumped at the invitation to attend a meeting in 2017, curious to know what was on their minds. By the time I made it to Audi's base of operations, fueled by adrenaline and excitement, my body was moving

into a new stage of pregnancy and my nausea was lifting (thankfully, as the catered buffet lunch in the room was a rich, pungent veal stroganoff on noodles). My visit included a tour of a factory floor where cars were made. It was a gray and cloudy day, and a bus picked us up outside the headquarters where the attendees had gathered and drove us through the drab and massive complex of buildings, dropping us off at a giant warehouse. I tossed my phone into a dirty rubber box in the hallway as instructed and followed our guide onto the factory floor.

In the factory, we marveled at massive cages encasing robotic arms that towered over our heads. The robots swung around and moved through their spaces in a fast, precise, and mesmerizing dance, sparks flying as they worked with the metal pieces that would eventually become cars. As we oohed and aahed over the spectacle, we gave barely any attention to the human workers who were stationed far away in another part of the room, doing something to the car bodies. The smooth operation of the robots seemed routine and almost boring to our guide, which was no surprise. Car companies have been working with caged robotic arms in their factories for decades. But the reason Audi had launched their new AI initiative was because the company knew that these factory robots, despite being an impressive display of high-quality German engineering, were not the robots of the future.

The world of robotics is changing. With increasing developments in sensing, visual processing, and mobility, robots are now able to move beyond their traditional caged existence in factories and warehouses and enter into new spaces—spaces that are currently occupied by humans. Companies like Audi are investing heavily in AI and robotics, not just in their factories but also in their cars. Robots are now being put to work inspecting our sewers, mopping our floors, delivering our burritos, and keeping our elderly relatives company. From our households to our workplaces, a revolution is coming. What does this mean for the people I saw working across the room in the car factory? According to some of the headlines, they aren't the only ones on the cusp of losing their jobs as robotic technology advances: we all are. Against the backdrop of broader economic and social anxiety, the conversation has turned from "Will robots replace me?" to "How soon will robots replace me?"

Many people are not thrilled by the anticipated robot takeover. Our

concerns are particularly centered on the idea of creating something like us, with humanlike agency, that will take our steering wheels and harm us or our children. Headlines paint a dystopia of robot brothels and robot-run restaurants and hotels, a world where robots take all human jobs, and where our nannies and boyfriends are replaced by machines. In Mary Shelley's story, Victor Frankenstein studies medicine in Ingolstadt and creates an autonomous, intelligent being that eventually turns against him. Along with the golem from Jewish folklore, Frankenstein's monster is considered an early story about robotics, despite being published more than a century before the word "robot" was coined. Science fiction writer Isaac Asimov would later describe a negative public attitude toward robots as "the Frankenstein complex." Today, a car manufacturer is grappling with a modern version of the narrative that originated in the same city, Ingolstadt, over two hundred years ago.

Is this fear justified? It certainly looks like we're trying to replace people with machines. In the fall of the same year I went to Ingolstadt, October 2017, Saudi Arabia granted a realistic-looking humanoid robot named Sophia Saudi Arabian citizenship. The announcement caused an uproar. A robot was being granted rights in a country that had barely announced (and not yet implemented) women's right to drive cars! I received a flurry of emails and phone calls, especially from reporters who wanted to explore whether robots deserved human rights. At this point, I was very pregnant and ignored most of them. I felt that "citizenship" for Sophia, a robot not nearly as advanced as people imagine, was basically a publicity stunt, but in usual fashion, when robots made the news, I received calls about the legal, social, and ethical issues involved. My own questions, however, centered on why this stunt generated so much attention in the first place.

My passion for robots and society goes back to when I was a law and economics grad student. While pursuing my studies, I met some students from robotics labs, started reading obscure robot ethics papers, and found myself arguing passionately with friends about robots, especially when I'd had a drink or two. I bought a baby dinosaur robot "pet" that I "adopted" (more on this in chapter 10). Thus began my pursuit of questions such as "What impact will increasing robotization have on

society?" It was the beginning of a completely different academic career than I had ever imagined for myself. For over a decade now, I've worked side by side with roboticists and applied my legal and social sciences background to the technology. I've researched literature, delved into human psychology, done experiments, and had conversations with people all over the globe.

