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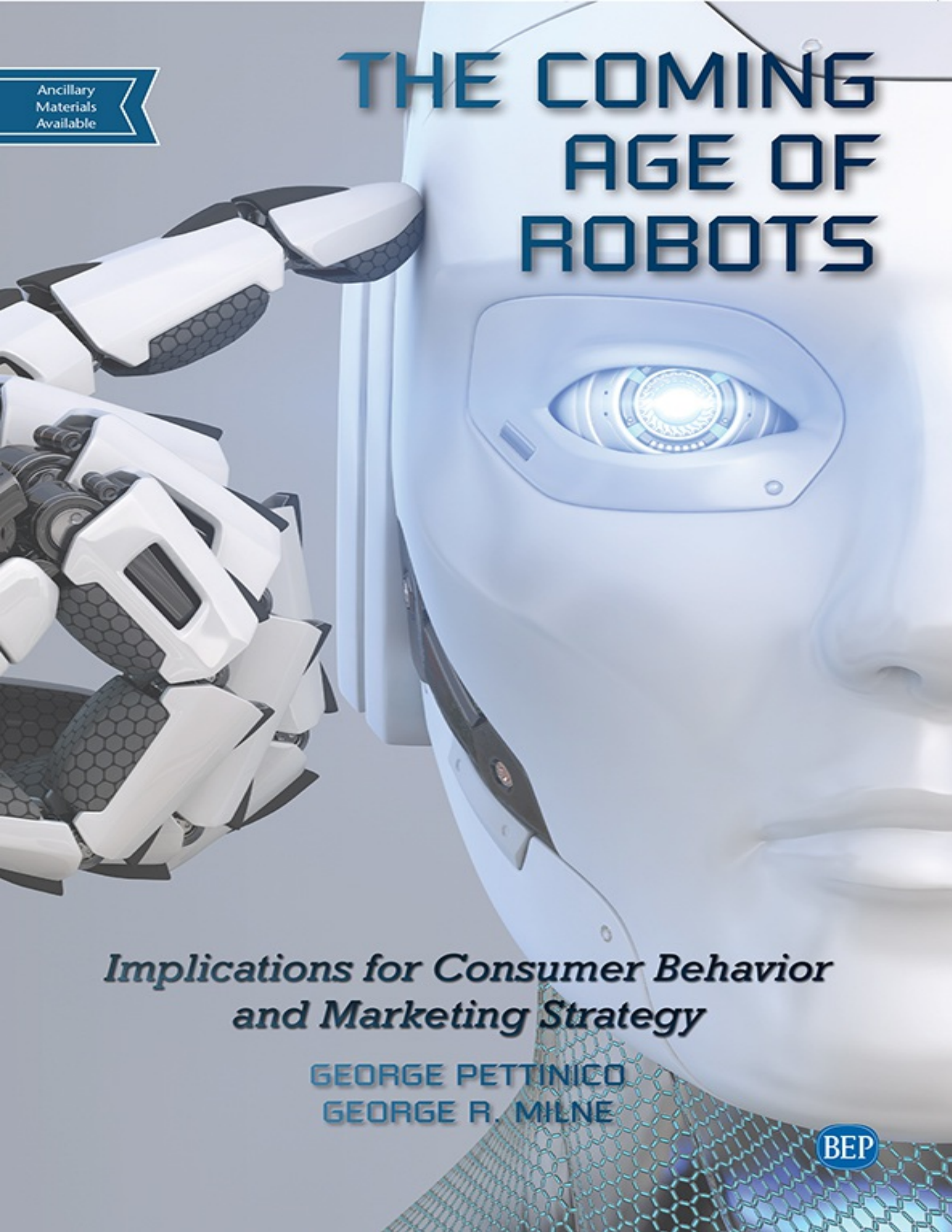
THE COMING AGE OF ROBOTS



Implications for Consumer Behavior and Marketing Strategy

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BEP

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The Coming Age of Robots

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Implications for Consumer Behavior and Marketing Strategy

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Dedication

To Sandy, William, and Andrea
To Shalini, Patrick, Courtney, and Ankrish

Abstract

Over the next 20 years, the presence of robots will dramatically increase in our daily lives. Unlike the first wave of automation, which took place deep inside factories and warehouses, this next wave will be up close and personal. Eventually, we will have robots in our homes, schools, stores, hotels, restaurants, hospitals, city streets … pretty much everywhere. They will serve as maids, gardeners, companions, waiters, security guards, journalists, nurses, teachers, playmates, receptionists, chauffeurs, soldiers, and prostitutes. And that is just a few of the roles robots will assume. These robots will be intelligent, autonomous, communicative, emotional, and will continually progress in their abilities. Ready or not, it's coming. And sooner than you might think.

This book describes what we can expect in terms of robot advances over the next two decades, particularly in the area of human-interactive robots. We provide an in-depth look at how American consumers will react to this dramatic social, economic, and marketplace revolution. Our insights come from national surveys we conducted with over 2,700 Americans, as well as a thorough review of existing academic research and expert predictions. We provide suggestions for acceptable robot roles, robot design, and the optimal marketplace approaches to successful human-robot interactions and, yes, even successful human-robot bonding. This book provides valuable insights for

robot manufacturers, companies considering using robots in consumer-facing roles and for consumers themselves who will be increasingly interacting with robots in their everyday lives. If you want to understand our future, you need to understand robots.

Keywords

robots; robotics; artificial intelligence; affective computing; androids; consumer behavior; marketing; customer service

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Preface

A robot revolution is coming, and it is going to have a massive impact on all of us.

Over the next couple of decades, the presence of robots will dramatically increase in our daily lives. This is not a science fiction story. This is a hard-nosed prediction voiced by the roboticists, artificial intelligence (AI) developers, and others who are working tirelessly to create this future. Robots have already revolutionized factories and warehouses. But that robot revolution, while displacing millions of workers and revamping the labor force, remained mainly hidden from everyday view. The upcoming robot revolution will be much more up-close-and-personal. Robots will soon become a highly visible feature in the daily lives of the average consumer.

The expectation is that over the next two decades, robots will significantly increase their presence in our homes, doing many of our chores for us. They will become companions to the elderly. They will babysit and play with our children. They will be the receptionists who greet us in office buildings. They will bring us our room service in hotels. In stores, they will help us find the products we are looking for. They will also serve as waiters, bartenders, security guards, journalists, nurses, phlebotomists, teachers, chauffeurs, soldiers, and prostitutes. And those are just

some of the roles robots will assume. Many of these robots, driven by remarkable advances in artificial intelligence, will be quite smart. They will recognize us by name when we come home from work. They will have conversations with us. They will sense our emotions and appropriately react to them. They will have their own unique personalities. Some will retain a distinctly mechanical look, while others will look more human. For the past several generations, society has been through dramatic technological changes that have transformed how we live. However, the coming robot revolution will lead to social and economic changes unlike anything we have seen before.

The very early stages of this revolution are already visible. Many of you reading this have by now noticed robots cruising around your local Walmart and/or grocery store, looking for spills in the aisles or checking inventory. Some of you may have already stayed at a hotel where your room service was delivered by a robot. Some of you may have noticed the supply delivery robots scurrying around the floors of large hospitals. If any of you were in China or Japan, you may have watched a humanlike robot delivering the news on television. Or, you may have seen another very humanlike robot named Sophia making the rounds on talk shows, having spontaneous conversations with the hosts.

This book describes what we can expect in terms of robot advances over the next 20 years. Our focus in writing this book, however, is to examine the human side of the equation, namely, how people are likely to react to the coming robot revolution. To do this, we conducted several national surveys, involving over 2,700 adult Americans. We also conducted in-depth, in-person

interviews with dozens more, to dig even deeper. In addition, we scoured academic journals, magazines, and conference proceedings that also studied potential human responses to the coming robot revolution. As far as we can tell, this is the first book that puts all this information together to offer a complete picture of the likely human reaction to our swiftly approaching robot future. As two marketing professors, we look at this issue via a consumer framework. Throughout the book, we offer insights on the impact of this robot revolution on consumer behavior, customer service, and marketing strategy.

In Chapter 1, we describe the general expectations for the coming robot future. In Chapter 2, we explore the impact on consumer perceptions of robot portrayals in the entertainment media, as well as the first generation consumer-facing robots in the marketplace and how they might be impacting current public views. In Chapter 3, we discuss the fundamental hopes and fears people have regarding a growing role for robots. In Chapter 4, we distinguish between the roles consumers will easily and will not so easily accept robots playing in their lives, in the marketplace, and in their communities. Chapter 5 does the same, though focusing exclusively on the health care industry (likely the "tip of the spear" for the robot revolution). Chapter 6 examines consumer reactions to different physical designs for robots. Chapter 7 dives deeper into the various factors that will help promote or hinder the development of meaningful relationships between humans and robots. Chapter 8 profiles several key robot manufacturers and their plans for the future. Finally, Chapter 9 provides concluding remarks, offering guidance (our Five Laws

of Consumer-Robot Interactions) to companies making and planning to use robots in customer-facing roles.

Writing this book was great fun, but also a great amount of work. Luckily, we had a fantastic team helping us out. William Pettinico, PhD student of Economics at the University of New Hampshire, assisted with secondary research and analysis of qualitative interviews. Kaeun Kim and Smriti Kumar, PhD students of Marketing at the University of Massachusetts, Amherst, assisted with fielding the national surveys. We are deeply grateful for their hard work and critical insights that have significantly enhanced this book.

We hope you find this book an enjoyable read. We believe a lot of what you encounter in this book will excite you. Some of it will surprise you. And some of it just might scare you.

CHAPTER 1

The Dawning Robot Revolution

Robots will soon be everywhere.

—Hanson Robotics webpage (www.hansonrobotics.com)

Chapter Overview

A robot revolution is coming sooner than many of us think. This revolution will take place over the next two decades, when companies will deploy enormous numbers of human-interactive robots in a wide variety of consumer-facing roles. Robots will assume roles such as delivering room service in hotels, providing security in malls, assisting shoppers in stores, helping care for patients in hospitals, serving as sex workers, among thousands of other uses. Robots will also be sold to consumers to work in their homes as maids, gardeners, playmates for children, and companions for older adults. The very beginnings of the robot revolution have already started, though, to paraphrase an old expression, "We ain't seen nothing yet." Over the next two decades these robots will become increasingly intelligent and autonomous, driven by continuing advances in artificial

intelligence. They will eventually be able to perform just about any task a person could do. The coming robot revolution will be unlike any other technological revolution the human race has yet experienced.

Defining Robots and the Current State of Affairs

As we complete this book in early 2020, humanity is at the cusp of a momentous robotics revolution. It is a revolution that will eventually impact just about every aspect of our lives. We can think of this as Phase Two of a transformative process that has already begun. Phase One, with roots going back to the 1970s, converted factories and warehouses from places that once teemed with human workers to environments that are now generally dominated by robotic devices that manufacture our products and move around our inventory. As significant as Phase One of the robotics revolution was, it will pale in comparison to the emerging Phase Two. Phase One took place generally behind the scenes, deep inside factories and warehouses. Phase Two of the robotics revolution will be far more dramatic, because this is when robots will: (a) become smarter and more interactive (driven by remarkable advances in artificial intelligence); and (b) occupy a closer proximity to us, moving into our homes, our schools, our hospitals, our communities, our white collar workplaces, our stores, our vacation destinations, pretty much everywhere we spend time. Over the next couple of decades, robots will make their way into our lives in increasingly large numbers and our world will never be the same again.

First, a definition—we define robots as *intelligent devices that have a degree of self-direction*. There are three important components to this definition (*intelligent*, *devices* and *self-direction*) worthy of further explanation. By *intelligent* we mean that they have some awareness of their surroundings, with the ability to continually learn and adapt so that they can interact with the world around them. With these capabilities, robots will walk up stairs, run down a crowded sidewalk without bumping into anything, and even drive fast-moving cars. For more advanced robots, this will include the ability to interact with humans—to recognize our voices and faces, to have substantive conversations with us, and to interpret our emotions. In this way, robots will act as pets, companions, and even friends. By *devices* we mean there is a physical presence, something to look at, touch, and feel. Finally, s*elf-direction* implies they have a degree of autonomy, meaning they can make their own decisions without anyone at their controls. They will be governed by self-learning, artificial-intelligence algorithms.