It's clear to me that the idea of robots we are most familiar with comes from our science fiction. I've always loved science fiction. I grew up reading all the sci-fi I could find, from trashy pulp novels to great authors like Ursula Le Guin and Octavia Butler who opened my mind to new ways of thinking. But now that I work in robotics, I've also seen how our mainstream Western science-fictional portrayal of robots does the opposite. As technology critic Sara Watson points out, our stories, too often, compare robots to humans.

I believe that this human comparison limits us. It stirs confusion about the abilities of machines, stokes an exaggerated fear of losing human work, raises strange questions over how to assign responsibility for harm, and causes moral panic about our emotional attachments. But the main problem I have with our eagerness to compare robots to humans is that it gives rise to a false determinism. When we assume that robots will inevitably automate human jobs and replace friendships, we're not thinking creatively about how we design and use the technology, and we don't see the choices we have in shaping the broader systems around it.

This book offers a different analogy. It's one we're familiar with, and it's one that changes our conversations in surprisingly significant ways. Throughout history, we've used animals for work, weaponry, and companionship. Like robots, animals can sense, make their own decisions, act on the world, and learn. And like robots, animals perceive and engage with the world differently than humans. That's why, for millennia, we've relied on animals to help us do things we couldn't do alone. In using these autonomous, sometimes unpredictable agents, we have not replaced, but rather supplemented, our own relationships and skills.

We've domesticated oxen to plow our fields and learned to ride horseback, extending ourselves and our societies in new ways physically and economically. We've created pigeon delivery systems, set loose

flaming pigs to ward off elephant attacks, and trained dolphins to detect underwater mines. From the beginning of laws known to humankind, we've dealt with the question of responsibility when autonomous beasts cause harm, even putting animals themselves on trial for the crimes they committed. And we've also extended ourselves socially: throughout history, we've treated most animals as tools and products, but have also made some of them our friends.

Using animals to think about robots acknowledges our inherent tendency to project life onto this technology, something that has fascinated me for years. From the simple vacuum cleaner roaming around in our physical space, to dragonfly robots that flap their wings in a biologically realistic way, we respond viscerally to moving machines, even though we know that they aren't alive.

In comparing robots to animals, I'm not arguing that they are the same. Animals are alive and can feel, while robots suffer no differently than a kitchen blender. Animals are often more limited than robots—I can train Fido to retrieve a ball, but not to vacuum a floor—but they can also handle unanticipated situations more easily than any machine. The point is that this thought exercise lets us step out of the human comparison we're clinging to and imagine a different kind of agent.

In collecting some of the parallels in the past, present, and future of our relationships to both animals and robots, I've found that using animals to think through our most pressing concerns changes a lot of conversations. Just like animals, robots don't need to be a one-to-one replacement for our jobs or relationships. Instead, robots can enable us to work and love in new ways. Using a different comparison lets us examine how we can leverage different types of intelligences and skills to invent new practices, find new solutions, and explore new types of relationships—rather than re-creating what we already have. Setting aside our moral panic also helps us see some of the actual ethical and political issues we will be facing as we begin to live alongside these machines, from nonlinear economic disruption to emotional coercion.

This book begins with a contemporary exploration of how we are integrating robots into our spaces and systems, drawing parallels to how we've used animals in the past. In this first part, "Work, Weaponry, Responsibility," I pick up many familiar questions that are in the

foreground of our conversations about the future: Will robots replace our jobs? Is artificial superintelligence a threat? How do we assign responsibility for unanticipated robot behavior? What I want to illustrate is how much our perception of robots as quasi-humans (falsely) shapes those conversations, and that using an animal analogy leads us down a new path, one that doesn't force us to put productivity over humanity.

The second part of the book, "Companionship," moves slightly further into the future and explores emerging developments in robot companions. Social robots, while not yet widespread, are on the rise. These robots can't feel, but we feel for them, with people even mourning them when they "die." Here, our history with companion animals demystifies the human-replacement stigma around our emotional connections to robots. Recognizing our ability to form relationships with a wide variety of "others" helps us set aside moral panic, but also reveals some unresolved challenges with privacy, bias, and economic incentives that we need to pay closer attention to as we move ahead.

The third and final part of this book, "Violence, Empathy, and Rights," takes the animal analogy all the way into the very futuristic-sounding realm of robot rights. The humanlike machines in our science fiction stories have prompted conversations about our likely future treatment of robots. But looking at the convoluted path of Western animal rights provides a different prediction for how a robot rights movement would play out. Our history of relating to nonhumans shines a harsh and insightful light on how we choose which lives have value, revealing a new understanding of how we relate—not just to nonhumans but also to each other.

Historians and sociologists have long used animals to think about what it means to be human, but animals also have a lot to teach us about our relationship with robots. The robotic technologies that are increasingly woven into the fabric of our daily lives bring questions and choices that we, as societies, will face. This book is a compilation of those questions, those choices, gleaned from the fields of technology, law, psychology, and ethics, and set against a backdrop of our historical relationship with nonhumans, to try and make sense of what a future with this new breed means for us, and how we can shape it.

# AUTHOR'S NOTE

## WHAT IS A ROBOT, ANYWAY?

"Never ask a roboticist what a robot is."

—Illah Nourbakhsh, a roboticist

Here's a surprisingly tricky question that I get a lot: what is a robot?

We all sort of know what a robot is: the metal Maschinenmensch from the 1920s science fiction classic *Metropolis*; Rosie from *The Jetsons*; and beloved *Star Wars* heroes R2-D2 and C-3PO. My toddler gleefully exclaims "beep boop" upon encountering a robot, like the vintage metal windup toy in his grandfather's office and the robot vacuum cleaner that roams our floor. But he also says "beep boop" to our office printer when it lights up and spits out pieces of paper, and he doesn't think that our computers are robots. The lines that adults draw aren't any less arbitrary. When digital rights expert Camille François and I ran a workshop with a fairly tech-savvy group of colleagues, they struggled to define the term and identify which of their household devices was a robot. Is it a machine that can perform tasks on its own? The dishwasher can do that, and so can a desktop computer, but people hesitated to put them in the robot category on our whiteboard.

Our colleagues weren't being ignorant: the definition of robot is elusive. Coined in 1920 by Karel Čapek, the term "robot" (*robota* = forced labor in Czech) originates from his play titled *R.U.R.* (*Rossum's*

*Universal Robots*), a story about the exploitation of artificial people who are put to work as "robots" in factories and eventually rise up against their makers. Early on, we started to use "robot" to refer to technologies that replaced humans with machines, applying the term to anything from gyrocompasses to vending machines. Some people say that the definition of a robot is simply a machine that's new and unfamiliar to the general public, and that these robots become "dishwashers" and "automatic thermostats" once the novelty wears off.

Asking roboticists for a concrete definition doesn't help very much, either. Their answers tend to be more technical and narrowly defined, but still leave plenty of fuzzy edges. Most of them agree that a robot needs a body. Artificial intelligence has been a hot topic of discussion for the past few years, but this book is mainly about physical robots for reasons I'll elaborate on in chapter 4—their embodiment has some pretty unique effects.

Some roboticists say that a robot is a constructed system with mental and physical agency that's not "alive" in the biological sense. Others use a paradigm called "sense, think, act," which describes machines that can sense, make autonomous decisions, and act on their physical environments. This sounds pretty good, but it gets tricky when drilling down on what terms like "act" mean exactly. My smartphone has sensors, can make decisions, and act on its environment (by making sounds, displaying light, vibrating, etc.), yet many roboticists don't believe a smartphone is a robot.

Without a concise definition, how can anyone even begin to write a book about robots? I asked one of my most respected friends and mentors, law professor Jamie Boyle, and he responded: "If anyone insists you give them an essential definition of a robot, you tell them, 'Definitions don't work the way you think they do, dumbass'" (the latter word presumably being a term of art in the law). The idea that there could be a definition of anything is a philosophical mistake. Our language is community- and context-specific, something that University of Washington researchers Meg Young and Ryan Calo have demonstrated in the case of "robot": how you define it depends on the field you're in. And that's fine. In fact, the very purpose of this book is to challenge a singular view of robots.

The reason this challenge to our thinking is so important is that robots are unique in a specific way: unlike other new technologies, like a cryptocurrency that people may struggle to picture in their minds, we all have a vivid image of what a robot is. It's an image that's heavily influenced by science fiction and pop culture. This book questions that image, of robots as quasi-humans, and shows that it seeps into how we design and integrate real robots in our world. A lot of the framing here applies to our thinking on artificial intelligence more broadly. At the same time, the ideas here don't apply to every single physical device that could technically be defined as a robot. Instead of establishing perfect definitions and rules that universally apply to all thinking machines, this book encourages us to stretch our minds and question our underlying assumptions.