The process has already begun. Robots created as of early 2020 are fairly advanced in their intelligence and self-direction. Yet, they are infantile compared to what is to come in 5, 10, and certainly 20 years. Consider the following robots that are already among us:

- Large grocery store chains such as Giant Food and Stop and Shop have robots that cruise the aisles looking for spills and other hazards. Walmart recently bought 300 robots that can serve as janitors, autonomously cleaning

their stores while shoppers are buzzing about all around them.

- Knightscope, Inc. has created a fleet of 4.5 to 6-foot tall rolling security robots (named K1, K3, K5, and K7) that patrol parking lots, office compounds, universities, and city streets. Resembling metallic cylinders with pointed tops, they navigate the terrain on their own, and use a complex set of video cameras, thermal imaging sensors, laser range finders, and radar to see better than a human could. They have visual technology that can recognize faces and read license plates, along with sensors to detect the presence of wireless devices. These (currently) unarmed robots were created to be on constant look out for crime or other anomalies and report it to human police and security. They have been referred to as *a cuter, less aggressive Terminator* (Williams 2013).
- Amazon has a prototype delivery robot named Scout, which looks like a large box on wheels, and which can navigate around our neighborhoods, move down sidewalks, and deliver packages right to our front doors. Rather than waving to your friendly UPS delivery person, soon you will get your packages from an autonomous robot.
- Indoor delivery is something robots can already do fairly well. Many hotels have robots that deliver room service. Some perform a small song and dance routine after delivery as their version of a “thank you.” Countless

hospitals already have delivery robots that autonomously buzz about their floors delivering food and supplies.

- Current social robots can carry on conversations. Hilton Hotels has experimented with an interactive robot concierge named Connie, who can perform the basic functions of a hotel concierge (such as answer questions about what to do in the area and recommend good restaurants). A humanoid robot named Pepper, created by Softbank Robotics, has a cute and friendly face, and is able to recognize and react to human emotions. Pepper is only one of many robots currently sold or in development to serve as companion robots. Walker from UBTech is another. They have the ability to recognize faces, carry on conversations and, while still early in this technology, can interpret and respond to emotions.
- Self-driving cars are essentially car-shaped robots that think for themselves while interacting with a complex environment. Numerous car companies are currently investing heavily in this technology, with prototypes already on the road.
- Perhaps the closest thing we currently have to Rosie the robot maid (from the 1960s futuristic television show *The Jetsons*) is the Care-o-bot 4 from the Fraunhofer Institute in Germany. It can roll around the house on its own, retrieve objects with its hands and arms, and carry on a conversation with its human housemates. And its face conveniently turns into an interactive computer

console when needed.

- Boston Dynamics has created robots that can run through the varied terrain of a forest or urban setting. Some of these are four legged and resemble large animals, while others are humanoid in shape, such as their Atlas Robot.
- A conversant, humanlike robot named Sophia, made by Hanson Robotics, has made the rounds of television shows having truly interactive conversations with TV show hosts. Sophia is considered among the most advanced robots ever made.

See Figure 1.1 for selected robots discussed in the preceding text.

See More Robots

Here we have provided URLs for additional images and videos of the robots mentioned in the preceding text:

- Grocery store robots: www.popularmechanics.com/technology/robots/a25896081/marty-giant-robot-grocery-stores/
- Walmart's janitor robots: www.popularmechanics.com/technology/robots/a25428388/walmart-cleaning-robots/
- Amazon's Scout delivery robot:

www.wired.com/story/amazon-new-delivery-robot-scout

- Connie the robot concierge: www.youtube.com/watch?v=ghbS-aTYw14
- Pepper the interactive robot: www.softbankrobotics.com/emea/en/pepper; www.youtube.com/watch?v=eZGSsLq28vY
- Boston Dynamics' Atlas robot: www.bostondynamics.com/atlas
- Sophia, the android robot: https://www.hansonrobotics.com/sophia/

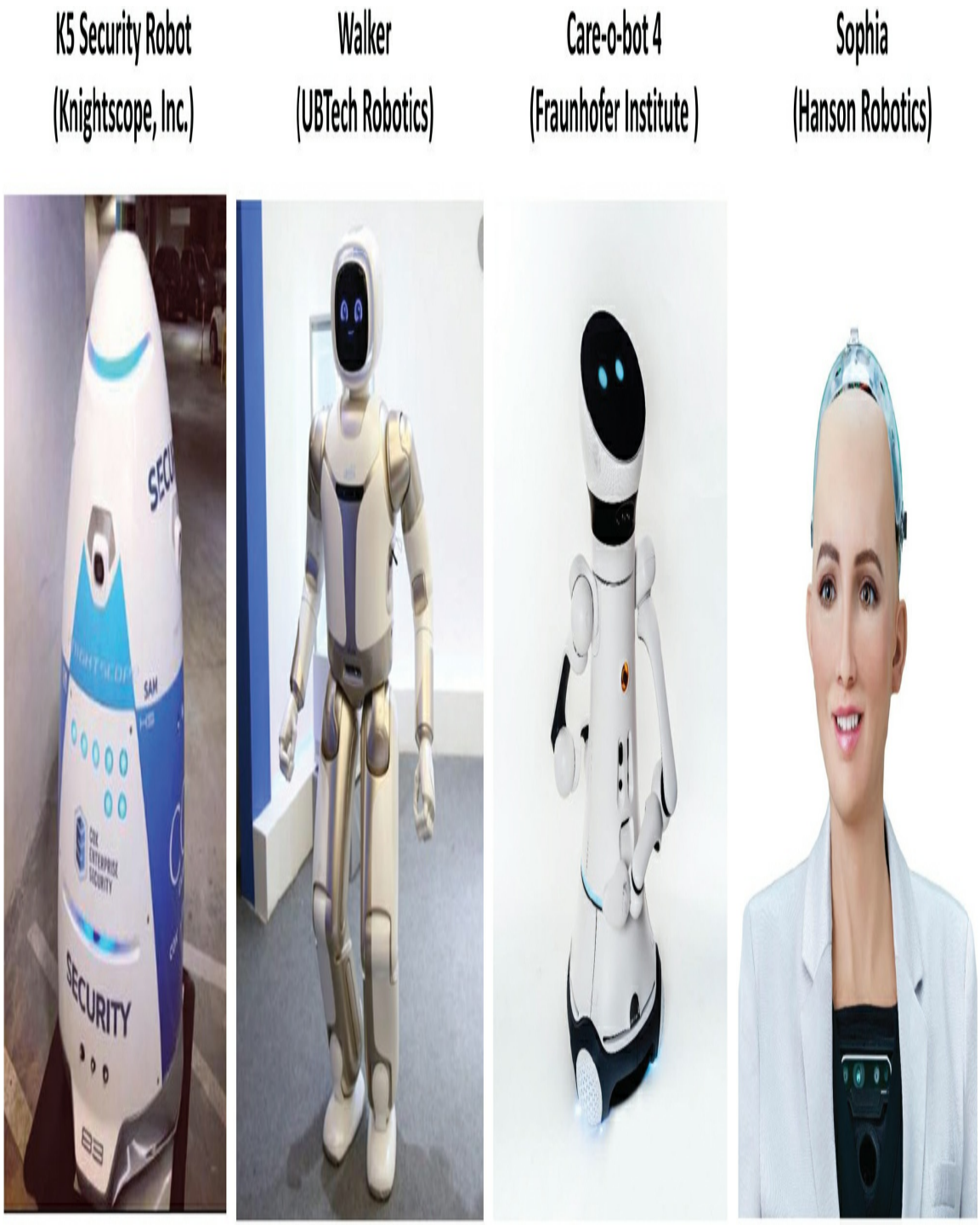

Figure 1.1 Robots already among us

As these examples suggest, the robots being developed to interact with humans in our daily lives (commonly referred to as

social robots) are coming in a wide variety of shapes and sizes. Some are only a couple of feet tall or less, some are human-sized, some are car-sized. Some are made to look more humanoid, while others retain a purely mechanical look. Some have a more cute appearance (large eyes, infantile look) while others have a more severe appearance (we would not want to encounter the Atlas robot in a dark alley).

Quick Look at What Is to Come

Experts predict that over the next couple of decades, social robots will become commonplace in advanced economies such as the United States, Europe, China, and Japan. They will become an integral part of just about every aspect of our lives (Smith and Anderson 2014). Some of the predictions supported by mainstream futurists include:

- **In our homes:** Many homes will have robotic servants that cook, clean, and garden. Current robotic vacuum cleaners and lawn mowers from iRobot are the start of this trend. However, in the near future they will evolve and be able to dust furniture, cook our meals, plant flowers—and change their task priorities based on our verbal commands or their own assessment of household needs. They may not, in the short term, be up to the level of *The Jetsons'* robot maid Rosie, but things are moving in that direction. Beyond housekeeping, robots will also play with and babysit our children. Robots will also serve

as companions for adults, particularly those who are disabled, elderly, or live alone. They will play games with us, converse with us, and never get tired of us complaining about our day (Rouhiainen 2018).

- **In hotels and restaurants:** Hotels will increasingly have robots to check us in, deliver our room service, and tell us about the best restaurants, bars, and night spots in town, as any quality concierge would. Restaurants will employ robotic hosts, wait staff, bartenders, and cooks. In the not-too-distant future, we might spend a weekend at a hotel and interact with very few, if any, human employees (Rigie 2018; Trejos 2016; Hospitality Technology 2017).
- **In hospitals and senior centers:** Hospitals will have robots that bring our food, help us bathe, draw our blood, administer medical exams, and even perform operations. In senior centers, robots will deliver daily care such as assistance for using the bathroom, as well as help with personal grooming and dressing. Robots will help seniors go for walks outside, and even assist them with errands around town. They will also serve as companions to the elderly and other homebound individuals by conversing with them, playing games, and listening to their life stories (Medical Futurist 2016, 2018; Moise 2018). Health care is a labor-intensive industry, with round-the-clock staffing needs. Hence, it is an industry investing significantly in robotic technology.

- **In schools and daycare:** Robots will assist teachers in the classroom, helping students in one-on-one and group settings. They may eventually become teachers themselves. As in a person's home, in daycare, robots will serve as babysitters and playmates for children (Rouhiainen 2018).
- **In our sex lives:** Simplistic robotic sex dolls have already gained a following. In a few years, far more advanced robotic models capable of mobility and greater humanlike interactions will capture the attention of even more customers (Morris 2018). Surprising numbers of people, particularly men, express openness to this type of encounter (more on this later).
- **In stores:** Robots will help us find the products we are looking for while shopping in stores, and tell us if the pair of pants and shirts we want to buy matches—the latter being a service at least one of the authors would greatly appreciate. They will serve as cashiers, security guards, and potentially even as store managers (Matthews 2018).
- **On our streets:** Robotic vehicles will cruise our streets, driving us around and also driving our trucks and delivery vehicles (Rouhiainen 2018). They may eventually serve as crossing guards, traffic directors, and police officers.
- **On the battlefield:** Robots will work with soldiers in battle zones, searching for IEDs, clearing land mines and potentially even fighting enemies alongside, or in place

of, human soldiers (Bachman 2018).

The list of how robots will interact with us in our daily lives is endless. As with any significant trend, these changes will not happen all at once. Some of these changes will come to fruition within 5 years, while other predictions may take 20 years or a bit longer. Some of the scenarios discussed in the foregoing text could be generations away. However, experts in the fields of robotics and artificial intelligence believe this is the irreversible course that we are on, that robots will eventually have all these capabilities. There are tremendous economic, demographic, and social factors driving the increased usage of robots for all the tasks mentioned here.

That said, this will not be a straight line progression. There will be ups and downs in the production and usage of robots. Not every robot that is introduced to the market will be successful. Between 2017 and 2019, we have witnessed a string of social and at-home robot launches that have been failures due to lack of consumer demand (the Jibo, Kuri, and Cozmo robots to name a few—all of which will be discussed later in the book). For robots to be successful, they will have to prove their worth in the tasks they can do for us, or in the entertainment, social interaction, or personal fulfillment they provide.

Japan is on the cutting edge of the robotics revolution, due mainly to their aging society and lack of immigrants (Holodny 2016). Simply put, the Japanese need robots to perform many of their daily tasks because with each passing year they have fewer working-age humans to do them. In the United States, we can

expect to see the incorporation of home-based robots first in the homes of wealthier members of society, most likely starting with Silicon Valley “techno-elites” and spreading to early adopters of technology in major metro areas. Robots will eventually filter down into the homes of middle class Americans, as prices are reduced. Before that, the average American will likely first encounter human-interactive robots in institutions such as hospitals, hotels, office buildings, and large stores.