This exercise begins in Part I in the workplace, where we should be thinking of robots not as our replacements, but more creatively: as a partner in what we're trying to achieve.

# THE NEW BREED

# I

# WORK, WEAPONRY, RESPONSIBILITY

· 1 ·

# WORKERS TRAINED AND ENGINEERED

[Content warning for this chapter: animal cruelty]

> "We have used pigeons, not because the pigeon is an intelligent bird, but because it is a practical one and can be made into a machine, from all practical points of view."
>
> —B. F. Skinner

One of the most enjoyable experiences in Claire Spottiswoode's life was the first time she walked through the woods, letting a little bird lead her to honey. Spottiswoode is a zoologist at the University of Cambridge and the University of Cape Town. She's done extensive field research in the savannas of southern Africa, learning how the Yao villagers communicate with a bird called the honeyguide.

The honeyguide is one of the few avians that can digest wax. To access their food of choice, they have evolved to attract the attention of humans, then lead them to beehives. Once people have harvested the sweet, golden honey, the honeyguide gobbles up the exposed comb and grubs. The birds and humans form a perfect team: the honeyguides are far better at finding beehives, which are often located high in the trees, but they need human help to open them.

The honeyguide-human collaboration goes back to at least the 1500s, but some zoologists think that we've searched for beehives together for closer to 1.9 million years. Honeyguides aren't the only animals that

we've partnered with—we've harnessed animals' unique skills to help us with tasks for millennia. Some, like the honeyguide, have evolved in a way that happens to be useful to people, and others have been intentionally domesticated and bred to live and work with us, their entire genetic lineages changed in the process.

The reason we've partnered with animals is not because they do what humans do. We've partnered with them because their skills are different from ours, and because we have much more to gain from combining their strengths with our own. In the same way, technology can and should be a supplement to our own abilities, a way to find the honey we could never reach alone. But this is not how we currently think about robots.

One muggy midsummer day, I stood outside the Baltimore/Washington airport and summoned a ride from the Lyft app on my phone. An older-generation red Prius pulled up nearly immediately and I slid into the back seat, relieved that, despite my delayed flight, I was going to make it to my destination with a few minutes to spare. We cruised down the highway toward Baltimore. My driver, Debbie, was listening to an R&B station, but turned down the volume once the music

switched to advertisements so that we could chat. When I told her what I did, she asked the question I've discussed with nearly every driver I've taken a ride with in countless cities and countries over the past ten years: "How long will it take before I'm replaced by a robot?" We spent the next twenty minutes talking about robots and jobs. Debbie, who was close to retirement age, said that she had heard on the news that all human work would be replaced by robots. She was hopeful she could drive for a few more years and retire before it happened, but she was worried for her grandchildren. Suddenly, Debbie realized that the navigation system had failed and we had gone fifteen minutes out of our way. I wound up being late for my panel, but I was glad that Debbie and I had time to chat.

With a big surge of interest in artificial intelligence and robotics in the past few years, the press is eagerly speculating about our future with robots, with headlines like "Will Robots Steal Your Job?," "The Robots Are Coming, Prepare for Trouble," and "Welcome, Robot Overlords. Please Don't Fire Us?" In 2013, a widely promoted University of Oxford study predicted that almost half of all employment in the United States was at high risk of being replaced by robots and AI within ten to twenty years, and others have predicted even greater vulnerability. Technology is advancing at a breathtaking pace, they say. And robots, the story goes, will soon be able to do everything that humans do, while never tiring, never complaining, and working twenty-four hours a day. A 2017 Pew Research study showed that 77 percent of Americans think that during their lifetime, robots and AI will be able to do many of the jobs currently done by humans. According to Pew surveyor Aaron Smith, most people "are not incredibly excited about machines taking over those responsibilities."

Not only are we on the cusp of the robot job takeover, say the headlines; some believe the robots will take over more than our jobs. Artificial intelligence, they claim, is on the threshold of outsmarting us. Respected thinkers have raised concerns about artificial superintelligence, predicting that robots could outpace human intelligence and wreak havoc on the world. From Stephen Hawking to Elon Musk, these high-profile individuals have sounded the alarm on what they view as the greatest threat to humanity, fanning the flames of latent fears. It's

easy for people to get on board with the robot takeover narrative, at least in the West. After all, most of our mainstream science-fictional portrayal of robots has been around precisely this topic, from *2001: A Space Odyssey* to *Ex Machina*.