A robot revolution is dawning; a revolution that will put intelligent and autonomous robots in close proximity with humans. Hence, now is the appropriate time to ask: How will people react to this significant social change—a change of the kind that has never before faced humanity? We approach these questions from a consumer point of view. It is in their role as consumers that individuals will decide whether or not they want to buy robots to assist them in their homes, and what tasks they do and do not want robots to do in their lives. It is in their role as consumers that people will decide whether or not they enjoy interacting with robotic room servants and concierges while staying at a hotel or whether or not they select a senior care center based on the presence of robots at the facility. Businesses need to quickly come to terms with the reality that how they design, introduce, use, and communicate about the robots they are deploying in consumer-facing environments will play a significant role in how consumers view their companies and brands.

Plan for the Book

In this book, we explore, and answer, the following questions:

- **Robot roles:** What activities will consumers readily allow robots to undertake in their lives and, conversely, what activities will they be more hesitant to turn over to them? We will look at situations in the home and in various service environments, such as hotels, restaurants, schools, hospitals, and assisted living facilities. Are consumers comfortable having robots cook their food, but perhaps not perform surgery on them? How about babysit their children?
- **Robot appearance**: How do we want our robots to look? Talk? Act? Should they mimic humans as much as possible, as in the replicates of the *Blade Runner* films? Or, should they remain distinctly mechanical, as in *Star War*'s R2D2? What aspects of robot design and behavior will make consumers more or less comfortable interacting with them? We will look at the role of cuteness in robot design, as well as the robot's ability to gesture with its eyes, head, and hands—all of which are, in fact, quite important to fostering human trust and willingness to interact.
- **Human-robot interactions:** How can we best conceptualize the manner in which humans will interact with robots? Will we treat them more akin to tools, like we currently do with our computers? Will we interact with robots similar to how we interact with our pets—

with affection and friendship, but thinking they are intellectually inferior to us? Or, will we treat robots as human? As equals? Will this depend on the robot itself—in terms of its appearance and role? We will explore many aspects of this, including the robot's ability to recognize individuals, read emotions, convey a personality and maintain a distinct persona—all of which are important to fostering human interactions and bonding.

- **Differences by consumer segments:** Which segments of consumers are the most open to interacting with robots? And which are the least? We propose and examine four attitudinal segments based on their openness to the robot future: Scaredy Cats, Ostriches, Open-minded Realists and Not on My Radar. We also look at attitudinal differences by age, with younger individuals expressing more optimism about the robot future and show more willingness to utilize and interact with robots than do their older counterparts.
- **General hopes and fears:** Taking a step back from specific daily situations, we will explore more generally what hopes and fears people have about the coming robot future. What gives people the most hope and, conversely, the most fear when they think about the coming advancements in robot technology? In terms of hope, do people foresee a *Jetsons*-like future where robots happily do all our daily chores for us so we have far more leisure

time? In terms of fears, are people mainly worried about the potential economic impacts, such as job loss? Or, are their anxieties more existential, such as the fear that robots will eventually take over society and enslave or even exterminate humanity (a *Terminator*-like future)?

We explored these questions via a series of nationwide online surveys that were conducted in the United States, involving over 2,700 adult consumers. We also conducted dozens of in-depth, in-person qualitative interviews lasting an hour or more each. In addition to our own research, we incorporate findings and insights from existing studies and expert commentary on the topic of robots and their interaction with humans. These secondary findings come from published academic studies, opinion surveys, press coverage, and the comments of experts from leading worldwide institutions such as MIT, Stanford University, and Oxford University.

From all of this work, we find a great deal of consumer excitement about the possibilities of robot advancement, but also a significant amount of concern. Most consumers have a fairly complex view of robots, with clear ideas about what roles are acceptable and not acceptable, as well as with which robot designs they are most comfortable. How consumers will interact with robots will vary based on the cues they receive from the robots themselves. For companies planning to utilize customer-facing robots, our research provides clear guidelines for what robot activities they should start with, versus what activities it may take a while (perhaps quite a while) for humans to trust

robots to perform. Our research also provides insights for designing the appearance and personality of robots in a manner that will make them more acceptable to consumers.

The robot revolution is imminent. Let us understand how humans will react: what is going to work well, and what is going to lead to trouble.

CHAPTER 2

Robot Exposure: In the Media and In Our Midst

We are fascinated with robots because they are reflections of ourselves.

—Ken Goldberg, Professor at UC Berkeley and noted technology writer (www.brainyquote.com)

Chapter Overview

In this chapter, we review two of the three main sources of current public opinion about robots, namely, robots as portrayed in the entertainment media and present-day robots with which consumers interact. The third source, news coverage/expert commentary, is discussed in later chapters. The fictional robots from films, TV shows and books that have left the greatest impression on our collective psyche include everything from positive images of robots (such as C3PO and R2D2 from the *Star Wars* franchise) to extremely negative images (such as the killer *Terminator* robots), which helps explain why the public has a mixed view regarding what a robot future may bring. Present-day robots used by consumers are fairly simplistic, helping with basic household chores (such as Roomba robotic vacuums) or

serving as toys/simple playmates (such as Chip the Robot Dog). Hence, consumers are more likely to think about robots in these basic roles. Our surveys show that, to a large degree, the American public is generally unaware of the more advanced capabilities that robots can already perform, mainly because these more advanced robots are not yet widely utilized.

Sources of Opinions about Robots

When thinking about people's current opinions regarding robots, we must first consider what are the main sources influencing those opinions. There are three major sources today from which people can form their opinions of robots:

Source #1: Robots in the entertainment media. We have all encountered fictionalized representations of robots in books we have read and TV shows and films we have watched, as well as video games we have played. These representations, though dramatized, cannot help but leave an impact on our views of robots.

Source #2: Robots we currently encounter in our day-to-day lives. Though we are still at the very early stages of the human-interactive phase of the robot revolution, there are already numerous robotic devices we encounter in our daily lives. As we advance through the next several years, we will all have significantly more interactions with such early stage social robots and these initial interactions will impact our views for the years and decades ahead.

Source #3: News coverage, expert commentary,

books and articles. Many people are reading about current robot advances and predictions about the robot future (just as you are right now!). In these books, articles, videos, and blogs, consumers encounter commentary from practitioners, researchers, or other types of prognosticators, both hopeful and fearful about the robot future, which likely impact their attitudes.

We will review the first two of these sources in this chapter, and how they might impact opinions. We touch on news coverage and expert commentary throughout several other chapters of this book and hence will not focus on it here.

Most Memorable Robots from the Entertainment Media

Robots have played an outsized role in films, TV shows, video games, and books for the past several decades. Humans are, in many ways, obsessed with robots. We enjoy watching them on a television, computer, or film screen or reading about them in novels. In some stories, robots have served as friendly and faithful companions, helping their human associates through a range of challenges. In other stories, robots are the enemy, a powerful and malevolent foe that is intent on destroying humans. Which of these media images have been most impactful on consumers?

In one of our national surveys of American adults (sample size = 476), we asked respondents, “When you think of robots from any book, movie or TV show that you have seen, what one

or two specific robots come to mind?" It was an open-ended question, meaning no answer options were given before or during the question, so that we truly get what automatically pops into people's minds. Interestingly, the responses show that there is a clear mix of positive and negative media images of robots that are most commonly recalled by American consumers. The results are shown in Table 2.1.

Table 2.1 Most commonly recalled (top of the mind) robots from the entertainment media

Rank	Source	Percentage of respondents who mentioned (%)	Portrayal of robots
#1	*Star Wars* franchise (1977+)	25	Mainly positive
#2	*I, Robot* (2004 film)	21	Mainly negative
#3	*The Jetsons* (1960s TV series, with later reboots)	17	Mainly positive
#4	*Wall-E* (2008 film)	16	Mainly

			positive
#5	*The Terminator* franchise (1984+)	15	Mainly negative

The two friendly *Star Wars* robots, R2D2 and C3PO, top the list of fictionalized robots that are recalled without any prompting. These two mechanical companions are portrayed in the blockbuster franchise (which includes films, TV shows, books, and video games) as trustworthy, loyal, and always supportive of their human companions. R2D2 can even be considered cute, due to its relatively diminutive size and communication through high-pitched beeps and tweets. As one study respondent told us, *I grew up with* Star Wars*, and C3PO and R2D2 were always my favorite robots. They were always dependable. And funny, like a comedy duo. And C3PO, he was more human than the human characters. He was more scared than the humans most of the time*. A quarter of adult Americans think of these friendly *Star Wars* robots when asked to think of any robots from the entertainment media.

However, second on the list is a more menacing portrayal of robots from the 2004 film *I, Robot*, based loosely on a collection of short stories by acclaimed science fiction author Isaac Asimov. In the film, the highly intelligent and resourceful robots, who have a humanoid look with somewhat eerie humanlike faces, attempt a violent uprising against their human masters. While these robots are portrayed in a fairly complex manner that is not

purely evil, they are still menacing and cause harm to humans. Robots in the film are portrayed as having self-awareness, emotions, and coming to the decision that humans are not the best group to be ruling the planet, and perhaps robots would be better in that role. Just over one in five American adults think of these robots when asked about fictionalized robots in general.

The third most commonly recalled media portrayal of robots comes from several decades ago, the friendly and hardworking mechanical household maid from the 1960s TV cartoon series *The Jetsons* (which had a couple of more recent short-lived reboots). Rosie, the robotic maid, was portrayed as a hardworking and friendly housekeeper who helped keep the Jetson family and their house in order. Rosie was metallic, generally humanoid in shape, moved about on wheels and wore a traditional maid's apron. As one of our study respondents, in her early 50s, stated, *When I think of robots I still think of Rosie on The Jetsons. I always thought it would be so cool to have a robot maid that would do all the work around the house*.Seventeen percent of adult Americans recall Rosie when they think of fictionalized robots.

Not far behind Rosie is Wall-E, the main character from the 2008 PIXAR film of the same name. Wall-E is a small and cute robot, who resembles a little tractor, with large, soulful eyes. Wall-E's job is to sort trash on a garbage-strewn planet Earth. The movie also features a crew of helpful robots aboard a space station, serving relatively helpless and overweight humans (who have grown helpless and overweight, in part, due to the attentiveness of their robot servants). Sixteen percent of adult

Americans think of the kind-hearted and friendly little robot Wall-E when they think of robots in entertainment.

Fifth on our list is among the most negative and frightening portrayal imaginable of robots. This comes from *The Terminator* film franchise. In these films, robots in the future—who resemble terrifying metallic skeletons with glowing red eyes—have almost destroyed all of humanity. These robots also travel back in time in a realistically human form to relentlessly track and attempt to assassinate the human protagonists. As one study respondent told us, *Oh my god,* Terminator *scared the crap out of me when I first saw it. I think I was too young when I first saw it. The Terminator was unstoppable. It just wanted to kill, kill, kill. And as the movie goes on it looks less human and more robot until it is totally a robot. I got nightmares from that.* This nightmarish portrayal of robots is top-of-mind for 15 percent of adult Americans when they think of fictionalized robots.

The most recalled robots from entertainment are clearly a mixture of positive portrayals (C3PO, R2D2, Rosie, and Wall-E) and negative portrayals (robots from *I, Robot* and *Terminator* films). With this mix of positive and negative portrayals of robots serving as our top-of-mind media references, it is not surprising that our research finds that Americans have highly mixed views of a future filled with robots—both hopeful and fearful (we will dive into their hopes and fears in detail in the next chapter). There is a bit of both R2D2 and *Terminator* on our minds when we think about the possible robot future.

Top Grossing Robot Movies

IMDb (Internet Movie Database) has compiled the top 35 grossing films (based on US domestic gross earnings) which involve a robot, android, or cyborg as a main character. The list is an interesting one (see Table 2.2). First, it shows the massive popularity of these types of movies, with combined US earnings approaching $5 billion dollars. Consumers appear to be intrigued by all things robotic, at least in entertainment. Second, it displays the extreme diversity of movies that fall into this category, showcasing robots of all shapes and sizes, with robots playing the hero and villain and everything in between. Consumers appear interested in watching robot movies that are dark and scary (*Terminator* franchise), fun and lighthearted (*Robots*), full of action and adventure (*Transformer* franchise), and thoughtful and introspective (*AI: Artificial Intelligence*).

Table 2.2 Top grossing movies with robots/androids/cyborgs as main characters

Rank	Film	Year	U.S. domestic gross (in millions)
1	*Avengers: Age Of Ultron*	2015	$459.0
2	*Transformers: Revenge of the Fallen*	2009	$402.1

3	*Transformers: Dark of the Moon*	2011	$352.4
4	*Transformers*	2007	$319.3
5	*Transformers: Age of Extinction*	2014	$245.4
6	*X-Men: Days of Future Past*	2014	$233.9
7	*Wall-E*	2008	$223.8
8	*Big Hero 6*	2014	$222.5
9	*Terminator 2: Judgment Day*	1991	$205.9
10	*Terminator 3: Rise of The Machines*	2003	$150.4
11	*I-Robot*	200	$144.8

		4	
12	*Transformers: The Last Knight*	2017	$130.2
13	*Robots*	2005	$128.2
14	*Prometheus*	2012	$126.5
15	*Terminator Salvation*	2009	$125.3
16	*Pacific Rim*	2013	$101.8
17	*Inspector Gadget*	1999	$97.4
18	*Star Trek: First Contact*	1996	$92.0
19	*Terminator Genisys*	201	$89.8

		5	
20	*Real Steel*	2011	$85.5
21	*AI: Artificial Intelligence*	2001	$78.6
22	*The Stepford Wives*	2004	$59.5
23	*RoboCop* (reboot)	2004	$58.6
24	*Bicentennial Man*	1999	$58.2
25	*RoboCop* (original)	1987	$53.4
26	*RoboCop 2*	1990	$45.7
27	*Short Circuit*	198	$40.7

		6	
28	*Ghost In the Shell*	2017	$40.6
29	*Surrogates*	2009	$38.7
30	*The Terminator*	1984	$38.7
31	*Sky Captain and the World of Tomorrow*	2004	$37.8
32	*Universal Soldier*	1992	$36.3
33	*Blade Runner*	1982	$32.9
34	*Chappie*	2015	$31.6
35	*Ex Machina*	201	$25.4

		4	

Source: IMDb (2019).

Interestingly, several of the top movies in IMDb's list are from the *Transformers* series, yet in our survey these robots were not most commonly recalled when respondents were asked to think of robots from the media. It may be that since these characters are portrayed as from another planet, they may be seen more akin to mechanical aliens than robots (not that there is necessarily a difference; however, they may not initially come to mind as traditional "robots"). Also, the *Star Wars* films are not included by IMDb as movies with robots as main characters. This is surprising, but it may be that with so much going on in the *Star Wars* films, the roles of C3PO and R2D2 are not enough to classify these films as featuring robot main characters (no doubt there are many who would debate this).

For the most thought-provoking films about intelligent social robots and their implications for future human society, we would suggest *Ex Machina* (2014), *AI: Artificial Intelligence (2001)* and the oldie but goodie *Blade Runner* (1982).

Interactions with Real Robots

While robots are prominent in fiction, they are also beginning to play a greater role in our real-world day-to-day lives. The current robots that people interact with are fairly infantile compared to what is to come. Yet, these nascent interactions are increasingly

impacting our view of robots.

Sales data shows the robot revolution is starting to take off. We will look first at home robots, defined as robots consumers use in their home environments. Sales of home robots in the United States were fairly stable at or below $200 million a year from 2012 to 2015. In 2016, they grew to $261 million, then more than doubled in 2017 to $566 million, and then increased significantly again in 2018 to an estimated $688 million (see Table 2.3).

Table 2.3 Sales of home robots in the United States

Year	Sales of home robots to U.S. retail dealers
2012	$180 million
2013	$196 million
2014	$167 million
2015	$201 million
2016	$261 million

2017	$566 million
2018*	$688 million

Note: *Estimated.
Source: Consumer Technology Association (2018).

There are two general types of home robots. The first are relatively simplistic "service robots" such as the suite of household helpers from iRobot, including the Roomba (robot vacuum), Braava (robot mop), and Terra (robot mower). They perform basic household and yard chores. While far less advanced than other robots, they are still intelligent enough to learn from their surroundings, allowing them to complete their chores autonomously. Even the relatively simplistic Roomba vacuum robots have enough on-board sensors (infrared beams, piezoelectric sensors, and touch-sensitive bumpers) and built-in intelligence to "learn" the layout of the house (yes, they remember your rooms) so that they can efficiently complete their vacuuming chores on their own (Woodford 2018).

The second type of home robots play a more interactive role with humans and are often referred to as *social robots* (Kanda, Ishiguro, and Ishida 2001). These robots serve as pets, interactive toys, or companions. One example of this type of robot is the Lynx Home Robot, which is enabled by Amazon's Alexa. The Lynx robot, a generally humanoid-shaped robot with a cute, youthful plastic face and lit-up eyes, stands 20 inches tall, is verbally interactive like Alexa, and can play music, make "to

do” lists and even teach yoga. Cozmo, made by Anki, is another social robot, quite small in size, which is used as an intelligent, interactive educational robot for children. Cozmo, which is no longer being sold (more on this in a later chapter), is programmed with artificial intelligence software that allows it to express any number of feelings and play a variety of games. Further, it has facial recognition abilities allowing it to remember faces and names.

Then there is Chip, the robot dog, made by WowWee Group, which does many of the things a real dog can do, such as fetching, learning tricks and nuzzling, all without the shedding of a real dog. It has sensors so it is aware of its surroundings at all times, including where the humans are. It sees and can respond to your gestures, as well as to your voice commands. See Figure 2.1.

See More Robots

Here are URLs for images and videos of more of the robots mentioned in the preceding text:

- iRobot Roomba, Braava and Terra: www.irobot.com
- Lynx robot: www.youtube.com/watch?v=RTIHsZQx5Xg
- Cozmo: https://www.youtube.com/watch?v=DHY5kpGTsDE

Figure 2.1 Chip the robot dog

People who have the opportunity to own and/or experience today's household service robots can more easily envision robots playing a supportive, servant-like role for domestic chores. People who have the opportunity to own and/or experience today's social robots can more easily envision robots playing an increasing role in entertaining and educational settings. These robot roles are still fairly narrow and prescribed, and generally viewed positively. The most advanced robots of today are not yet out in full view of the larger public.

Awareness of What Robots Are Currently Doing

The most advanced of today's robots are already capable of doing a wide variety of fairly complex activities; however, much of this is not yet fully visible to the average person. Consider the following:

- **Robotic pharmacists.** At a pharmacy at the University of California, San Francisco, robots are already doing all the work. They are receiving prescription orders, packaging, and dispensing them. During the first phase trial run of 350,000 doses, there were no errors (Hill 2017). No humans are needed at that pharmacy.
- **Robotic chef.** Moley Robotics, headquartered in the United Kingdom, developed a robotic chef that can cook over 100 meals. That is far more meals than at least one of this book's authors can cook. The company expects this to soon expand to thousands of recipes (Huen 2016).

- **Robotic phlebotomist**. Veebot, from Veebot Systems, Inc., is a robot that can draw your blood. Using infrared light and ultrasound technology, combined with artificial intelligence, it is 83 percent accurate at finding a proper vein for drawing blood, which is on par with a trained human phlebotomist. Yet, it performs the procedure faster than a human, which might be nice for those of us who do not enjoy the experience (Jung 2013).

How aware are consumers of these and other capabilities of current robots? While consumers are aware of some of the activities robots are currently doing, they are, in fact, fairly unaware of many of the more advanced existing capabilities of robots. In one of our national surveys (sample size = 345), we asked respondents if they were aware or not that robots are capable of the following 25 activities (all of which robots can do as of late 2019). Results are provided in Table 2.4.

Table 2.4 Awareness of current (actual) robot capabilities

Task	**Percentage aware robots can currently perform (%)**
Vacuum	88
Greet people	81

Drive vehicles	77
Sort and deliver packages	75
Wash floors	68
Perform music	65
Win at contests and board games	64
Help customers find goods they are looking for	63
Be your pet	61
Lawn mowing	53
Wash dishes	50
Check your bodily vital signs	49

Companionship—such as playing cards with you or reading books to you	48
Perform surgery on you	48
Massage your back	44
Hospital receptionist—take your information when you arrive	42
Analyze the results of your X-rays, CT Scans, MRIs	41
Paint	38
Fold and organize clothes	34
Lift an elderly patient from a bed to a wheelchair	31
Write music	31

Iron clothes	30
Cook a variety of different meals	27
Draw your blood for testing	17
Perform your annual health check ups	10

Note: For references for these current robot capabilities, see the list of sources in Appendix B.

Not surprising, given that home service robots are somewhat common already, a vast majority of adult Americans are aware that robots can perform simple chores like vacuuming, washing floors, and sorting packages. Also not surprising given the many home social robots currently for sale, a strong majority of adult Americans are aware of the basic social functions robots can perform, such as greeting people and acting as pets. And given the publicity of robots such as Watson (the IBM supercomputer) performing on TV game shows like *Jeopardy*, it is not surprising that roughly two-thirds of adult Americans know that robots can win at games.

However, there is still a significant lack of awareness regarding many other current robot capabilities. This is likely because these activities are not yet commonly witnessed by a large number of consumers, and for some it may seem too

advanced to believe. There is low to moderate awareness that robots can currently perform basic service functions such as wash dishes and iron and fold clothing. There is almost no awareness that robots can undertake more advanced activities such as cook meals, draw blood, and perform annual health checkups. This lack of awareness may end in the next few years, as human-interactive robots become more and more commonplace in society.

Forecasting a Robot Explosion

Forecasts for the near future suggest an explosion in the sale of robots made to interact closely with humans. We will explore these types of robots under three headings: personal service robots, collaborative robots, and robots in the health care industry. There is overlap in these categorizations. However, industry forecasts are under these headings, so a review is worthwhile.

Personal service robots include the home robots mentioned earlier in the chapter which serve as domestic helpers and companions. They also include similar robots used in customer service industries such as hotels, hospitals, and restaurants, as well as robots meant for entertainment and leisure. These robots have been forecast to more than double in sales in the United States between 2017 and 2021 (see Table 2.5).

Table 2.5 Projected worldwide sales of personal service robots

Year	Sales of personal service robots
2017 (actual)	$2.01 billion
2018 (projected)	$2.85 billion
2019 (projected)	$3.70 billion
2020 (projected)	$4.42 billion
2021 (projected)	$4.99 billion

Source: Statista (2019).

A collaborative robot is defined as a robot that is designed to interact with humans, in the home, workplace, or community. This includes the more advanced robots of the personal service category, as well as interactive robots that might be serving in a factory or jobsite. The key is these are collaborative robots with which people will communicate and otherwise interact closely. Worldwide sales of these robots are expected to grow dramatically over the next few years (see Table 2.6).

Table 2.6 Projected worldwide sales of collaborative robots

Year	Sales of collaborative robots (in units)
2018	60,900
2019	66,150
2020	126,000
2021	242,030
2022	353,330
2023	508,200
2024	637,350
2025	735,000

Note: Figures projected.
Source: Statista (2018).

Health care is a growing need across the planet, as humanity

experiences an aging trend never seen before. Health care is also a labor intensive sector. As many of the examples already discussed in this book suggest, companies are aggressively turning to robotics to help them with their labor needs in health care. The medical robots market is projected to reach $22.1 billion by 2027, growing significantly from an estimated $6.46 billion in 2018 (Singh 2019). The role robots will play in health care is expected to be particularly critical. Hence, we devote an entire chapter to this topic later in the book.

The recent and projected sales data reviewed in this chapter shows that the rise of a human-robot interactive world has started, and will accelerate dramatically in the very near future. And still, most people are not fully aware of current robotic capabilities, and most are not yet prepared for the robot revolution that is coming.

Implications for Consumer Behavior and Marketing Strategy

Marketers need to start thinking seriously about how robots might be utilized in consumer-facing roles in their industry. They need to pay attention to advances in robotics and consider the various consumer interactions in which robots could play a role, as well as understand what that customer-robot encounter should be like, and what type of robot would fit best. Even if a company has no plans to use robots in the near future in consumer-facing roles or sell robots directly to consumers, it is likely that their current competitors, or new completely

unexpected competitors, are starting to explore this possibility. We suggest marketers read articles and blogs in any of their trusted industry's sources, or attend conference presentations dealing with the use of robots in their industry. For general updates on advancements in robotics (from a business-friendly, less tech-heavy perspective), you can check out any of these sources:robotics.org, robohub.org, roboticsbusinessreview.com. In later chapters, we will provide a more detailed framework to think about the use of robots in consumer-facing roles, but as the forecast data shown in this chapter suggests, the robot wave is at hand and robots will increasingly be part of everyday business.