New technologies often inspire concern, but perhaps not quite in the same way as robots. According to tech philosophy and ethics scholars Peter Asaro and Wendell Wallach, our robot narratives throughout history are about good robots turning evil, either turning against their genius creators, like Frankenstein's monster, or turning against human civilization at large. Is this because robots inherently pose this threat? It's worth noting that this fear seems culturally specific. Karel Čapek's famous 1920s play about the uprising of robot factory workers was performed in both Western countries and Japan. But while the West embraced its negative messages in our robot narratives, Japan gravitated toward friendlier robot portrayals in popular culture, like the famous cartoon *Astro Boy*. In the 1960s, Japan began to view robots as a potential driver of productivity and growth, and when robotics played a big role in Japan's economic revival, it inspired a positive image of robots as nonthreatening and helpful to humans.

Many of my colleagues in robotics are weary of the Western trope that the robots will take all the jobs and become our overlords. The news media often reports on their work in ways that are clickbaity and alarmist, complete with an obligatory picture of the Terminator. I've heard curse words directed at the public intellectuals who extol the dangers of robot takeovers, and complaints that the big-name alarmists are mostly physicists, philosophers, and CEOs who don't have in-depth knowledge of artificial intelligence or robotics. But the Cassandras tend to shoot back that the people who actually work in the field aren't the best judges of broader trends. One night at a conference, I watched Sam Harris, a writer and philosopher with a degree in neuroscience, get on a small stage in front of about a hundred roboticists from some of the top research centers in the world and argue that artificial superintelligence was a significant and likely danger to humanity, and that the technologists who disagreed weren't able to see the forest from their position among the trees. The ensuing uproar was monumental.

I was still thinking about his words the next day, as I rested my head

against the back of my seat in a fancy black car driving smoothly down the empty early morning highway toward the airport. "What do you think about self-driving cars?" I asked the young, clean-shaven driver in a black suit and tie. He kept his eyes on the road. He told me that he had gone through a year of training to be a professional black-car driver, a lot of which was about more than just driving. He said he was trained to handle unanticipated situations, like protecting his passengers from attacks or violence, and that, if we got into an accident, his first aid skills could save my life. He asked me, solemnly: "Can a robot car do CPR?"

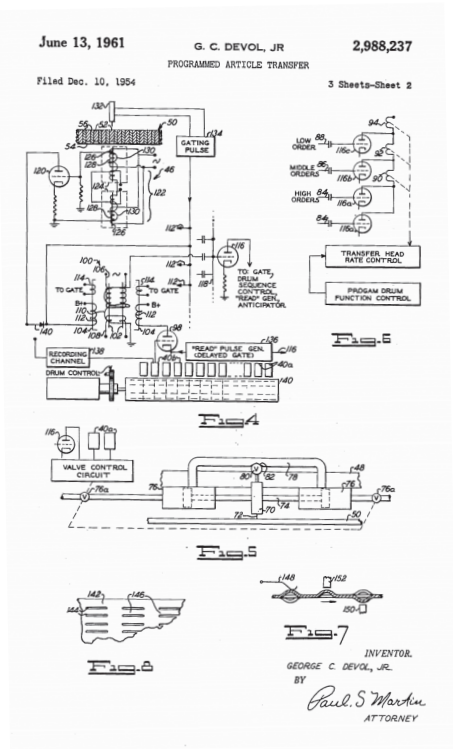
## DIRTY, DULL, DANGEROUS

It's not that robots aren't capable or smart—like animals, their physical and sensory abilities are often better than ours. But before I get into the animal world, I want to put the current state of robotics into perspective. Because it's important to understand that robot abilities differ from human abilities in significant ways.

The first practical robot we put to work was a robotic arm called Unimate. Devised by inventor George Devol in the 1950s, Unimate was set up at General Motors in New Jersey to maneuver the blistering hot die-cast car parts that were dangerous for workers to handle. This factory arm was the ancestor of industrial robotics, the technology still used in manufacturing today, and it defined how we would come to view the function of robots in industrial settings.

Robots have classically been delegated jobs that qualify as one of the three Ds: tasks that are dirty, dull, or dangerous for humans. Industrial robots like Unimate ushered in a shift toward automating certain tasks that were high risk or required repetitive grunt work. The machines were accurate, and incredibly strong. Robots could do heavy lifting and take over difficult work in areas with toxic fumes or other health hazards. But they were also fairly crude and limited to very specific tasks, and they themselves were dangerous machinery to be around, necessitating cages and other safety measures to keep humans away.