Marketers need to also keep in mind that most consumers are not yet aware of many of the developments going on in robotics, and will likely react with shock and even some pushback as robots are increasingly utilized by businesses in consumer-facing roles, especially if robots are taking on more advanced tasks. Further, any industry that wishes to use robots in public roles will be competing with the powerhouse of the entertainment industry in creating an overall image of the pros and cons of robots. Hence, robots can use continual positive public relations to showcase to consumers what they are capable of doing and how they can improve consumers' everyday lives. Hanson Robotics has been doing this by participating in talk shows and news programs showcasing its highly advanced Sophia android, where Sophia has conversations with TV show hosts. The TV advertisements from iRobot do this as well, promoting the capabilities of their home robots. Videos on social media and on robotic company websites, such as those for Buddy the

companion robot (http://www.bluefrogrobotics.com/robot/), also do an effective job in showcasing the advancement of robots. Companies need to continually communicate the improvement in the robots they are developing and show how these robots can help successfully service the wants and needs of consumers. We discuss how this should be done throughout the book.

CHAPTER 3

Hopes and Fears about the Robot Future

Contrasting Views from Two Tech CEOs Regarding Our Robotic Future	
Fearful	**Hopeful**
I have exposure to the most cutting-edge AI, and I think people should be really concerned by it. AI is a fundamental risk to the existence of human civilization in a way that car accidents, airplane crashes, faulty drugs or bad food were not—they were harmful to a set of individuals within society, of course, but they were not harmful to society as a whole. Elon Musk , CEO of Tesla (July 15, 2017 speech to the National Governors' Association)	*… with AI especially, I am really optimistic. And I think people who are naysayers and try to drum up these doomsday scenarios—I just don't understand it. It's really negative and in some ways I actually think it is pretty irresponsible.* Mark Zuckerberg, Facebook CEO (During a July 23, 2017 Facebook Live session)

Chapter Overview

In this chapter, we do a deep dive into our survey data to size the segments of the American population who are positive, negative, and mixed regarding the likely increased use of robots in our daily lives. We find the majority of Americans have mixed to somewhat positive views, though a sizable minority has clearly negative views. In our research, we probe deeper to understand the various factors leading to greater positivity or greater negativity in opinion regarding a growing role for robots in society. Much of the public's optimism regarding our impending robot future is based on the hope that robots will do many of the daily chores or dangerous tasks that we do not want to do, as well as add a certain amount of efficiency and courtesy to consumer service. Much of the public's anxiety comes from fears about a loss of control to robots, particularly that robots will take away jobs, spy on consumers, or cause us to regress in our personal knowledge and skills. The public's anxiety about robots also comes from the perception that robots can be hacked or they could malfunction in dangerous, unpredictable ways. Or even that the robots will eventually become so advanced they will turn against humans (yes, this is a sizable concern). When consumers think about robots progressing past human capabilities, their views become much more negative. While examining public opinion, we also bring in the point of view of experts, to see where the public's hopes and fears align with expert predictions. The public has a complex love/hate relationship with the idea of a robot future, which companies need to understand as they roll out robots in customer-facing roles.

Sizing the Overall Positive and Negative Sentiment of the American Public

The American public has a complex view of the coming robot future, expressing both great hope and significant trepidation about the possibilities new generations of robots may bring. This mixed view is perhaps not surprising, given that the robots they most readily recall from the entertainment media range from the friendly R2D2 to the malevolent *Terminator* robots. The public's mixed views also reflect the diversity of opinion among technology elites, such as those expressed by Mark Zuckerberg and Elon Musk. Mr Zuckerberg feels nothing but optimism regarding our robot future while Mr Musk thinks it could lead to the end of human civilization.

In this chapter, we will explore the American public's hopes and fears regarding the robot future in two different ways. First, we will look at quantitative results from scaled questions that allow us to size the optimistic and pessimistic segments. Second, we will analyze responses to open-ended questions that allow us to dig behind the numbers, exploring the complex issues, thoughts, and perspectives driving people's hopes and fears.

In one of our national surveys (sample size = 370), we offered the following statement to respondents: "Robots are expected to advance significantly in their intelligence and capabilities over the next 10 to 20 years, allowing them to play a much larger role in all aspects of our society." We then asked respondents how they would describe their opinion regarding this statement on a scale from very positive to very negative. Just over half, 57

percent, rated their reaction as positive (21 percent *very* positive and 36 percent *fairly* positive). All in all, it seems Americans lean in an optimistic direction regarding our robot future (at least when described in this manner). However, it is far from an overwhelming endorsement. Almost one in three American adults or 29 percent take a mixed stance, saying more advanced robots in our future will be equally positive and negative for human society. Finally, 14 percent—roughly one in seven American adults—feel negative about the robot future (9 percent *fairly* negative and 5 percent *very* negative). Perhaps the easiest way to interpret these results is that the bulk of Americans, roughly two-thirds, fall into a neutral to mildly positive stance toward our robot future (the two most common responses). The results are summarized in Table 3.1:

Table 3.1 Opinion regarding more advanced robots playing a larger role in society

	%
Very positive for society	21
Fairly positive for society	36
Equally positive and negative for society	29

Fairly negative for society	9
Very negative for society	5

We see a significant difference by age for this question, with younger respondents (aged 18 to 34) more positive than their older counterparts (aged 35+) about the coming robot future. A full two-thirds (67 percent) of respondents aged 18 to 34 responded to the above question positively (very and fairly positive combined), while less than half (46 percent) of respondents aged 35+ did the same. Is this a result of natural youthful optimism? Is it because the young have grown up with more technology around them? We will get some insights into this in Chapter 4 when we see that younger respondents, more so than their older counterparts, are looking forward to having robots do a lot of their daily chores for them.

The Brookings Institute asked a somewhat similar question regarding artificial intelligence (AI) and its role in our future in one of their national surveys (sample size = 1,535). The connection between AI and robots is that AI will power the capabilities of our most advanced robots. AI is the "brain" inside each robot. While the scale used in the Brookings survey was different than ours, the results lead to a similar finding: Americans lean in a somewhat more positive than negative direction when they think about AI in our future. However, the reaction is far from overwhelmingly positive. A large segment is

neutral or not sure, while a significant number of Americans have negative feelings about AI. See Table 3.2.

Table 3.2 Opinion regarding a greater role for artificial intelligence in our future

	%
Very positive	14
Somewhat positive	27
Neutral/not sure	36
Not positive	23

Source: West (2018).

Throughout our history, Americans have been generally optimistic about the future. It is part of our national culture. Americans have also been generally supportive of technological change. We see that general tendency borne out in the survey responses to robotics and AI. However, there is clearly also a significant note of caution and concern coming from the public.

Four Attitudinal Segments

To further understand, from a quantitative perspective, the positive and negative sentiment of Americans regarding our robot future, we created four attitudinal segments. Our segmentation was inspired by the writings of Dr. Max Tegmark, MIT Professor and prolific writer on technology subjects. He has suggested a two-dimensional approach to classifying people's perspectives on AI (Tegmark 2017):

1. **Feelings:** will it be good or bad when AI surpasses humans in its capabilities?
2. **Expected timing:** when will this happen, if ever?

Whether AI superiority (in overall capabilities versus humans) is perceived to be good or bad for society is clearly a core issue to measure. However, Dr. Tegmark emphasizes that this should be measured along with how soon people expect AI superiority to occur. Timing is important, because if people believe it will occur soon (within 50 years), then it becomes a much more immediate issue. The potential good or potential bad becomes more real and more meaningful in its impact to individuals themselves, their children, or other people they know alive today. If AI superiority will not occur for a hundred years, several hundred years or never, then the concern about the bad or the excitement for the good becomes much more hypothetical.

We repeated Tegmark's questions in one of our national surveys (sample size = 395), customizing them to robots. Note

that these questions push the envelope further than the first survey question discussed in this chapter. The survey question discussed at the opening of the chapter simply asked the public about *more* robot activity in society. This one talks about the actual possibility (deemed very likely by experts) that robot capabilities will *surpass* that of humans on just about all tasks.

Question 1: Feelings	***Question 2: Timing***
Robot superiority (vs. humans) in capabilities Good or bad?	Robot superiority (vs. humans) in capabilities When will it happen?
Response options: • Definitely bad • Probably bad • Uncertain • Probably good	Response options: • Never • In about 300 years • In about 100 years • In about 50 years

• Definitely good	• In a few decades

Our two-dimensional analysis produced four distinct attitudinal segments, as shown in Table 3.3.

Table 3.3 Four distinct attitudinal segments regarding our robot future

	Robots surpassing humans will be *bad* for society	**Robots surpassing humans will *not necessarily be bad* for society**
Robots will surpass overall human capabilities in roughly *50 years or less*	***Scaredy Cats (24%)*** Robot superiority is coming soon and it's bad!	***Open-minded realists (40%)*** Robot superiority is coming soon and we are open to seeing the upside
Robots will surpass overall human capabilities in roughly *100+ years (or never)*	***Ostriches (16%)*** Robot superiority is bad, but it's a long way away (if ever)	***Not on my radar (21%)*** We are open to the possible benefits of robot superiority, but it is a long way off (if ever)

Let us explore each segment further.

Scaredy Cats (24 percent of population). This is the segment of Americans who are most terrified about our robot future, because they: (a) see it as a negative development and (b) believe it is coming soon. A perceived detrimental development for human society that is right around the corner is, indeed, scary. The key feelings they express are fear and anxiety regarding robots. This includes economic fear (they will take my job) and even existential fear (they will enslave humanity). Hence, they want to push back and slow down the progress of robot development. In terms of subgroup differences, Scaredy Cats are composed of a relatively high proportion of younger women (aged <35 years).

Following are selected quotes from Scaredy Cats in our study, to help illustrate their perspective:

> When asked about the possibility of robots that might one day enslave humans:
>
> *Robots may lead us to become dependent on them and with enough autonomy it may lead to us being enslaved by them. The freedoms we have would be lost thanks to robots that want to control everything … all thanks to the greedy corporations who want to replace our way of life.*
>
> When asked about robots' potential impact on job losses:
>
> *This is a very serious concern of mine. Many people rely on unskilled labor to survive. If intelligent robots came along they could very easily replace the overwhelming majority of those jobs and leave many without gainful employment. This could lead to many things such as rioting and looting and just general rebellion.*

Ostriches (16 percent of population). This segment of Americans sees the advancement of robot capabilities as an overall negative for human society; however, they believe it will

be a hundred years or more (if ever) before robots reach a level that will surpass humans in overall abilities. Hence, though a negative development, it feels quite distant and perhaps even unachievable to these individuals. We called them *Ostriches* because their head is in the sand. Their sense of when robots will surpass humans in general capabilities is far later than what most experts think. Among this segment, a whopping 62 percent say robots will *never* surpass humans in ability, 14 percent say it will happen in 300 years and 24 percent say it will happen in 100 years. In contrast, experts in the field believe AI will surpass overall human capabilities in less than 50 years (Grace et al. 2018—more on this topic in the next chapter). Plus, people in this segment tend to be less aware of what robots can already do. They appear to be ignoring what is currently happening and in denial regarding what is likely to come. This is the smallest segment, though still significant in size at roughly one in six Americans. In terms of subgroup differences, Ostriches have a higher proportion of women than men.

Following are selected quotes from Ostriches in our study, to help illustrate their perspective:

> When asked about the possibility of robots that might one day enslave humans:
>
> *I don't know that robots would ever become advanced enough to program themselves and be self-sustainable. However, I may also be ignorant about the technological advances in robotics. I feel like engineers would always create some kind of 'fail-safe' to prevent this from happening*.
>
> When asked about the potential impact on job losses by robots:
>
> *I don't believe that robots will take the place of humans in employment on a mass scale for a long time. The nature of the different kinds of jobs is extremely varied, and, at least for a long time, I don't believe it will be profitable for companies to*

produce the high number of varied robots to perform all tasks.

Open-Minded Realists (40 percent of population). This group leans in a positive—or at least open—direction regarding the future of robots, and they see it coming soon. They are open to the possibility that advanced robots will not be bad for human society (they are either uncertain [58 percent] or positive [42 percent] about it), and they believe robots will surpass humans in overall capabilities within 50 years—within the lifetimes of many people alive today. This is closer to the predictions of experts, and hence we call the people in this segment *realists*. Members of this segment are more in tune with the current state of robotics, with greater awareness of current robot capabilities. They are more open to a larger role in society for robots than is any other segment.

Importantly, this segment cannot be described as jumping for joy about the potential for superhuman robots. Roughly six in ten of them are uncertain. The point is that they are not knee-jerk negative. They are open to the possibility that super-advanced robots can be overall beneficial to society. In terms of subgroup differences, Open-Minded Realists have a higher proportion of men than women. This is the largest segment, including four in ten Americans.

Following are selected quotes from Open-Minded Realists in our study, to help illustrate their perspective:

When asked about the possibility of robots that might one day enslave humans:

I think it is highly unlikely that robots will one day become the overlords of the human race. While artificial intelligence does allow for many robots to process independently, that level of higher thought—and desire for dominion over a lesser

or equal species—seems extremely improbable, if not impossible, to me.

When asked about the potential impact on job losses by robots:

People had the same concerns at the start of the industrial age. It was feared that widespread industrialization would destroy jobs and so consolidate work that whole classes would be made unemployed. As we know now, industrialization brought about whole new industries that could never have been foreseen and heralded the start of probably the largest and longest sustained rise in living standards ever seen. I have no idea how the information age will affect us, but although there are many risks I am still glad to see it, as the human race has shown before that it can cope with these challenges.

Not on My Radar (21 percent of population). As with the open-minded realists, this segment is open to the possibility that advanced robots will not be bad for human society (they are either uncertain [72 percent] or positive [28 percent] about it). However, they do not believe robots will surpass humans in overall capabilities anytime in the near future, neither in their lifetimes nor during the lifetimes of anyone they know. In fact, roughly half of this segment says robots will *never* surpass humans in ability, 17 percent say it will happen in 300 years, and 32 percent say it will happen in 100 years. Hence, there is no immediacy and less meaning to the entire issue for them. It is not surprising that they show the least concern regarding issues such as the economic threats or security threats potentially posed by robots.

Following are selected quotes from the Not-On-My-Radar segment in our study, to help illustrate their perspective:

When asked about the possibility of robots that might one day enslave humans:

What good would human slaves even be to robots? … What's a robot's motivation for this anyways? AI doesn't have human motivations with its lust for power and wealth. Besides, most robots are pretty fragile right now. I put my money on the

human with a baseball bat.

When asked about the potential impact on job losses by robots:

A human touch is required in most fields and in certain fields human emotion is necessary. .... Robots just aren't capable of doing some things as well as humans and I think this will always be the case.

Table 3.4 highlights the differences across the segments regarding some key worries about the robot future. Note the Scaredy Cats generally show the greatest level of fear, with Ostriches typically in second place (except for concerns about privacy issues, where the two reverse). On the other side, the Not on My Radar group shows the least concern on all items, reflecting their sense that robot supremacy is likely never to happen or is far off in the distance, and if it does happen it might not be that bad.

Table 3.4 Concerns about the robot future—by segment

	Scaredy cats (%)	**Ostriches (%)**	**Open-minded realists (%)**	**Not on my radar (%)**
Robots taking human jobs and causing massive unemployment	37	29	21	11
Robots being completely autonomous	31	18	18	2

Robots becoming more intelligent than humans	30	16	16	6
Robots causing data insecurity or privacy breaches	18	26	13	11

Shown: Percentage extremely concerned (7 on a 7-point scale).

Digging Deeper: Issues Driving People's Hopes and Fears

It is useful to classify people as shown in Table 3.3 to determine the size of the various optimistic and pessimistic groups within the public. Now, we need to dig deeper and find out what are the rationales behind the positive and negative sentiments. In other words, what hopes are driving the positive views and what fears are driving the negative views? To do this, we turn to open-ended questions that we fielded in our studies where people were asked to write lengthy free-form answers.

In one of our national surveys (sample size = 476), we asked adult Americans two open-ended questions:

- If robots did become a more commonplace part of everyday life in the near future, what do you think would be the *best* things about this, if any?

- If robots did become a more commonplace part of everyday life in the near future, what do you think would be the *worst* things about this, if any?

Open-ended questioning means we did not supply any possible responses. We offered only a blank text box, and respondents were asked to respond with anything that came to mind. We asked both questions of all respondents, regardless of whether they leaned in a more positive, negative, or neutral direction. Interestingly, most respondents were able to offer us ideas for both sides—having clear thoughts about the positives and negatives of robots in our future. Hence, it is not surprising that so many individuals are uncertain, neutral, or at the very least cautious about the robot future, given their mixed viewpoints. Table 3.5 shows a summary of the greatest hopes and greatest fears expressed by Americans regarding the robot future.

Table 3.5 Greatest hopes and fears regarding robots in our future

Greatest *hopes* about robots in our future	**Greatest *fears* about robots in our future**
Extremely Common (vast majority of respondents) 1. Robots will do our personal chores, freeing humans for more enjoyable pursuits	*Extremely Common (vast majority of respondents)* 1. Robots will take our jobs

	2. Robots can malfunction and get hacked, causing chaos
Very Common (about half of respondents) 1. Robots will perform society's most dangerous tasks (work in mines, help with law enforcement, etc.) 2. Robots will lead to improvements in customer service: (a) more accuracy, (b) faster results and (c) more polite interactions	*Very Common (about half of respondents)* 1. People will become overreliant on robots, and become helpless 2. Robots will reduce human interactions 3. Robots will reduce our personal privacy
Somewhat Common (about 1/5 to 1/4) 1. Robots will provide companionship	*Somewhat Common (about 1/5 to 1/4)* 1. Robots will take over the world

We will now explore in greater detail each of these hopes and fears, and discuss implications for businesses. A key theme throughout this discussion is control. Positive views of robots in our future involve robots occupying a subservient role to humans. In these scenarios, robots are under our control, doing what we want them to do to improve our lives. Negative views of

robots involve robots acting outside of human control, or at least outside the control of most humans. Such negative views of the future have robots either doing what they themselves want or acting in the service of only a select few humans (perhaps only controlled by corporations or a ruling elite) and not in the service of society as a whole. The level of control the average human will have over robots plays a significant role in the optimistic versus pessimistic views of our robot future.

Where available, we also note what experts predict about our robotic future, and how well that aligns with the public's hopes and fears. Expert insights were obtained from a Pew Research Center report, published in 2014, which contains a canvassing of relevant experts from industry, academia, and government on the topic of the coming AI and robotics revolution (Smith and Anderson 2014). Additional expert insights were obtained from published academic journal articles.

Greatest Hopes about Robots

Hope #1. Robots will do our personal chores, freeing humans for more enjoyable pursuits (extremely common)

The vast majority of adult Americans can envision an optimistic future scenario of robots doing many of our mundane, day-to-day chores. They can envision robots acting as servants, doing simple household tasks for us, in our houses and outside in our yards. Because today's available robots, such as the Roomba vacuum cleaner, are already doing this, it is not hard for consumers to extrapolate this into an even greater role in the future.

The benefits of this vision, according to our study respondents, are numerous. First, most of us do not enjoy doing these chores. Second, having robots doing our mundane chores frees up time for people to pursue other interests and hobbies, and enrich their daily experiences. Most of us complain about not having enough time in the day and this robotic vision offers at least a partial solution to that. And third, it places robots in a subservient role. They are seen as under the control of their human masters, working for us as our servants.

Selected Comments from Survey Respondents

The best part about robots becoming a staple in the future is that a lot of things that people do now that are seen as time wasting or just trivial, will be able to be performed by robots instead. Things like mowing the lawn, and cleaning the house. … this will allow people to have a lot more time on their hands to do other things. (male, 25 to 34)

The best thing will be the convenience it adds to our daily lives. The robots will be able to take care of daily chores that humans will either not want to do or will be too busy to do. (male, 25 to 34)

…if robots became a more commonplace part of everyday life by completing errands or mundane, tedious tasks, our lives would change for the better. I think it would free up more time in our day to pursue other things we want to do but never have the time to for. If, for example, we had a robot who could properly clean the entire house and do our laundry, we could go out with friends or family and enjoy more time to ourselves. (female, 35 to 44)

Expert Point of View—Robots Doing Our Personal Chores

Experts (drawn from a wide variety of technological and academic backgrounds) agree that intelligent robots will

play a considerable role in day-to-day household chores in the next couple of decades. They expect more and more consumers to utilize service robots to do much of the mundane house and yard work most of us would rather not do. Once this trend starts, the experts believe consumers will increasingly demand these household service robots. This growing demand will launch many new product categories of helper robots for the home. The promise of more free time due to technological advances, long promised but not yet achieved, may actually become a reality for humankind.

> *All the fundamentals of life can and will be automated, from driving to grocery shopping. Chores effectively disappear in terms of time consumption. (Nilofer Merchant, author)*

> *It is not the large things that will make AI acceptable it will be the small things—portable devices that can aid a person or organization in accomplishing desired outcomes well. AI embedded into everyday technology that proves to save time, energy, and stress that will push consumer demand for it. (Lillie Coney, Legislative Director specializing in technology policy in the U.S. House of Representatives)*

There are concerns among experts, however, that it may be only the wealthy who can truly afford these

robotic servants:

> *The degree of integration of AI into daily life will depend very much, as it does now, on wealth. The people whose personal digital devices are day-trading for them, and doing the grocery shopping, and sending greeting cards on their behalf, are people who are living a different life than those who are worried about missing a day at one of their three jobs … (Bill Woodcock, Executive Director for the Packet Clearing House)*

Source: Smith and Anderson (2014).

The implication for business are significant. Consumers will be highly receptive to robots that can assist with day-to-day chores in the house and yard. This type of home service robot may represent the lowest hanging fruit for businesses to introduce robots into our lives, a simple first step to ease most Americans into the robot revolution. Home service robots can be marketed to show how they free our time, allowing us to live much more fulfilling lives doing what we always wished we had time to do. It would be helpful to the corporate reputations of these companies if they could create different levels of servant robots, with some sold at more affordable price points even if that means profit margins are slim. In this way, robots (beyond the basic Roombas) will not be seen as only for the wealthy.

Hope #2. Robots will do our dangerous jobs (very common)

A majority of Americans believe a positive aspect of robots in our future is that they will undertake society's most dangerous jobs. Americans perceive robots as lacking human fear and emotions, and hence would be a natural fit for dangerous jobs such as firefighting and hazardous roles in mining and construction. Further, while human life is viewed as precious and irreplaceable, Americans believe a robot damaged on the job can simply be repaired or replaced.

Selected Comments from Survey Respondents

There is a lot of work that is dangerous to human beings. Some aspects of law enforcement for instance can be done by more advance robotics. Situations dealing with armed suspects for instance can be taken care of by advanced robots instead of SWAT teams or police dogs. This will reduce the dangers of the job significantly which means less deaths to law enforcement. Robots can also handle jobs like dangerous construction and field work. If robots can work efficiently enough to handle work that is done in harsh conditions, it will reduce work-related deaths. (male, 25 to 34)

Safety robots could do jobs that may be too dangerous for humans, eliminating hazardous conditions for humans like heavy lifting, hazardous chemicals, bomb detonation. They can work in any environment. (female, 45 to 54)

The implication for business is that while consumers are highly concerned about widespread job losses due to robots (more on that later), they are receptive to robots replacing human workers if it can be convincingly shown the rationale is worker health and safety.

Hope #3. Robots will lead to improvements in

customer service: (a) more accuracy, (b) faster results, and (c) more polite interactions (very common)

The majority of American adults expect robots to play an increased role in their interactions with businesses, and they foresee positive outcomes from this. Importantly, for businesses, consumers expect benefits to be realized in three areas in particular:

A) **More accuracy.** Because robots are viewed as being more precise in their processing, without the human tendency to get bored or distracted, Americans believe the use of robot customer service workers will lead to more accuracy. When dealing with robots in such a role, they expect fewer errors and reduced problems.
B) **Faster results**. Americans also expect faster results when dealing with robot customer service workers, since robot processing speed is viewed as far superior to that of humans. And robots never need to take coffee or lunch breaks.
C) **More polite interactions.** Americans also acknowledge that humans can be grumpy when they are having a bad day, reducing the enjoyment of service interactions with them. Our survey respondents believe that robots, devoid of such human emotional shortcomings, can be programmed to be permanently well-mannered. As a result, customers might find more pleasure interacting with an always cheerful robot versus an occasionally grumpy human.