After the success of welding car parts, the market for industrial robots exploded, as did innovation around what else we could use robots to do. Companies started exploring using industrial robots for tasks like




Figures from George Devol's patent on the first robot arm, filed in 1954

packaging, palletizing, basic transport, and loading. Farming industries also got in on the action. On today's farms, agriculture robots spray crops, plant seeds, pull weeds, and even deal with the delicate job of picking fruit. After robots permeated our industrial world, it wasn't long before they made their way into other workplaces.

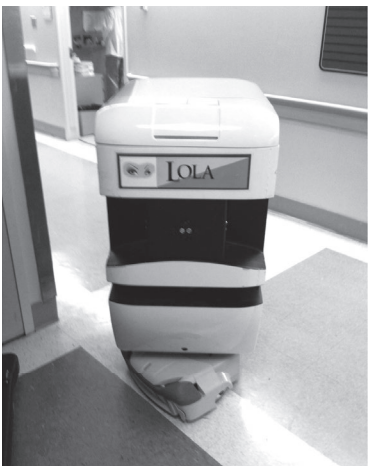
Straight out of high school, I wanted to work in software development. I interned with a Swiss company, at the time the main IT services arm of a bank, and was delighted with how much the experience matched every pop culture parody of corporate office life. There were lots of lunches and coffee breaks. Nobody seemed to be able to properly explain what the company did, or how their role fit into its larger

mission. But my favorite part was the robot. The company had invested in a modern art piece: a robotic office copy machine that was designed to wander the halls, randomly creating and spitting out copies of nothing. I only got to see it once, because, sadly, it wasn't able to recognize stairs and eventually fell down them.

Having a robot in the office was a novelty, but not completely new: beginning in the 1970s, mail delivery robots called mailmobiles were used in office buildings, the first one in Chicago's Sears Tower. The 600-pound, 4 × 6 × 2–foot rectangular robots would move slowly through the halls, ringing a bell as they read barcodes on the floor so that people knew to come collect their mail. (Many FBI offices also used them, as some will recognize from the TV show *The Americans*.) These robots, which weren't phased out until 2016, would beep to alert staffers to their presence, but would often run into people or pin them against the wall. They would get stuck, bump into things, and needed frequent repair.

The technology has improved since the 1970s. Delivery carts shaped like rectangular boxes rumble around hospitals, bringing medicine and other items from room to room. Some hotels have room service robots that can deliver meals, ice, and other necessities to hotel guests, allowing for greater privacy. These robots are able to navigate fairly well-defined spaces and avoid obstacles, stopping or going around people and things instead of bumping into them.

Nowadays, the applications for robots go beyond the three Ds. Robots don't just hold that blistering hot factory part or drill. They are entering our workplaces, households, and public spaces. After the long-unfulfilled promise of widespread robot lawn mowers in the late 1960s, robots are now able to help homeowners cut lawns, as well as vacuum and mop their floors. The machines perform laparoscopic surgery and assist with bone implants, take inventory in stores, and dispense medication in pharmacies. Security robots patrol parking lots, and our military weapons can aim themselves. We're robotizing cars, ships, trucks, planes, trains, and submarines. We already have robots that can drive, mix cocktails, milk cows, and hit ten out of ten free throws. But even though it seems that we're about to be made obsolete, we tend to underestimate our comparative advantages as humans.


Two hospital delivery robots whose sexy nurse names, Roxie and Lola, made me roll my eyes so hard they almost fell out (2012)

## HUMANS ARE UNDERRATED

When I first set foot on MIT's campus in 2011, I was eager to see the cutting-edge work being done in robotics. It was fall, and people had returned from summer break ready to do research and present their work. But while everyone was happy to tell me what experiments they were running and explain all the technology they were using, my requests to see demos were mostly denied. "We can only turn this robot on for testing," they would say, or "these are all broken right now, but we can show you a video." Some of the more well-known robots that I had been excited to finally see in person had been out of order for so long that the only graduate students who knew how to repair them had long left the Institute, taking their knowledge with them. While industrial factory arms and newer commercial robots are more robust, this sobering vision of robotics at MIT isn't uncommon.

It's no wonder my colleagues, who work for months to get a simple demo to function, roll their eyes at the worry that robots will replace us. The reality is that we are in the process of creating a huge range of different types of robots. These robots, while a far cry from our