Selected Comments from Survey Respondents

More Accuracy

If robots became more commonplace, then it could help with less mistakes being made, less human error. (female, 35 to 44)

I think that it would be great because everything that robots do is going to be done correctly and without fault very often. (male, 18 to 24)

Robots would also help in accuracy when it comes to almost everything involved with human error. Having robots doing things for us will increase optimization and accuracy. (female, 35 to 44)

Faster Results/More Reliable

Humans can be unreliable. Robots do not call out of work. They don't need breaks. (female, 35 to 44)

The best thing about robots in the future is that when they are integrated properly into human society, they would provide increased efficiency to typical jobs such as mail delivery and even greeting customers at restaurants. (female, 45 to 54)

More Polite

If you went to the store and were treated rudely by a cashier, this wouldn't happen with a robot. You'd get the same thing every time. Also, I think robots would be more reliable. (female, 55 to 64)

The best thing about more robotic interactions would be the fact that they are not emotional, and they also don't respond if a person gets emotional. (female, 35 to 44)

You would be dealing with a robot and not have to deal with someone who is having a bad day and takes it out on you. (male, 18 to 24)

Expert Point of View—Robots in Customer Service

Experts agree that robots will play a growing role in customer service functions, interacting with humans all

across the marketplace—in stores, hotels, restaurants, and so on. These experts believe powerful economic factors will drive companies to move quickly in this area, as the capabilities of robots increases and the cost and hassle of human workers also increases.

> *A large portion of service jobs may be taken over by AI—ticket clerks at movie theaters, bank tellers, automated clerks in most service positions. Once we begin to program the software to manage intelligent response to human interaction we may find that simpler tasks may be taken over completely by AI. (Anonymous expert respondent)*
>
> *Robots will be able to stock store shelves and check out and bag groceries and other store purchases. They'll do much of today's custodial work, delivery services, and transportation. Customer service will be almost entirely done with scripted agents. (Judith Donath, a fellow at Harvard University's Berkman Center for Internet & Society)*

Source: Smith and Anderson (2014).

The implications for businesses are quite substantial. If businesses advertise, or are known for, a reliance on robotic frontline servants, they will raise expectations significantly for improved customer experiences. Customers will expect more

accuracy, faster turnaround times, and more polite service. There will likely be little patience on the part of consumers regarding the working through of bugs or system problems with customer-facing robots. While a customer might have some empathy for a human who makes a mistake and is contrite about it, they will likely have much less empathy if the mistake is made by a robot, for which they have higher standards.

Hope #4. Robots will provide companionship (somewhat common)

This hope for robots was voiced by about a quarter of respondents. They acknowledge there are many lonely people in society, and there are often no human companions available or willing to spend time with them. Robots with social skills could provide this companionship. This is seen as particularly useful for elderly and disabled individuals.

Selected Comments from Survey Respondents

I think the best thing would be always having someone around and always having a companion and someone to talk to. Robots will keep us company and become man's second best friend. (female, 55 to 64)

I suppose in a strange way they could become somewhat of companions to people who live alone and are lonely. (female, 25 to 34)

I also think that robots will allow people with disabilities to live more productive lives and they will provide friendship to lonely people. (male, 25 to 34)

Expert Point of View—Robot Companionship

Experts agree that robots will soon play a significant role in the lives of the elderly and disabled, and as a result improve their quality of life significantly. Besides simply providing companionship, experts believe in the next decade or so robots will play a growing role assisting them with the daily activities of living—reminding them to take their medication, exercising with them, helping them move around the house, and so on. They believe AI programming will allow robots to assume the role of effective companions, much as a thoughtful and caring human can do today. The need in this area is large and expected to grow significantly as society ages.

> *I expect more robotic assistance for the elderly and infirm, because the demands are manageable and the need is increasing. (Jonathan Grudin, principal researcher for Microsoft)*

> *Smart interactive virtual human agents will be a common part of modern life … guiding self-care and care for loved ones at home. This will improve the quality of self- and other-care, as well as enhance adherence with health regimens in the future. (Gary Kreps, professor at George Mason University)*

Source: Smith and Anderson (2014).

Robotic companionship for the elderly, disabled, and others who often live alone at home is clearly a business opportunity for which many consumers are already highly receptive. It is a natural entry point for businesses to introduce large numbers of social robots into society, particularly more advanced robots with social skills and emotional intelligence.

Greatest Fears about Robots

While most respondents had no trouble describing at least some hopes for a robot-filled future, most were also quick to point out several substantial fears regarding it as well.

Fear #1. Robots will take our jobs (extremely common)

By far, the most commonly voiced concern about robots is that they will take jobs away from people, leading to significantly higher levels of unemployment. Robot replacement of human workers has been happening for decades in factories and warehouses, so it is not surprising that this concern is on the minds of almost all Americans.

Interestingly, the comments voiced by respondents suggest they still see this as a concern for entry-level, unskilled jobs. Many felt this could accelerate the wealth gap, something that has been growing in American society for decades, between an increasingly struggling working class and a small group of techno-elites. To a large extent, they are not appreciating the likelihood that robots may, in the near future, be the cause of large-scale job loss among white collar occupations as well, as the advances in AI will allow robots to perform highly skilled work.

Selected Comments from Survey Respondents

The jobs market would change drastically. There will be less and less low-skill jobs. … The current low-skill workers may not be able to adapt. There could be more unemployment. (male, 18 to 24)

I think there would be less general labor jobs. This could spark anger in the groups of people that lose their jobs and cause many economic problems and outrage. Businesses would profit more, and this could possibly widen the rich versus poor gap. (female, 35 to 44)

I think one of the biggest downfalls would be robots taking jobs away from the common working class person. There is going to be so many unforeseen outcomes whenever it does become a thing, but the loss of income is really going to be the worst of it for so many people. (male, 18 to 24)

We included a quantitative measure of this concern (see Table 3.6) in one of our subsequent surveys (sample size = 395). Results confirmed this fear is held by almost two-thirds of American adults.

Table 3.6 Concerns about robots taking human jobs

	Concerned (5, 6, 7 on a 7-point scale)	**Neutral (4 on a 7-point scale)**	**NOT concerned (1, 2, 3 on a 7-point scale)**
Please indicate the extent to which you are concerned about … robots taking human jobs/causing massive unemployment	62%	9%	29%

Expert Point of View—Robot Impact on Jobs

Experts agree that the coming robot revolution will lead to significant job displacement. They see it as essentially unavoidable that robots with increased intelligence, improved social capabilities, and enhanced mobility will naturally take jobs that they previously could not. However, the experts are fairly evenly divided on the ultimate outcome. About half of the experts canvassed by the Pew Research Center have a clearly negative view of the end result. They believe robots will eventually displace a significant number of both blue and white collar workers, and these jobs will never come back. The net results will be a job loss for humans. They see this leading to an even greater wealth divide and potentially even cause substantial social unrest.

> *Unlike previous disruptions such as when farming machinery displaced farm workers but created factory jobs making the machines, robotics and AI are different. Due to their versatility and growing capabilities, not just a few economic sectors will be affected, but whole swaths will be. This is already being seen now in areas from robocalls to lights-out manufacturing. Economic efficiency will be the driver. The social consequence is that good-paying*

> *jobs will be increasingly scarce. (Mark Nall, Program Manager for NASA)*

On the other hand, about half of the experts interviewed believe robots will not lead to a net job loss. Instead, as with all technological revolutions in the past, they see a shift in jobs. While robots will take many jobs, other new labor opportunities will be created. These experts say more jobs will be produced in professions that require the "human" traits of creativity and innovation. They emphasize the need for ongoing education and job training to help human workers transition to these new occupations. These experts say that if handled correctly, the shift can be temporarily tumultuous, but in the end generally positive.

> *Driven by revolutions in education and in technology, the very nature of work will have changed radically … Some classes of jobs will be handed over to the 'immigrants' of AI and robotics, but more will have been generated in creative and curating activities as demand for their services grows exponentially while barriers to entry continue to fall. (JP Rangaswami, Chief Scientist for Salesforce.com)*

Source: Smith and Anderson (2014).

Amazon is at the forefront of this movement, with plans for a massive robotic workforce at the expense of human employees. Already, Amazon has placed over 100,000 robots in its warehouses, working tirelessly sorting and retrieving packages. This activity remains generally out of sight for most consumers. Soon, however, Amazon plans to unleash an army of robots to deliver our packages (Shell 2018). These robotic drones, wheeled delivery "Scout" robots, self-driving and eventually self-flying vehicles will replace for many of us the friendly delivery person.

This has significant public relations implications for businesses. While there may be economic benefits in replacing human workers with robots, there will clearly be a negative impact on corporate image. The public's antennae are up, and they are watching to see if companies will lay off workers and replace them with robots. If it happens with frontline workers such as restaurant waitstaff and hotel receptionists, it will be much more visible to consumers than when it occurred in factories and warehouses over the last few decades. And if companies begin to significantly replace white collar workers with robots, it will be a shock to this segment of society who is not yet expecting this.

Widespread job replacement, if it occurs without a plan for new opportunities for the replaced human workers, will lead to a significant public backlash against robots. We would expect a degree of violence and vandalism against these robots in reaction to large-scale job losses. There have already been numerous incidents of attacks on working robots. At least two security robots (the K5s mentioned in Chapter 1) have been physically

attacked. A service robot in a mall in Osaka, Japan, was viciously beaten by a group of young men. In Moscow, a man beat a teaching robot with a baseball bat and kicked it while on the ground, all while the robot pleaded for help (Bromwich 2019). Companies planning to replace human workers with robots on a large scale should think ahead, and start working now with government, nonprofit groups and others to plan for the best way to manage this massive labor transition. Given the reality that government is generally slow to deal with long-term crises, corporations need to get out in front of this one.

Fear #2. Robots can malfunction and get hacked, causing chaos (extremely common)

We live in an era when our digital information gets hacked more often than we would like, and our phones and computers regularly experience bugs, malware, and other problems. Recent events in the news with Russian election hacking and digital data ransoming add to this concern. Hence, Americans expect some degree of problems with any mechanical and electronic equipment, and they extend this to robots as well. The vast majority of Americans worry that robots, even highly advanced ones, can malfunction and get hacked. Making this an even greater concern is an understanding that if humans give robots greater and greater control in society, a malfunction in one or many robots can lead to significant society-wide problems.

Selected Comments from Survey Respondents

I think the worst thing that could happen is that the robots could potentially be hijacked by unscrupulous hackers, if adequate security measures and second- and

third-level verifications are not in place. This could be catastrophic in the cases of trains, buses, and automobiles. One bad actor could potentially wreak havoc on an entire city with a renegade robot taxi, for example. (male, 25 to 34)

You can't hack a human mind… but you can definitely hack a program. … and now imagine these robots being hacked by some shady group or whatever, and the chaos that could ensue. (female, 18 to 24)

The worst part would be complications. If a robot was wired wrong and made a mess of the house rather than clean it, that could be problematic. If a robot designed to help with restaurant orders got everything wrong, the restaurant could lose customers. If a robot designed to sort medication messed up, it could be a huge calamity. (female, 35 to 44)

Clearly, businesses need to be cautious in their utilization of robots, particularly in roles where any malfunctions can cause harm to consumers, or be easily noticed by them. Consumer anxiety in this area can make even small robot errors seem like large ones, and exacerbate their concerns. It taps into consumers' concern that robots must always be under our control, and if they are for any reason out of our control or under the control of a few rogue agents, then our worst fears will be realized. Companies should be willing to make significant investments in security against hacking, and do large amounts of testing to identify potential malfunctions. Rushing for short-term financial gain could lead to long-term loss of brand image and customer trust if potential problems are missed. Companies should advertise the efforts they put into securing the data and software used to run their robots. This will be a sign of responsible corporate leadership to the public.

Fear #3. People will get lazy/overly reliant on robots (very common)

This is the *Wall-E* view of the future. A large segment of Americans worry that we will become too reliant on robots. As a result, we will lose our ability to do things for ourselves. As a race, humans will become lethargic and lazy. This concern manifests the duality of the public's views regarding our robot future. On one hand, as reported earlier, consumers are excited about robots doing mundane tasks for them, to free up their time. However, as they express here, they do not want to become too reliant on robots, losing their knowledge or ability to perform basic tasks.

Selected Comments from Survey Respondents

I think robots would make humans lazy, because they would be doing all the work for them. People would depend on them, and as a result, the obesity rate will probably skyrocket. (female, 25 to 34)

I could see a future that looks much like that depicted by Disney/Pixar in Wall-E. A future where everyone is morbidly obese. A future where people struggle just to move their own body weight. A future where they just lie around doing nothing because there is nothing left for them to actually get up and do but eat, sleep, and poop. This would be a rather sad future. (male, 18 to 24)

I think we would stop doing whatever tasks the robots are doing for us entirely and overtime may even forget how to complete it on our own and perhaps younger generations would never learn them at all. For example, if self-driving cars were the norm, people might not learn how to drive anymore. (female, 45 to 54)

There is always the part where people ask robots to do their every little chores. Humans will lose their set of skills acquired through thousands of years of evolution. That is sad. (male, 55 to 64)

This concern should be kept in mind when companies market the value of robots. Companies must walk the fine line of presenting robots as helping humans by freeing up our time, but

not diminishing humans by causing us to forget how to do everything. Positioning service robots as giving people time to pursue hobbies and fulfilling activities is a plus. Anything that makes it appear as if we will become listless, lose our skills, or become overly dependent on our robot servants should be avoided. The latter scenario suggests a loss of control, and any loss of control to robots will lead to anxiety for most consumers.

Fear #4. Robots will reduce human interactions (very common)

Just under half of the respondents suggested that an increased role for robots in society will reduce human interactions, and cause us to lose our ability to communicate effectively with each other. An increased reliance on robots will break down social bonds and human-to-human connections, making for a colder and more isolated society. Many respondents commented that due to smart phones and computers, we already spend more time staring at screens instead of into the faces of people around us. They worry a robot future will simply accelerate this, and we will increasingly lose our ability to interact with our fellow human beings.

This, again, is another example of the complex duality in opinion people express regarding the possible robot future. As stated earlier, there is optimism more robots in frontline service positions can lead to greater accuracy, efficiency, and politeness. However, there is also real concern that too large a presence of robots in these positions will reduce necessary human bonds in society.

Selected Comments from Survey Respondents

The worst things would be there would be a lot less human contact. Instead of communicating with a human you would be talking to a robot more. The newer generation will not be able to have good people skills. It would be harder for them to have good relationships. (female, 45 to 54)

It would definitely replace a lot of human-to-human interactions. …. So during a typical day, a person might interact with a coffee shop barista, a couple of restaurant servers, a package delivery person, a grocery store cashier. The person might not notice all these in-person interactions now, but if they all get replaced by robots someday, it might feel pretty lonely and isolating for a person. Maybe the whole world would be a lot quieter, as there will be less and less people talking to each other … (female, 25 to 34)

The worst part is losing more socialization than we already have. We as a society already struggle to communicate and taking one more social aspect out would make that even worse. The generation coming up wouldn't know how to deal with people. (male, 45 to 54)

Expert Point of View—Robots Reducing Human Interactions

Experts share the concern that an increasing reliance on robots means a reduction in human interactions, and this worries them. They foresee a robot future that is much more isolated and lonely, with critical human-to-human social bonds fraying.

> *AI and robotics will change the way we interact with other members of society. The tendency will be toward more social isolation and fewer human-to-human contacts taking place. … The world will be more bureaucratic and 'cold' in 2025 than it is today. (Vytautas Butrimas, former Vice Minister, Ministry of Communications and Informatics,*

Lithuania)

Some experts believe it will be seen as a "luxury" offering if a company/organization provides a human representative with whom to interact.

> *Customer service will be almost entirely done with scripted agents. … Live, human salespeople, nurses, doctors, actors will be symbols of luxury, the silk of human interaction as opposed to the polyester of simulated human contact. (Judith Donath, fellow at Harvard University's Berkman Center for Internet and Society)*

> *I expect that the world will become increasingly divided between 'standard' service and 'concierge' service in many aspects, with standard service left entirely to the machines and concierge service resting more upon human relationships. (Andrew Bridges, partner and Internet law litigator and policy analyst at Fenwick and West LLP)*

Academic research also echoes this concern. Several scholars have found that increasingly advanced robots will likely become heavily anthropomorphized and many humans will minimize their social bonds with other humans and instead prefer the more comfortable and controllable relationships with robots (we will dive deeper into this issue in Chapter 7).

Sources: Smith and Anderson (2014), Turkle (2017), Scheutz (2012).

This will be a challenge for companies. How can they make their places of business still appear warm and "human" if they rely increasingly on robotic frontline workers? How do they respond to the concern that an overreliance on robots will reduce the necessary human bonds that keep a society functioning? This suggests there will remain a role for human interaction in any frontline service environment, even if the services can be completely replaced by robots, at least at first. This would also create opportunities for other companies to produce services and environments that foster human-to-human interactions, to make up for what is lost in other areas. Whole new industries may sprout up around finding ways to get humans to interact with other humans in a meaningful way.

Marketing can emphasize that robots will give people more time to socialize with one another, if robots help us with our mundane chores and improve the efficiency of daily tasks. It will be a difficult tight rope for marketers to walk—showcasing the positives of their robot service workers, without activating concerns regarding a breakdown of the social fabric that makes human society work.

Fear #5. Robots will reduce our privacy (very common)

Public concerns about privacy are already at a high level, due to the increased accessibility of personal data in the digital sphere (Milne et al. 2017). Americans see the widespread utilization of robots as only worsening this problem. Many

Americans view robots as potential spies for companies, watching consumers as they live their lives and collecting information on their behaviors. Some of our survey respondents referred to the recent issues regarding virtual assistants such as Alexa listening in to personal conversations (McCue 2019). They see intelligent robots pervasive in society as a significant threat in this regard. This is another aspect where the issue of perceived control comes into play. Americans worry that if robots are not serving the best wishes of the consumer and are instead serving another nefarious purpose (of a company, government or techno-elite), then the robot future will indeed be a negative one. This is exacerbated by the fact that consumers have very little trust in big businesses to begin with (Gallup 2019).

Selected Comments from Survey Respondents

Many people would also not trust robots and think that they are being spied on by their significant others, the government, their family, or someone else. They may think that robots cannot be trusted, and they may be right. (female, 25 to 34)

I think I would fear the information that would be stored within the robots and I would be concerned that my safety would be compromised. I would question if I could trust the robots, and the information that they may be privy to. Also, alongside the concerns that already exist for smart speakers, there's always the concern that they are listening when they're technically not supposed to, and recording that information. (male, 35 to 44)

Privacy would be a major issue. If your robot has constant access to your voice, home, web search there is no telling when the robot would stop listening and how that information could be used against you. This could be for something simple like advertisement or something more sinister like blackmail. (female, 18 to 24)

We included a quantitative measure of this concern in one of our subsequent surveys (sample size = 395). Results confirmed this fear is held by 52 percent of American adults as shown in

Table 3.7.

Table 3.7 Concerns about robots invading our privacy

	Concerned (5, 6, 7 on a 7-point scale)	**Neutral (4 on a 7-point scale)**	**NOT concerned (1, 2, 3 on a 7-point scale)**
Please indicate the extent to which you are concerned about … robots causing data insecurity or privacy breaches	52%	15%	33%

Expert Point of View—Robots Reducing Our Privacy

Scholars who study human-robot relations are concerned that the proliferation of robots in our lives could create a significant privacy risk. Robots will provide new opportunities for data collection as they live in our homes and are present throughout much of our day. Further, social robots will be programmed to be engaging and endearing, and often designed to look friendly and trustworthy, and hence may lower our resistance to sharing information with them.

Source: Fogg (2003), Calo (2012).

Companies must take this concern seriously. They should resist the temptation to use robots for data collection. Companies must assure consumers that their personal privacy is of the utmost importance. If consumers do not trust robots, they will not buy them for use in their homes nor want to interact with them in the marketplace.

Fear #6. Robots will take over the world (somewhat common)

This is the *Terminator* scenario. Roughly one in four respondents voiced this concern. While nowhere near a majority, given the extremity of the view it cannot be taken lightly that roughly a quarter of Americans perceive it as a real possibility. This concern is driven somewhat by nightmarish portrayals of robots in the entertainment media, somewhat by opinions voiced by worried elites such as Elon Musk, and somewhat by the understanding that AI is a completely new and powerful technology with unknown outcomes. This is the ultimate loss of control scenario. Pandora's Box is opened and whatever is unleashed cannot be contained. For many Americans, super-intelligent, autonomous robots represent a potential existential threat to humanity, much as nuclear war has been for several decades and climate change has been more recently.

Selected Comments from Survey Respondents

The intelligence of machines could, given the processing power of computers, develop very quickly to surpass the intelligence of human beings. There is no guarantee that the new intelligence would be friendly to human beings, and in

fact, its superior rationality and lack of susceptibility to cognitive bias, could actually determine that humans are useless or harmful and kill us all. Which would be a bummer. (female, 35 to 44)

They will take over. They have no feelings so they will be cruel. If they are in enforcers roles like police then it would be a big trouble. They will control all of us. (female, 18 to 24)

As robots get more and more advanced and equipped to complete more and complex tasks, it requires their corresponding programming to become more and more complex and in-depth. Giving machines more abilities runs the risk of the machines themselves actually becoming sentient, as in the movie The Terminator. It would be very dangerous if machines were able to develop minds and inclinations of their own, because that would mean that they would no longer be under human control. (male, 35 to 44)

We included a quantitative measure of this concern in one of our subsequent surveys (sample size = 395). Results confirmed this extreme fear is held by 24 percent of American adults shown in Table 3.8.

Table 3.8 Concerns about robots enslaving humans

	Concerned (5, 6, 7 on a 7-point scale)	**Neutral (4 on a 7-point scale)**	**NOT concerned (1, 2, 3 on a 7-point scale)**
Please indicate the extent to which you are concerned about … robots enslaving humans	24%	9%	67%

Expert Point of View—Robots Taking Over the World

Many respected leaders from science and technology have said the scenario of intelligent robots taking over the world from humans is possible, and efforts should be made starting now to make sure it does not happen. Among the experts who see this as a possibility include physicist Stephen Hawking (before his death in 2018), Microsoft founder Bill Gates, Tesla and Space X founder Elon Musk, Skype co-founder Jaan Tallinn and MIT cosmologist Max Tegmark. Not a shabby list of names! These experts are not saying this apocalyptic outcome is likely. However, they do feel there is at least a small chance, and given the severity of it, efforts should be made to ensure it is avoided. Several of these luminaries support the Future of Life Institute, whose purpose is to mitigate existential risks to the human race, which includes super-intelligent robots (www.futureoflife.org).

Source: Rawlinson (2015), Future of Life Institute (2019), Kharpal (2017).

Companies should take this concern seriously. It is not simply the stuff of science fiction movies but a belief held by a sizable segment of the population. Companies should be cautious in their research and development in this area. Let the public know serious thought and ethical considerations are being given

to advancements in AI and robotics. The public wants to feel companies are not rushing headlong into our robotic future without stopping to think about the consequences.

Implications for Consumer Behavior and Marketing Strategy

All consumer groups, including those who lean toward more positive beliefs and those who lean toward more negative beliefs regarding a robot future, will hold companies accountable on how well the robot future unfolds. They will expect that robot advancement and implementation is done carefully, with the larger societal good constantly kept in mind. This applies to all the items mentioned, from job losses to privacy issues to the fate of the human race.

The fundamental consideration for businesses developing robots or planning to use them in consumer service roles is to make sure consumers always feel firmly in control in their interactions with robots. One way to do this is to make robots smaller than the average adult, with visible cues denoting deference and submission to humans (more on this in our chapter on robot appearance). The first customer-oriented usage of robots should be in supportive roles, avoiding any positions of authority or power over humans. For instance, security robots, such as those by Knightscope, should be used for surveillance purposes but not used to subdue or confront humans. Also, consider having a verbal command that can put any robot into a temporary sleep mode (a “kill switch,” so to speak), and inform

consumers of this command so that they always feel they have the upper hand if a situation begins to feel threatening to them (there likely will be a few exceptions to this, such as the aforementioned security observation robots). And companies must avoid the temptation to use robots to collect personal data about consumers.

Another fundamental issue for companies to keep in mind is that robots must be seen as if they have been incorporated into the customer journey to make the experience better for the end user, and not purely in the service of corporations (as merely a way to save money, for instance). Consumers currently assume that if robots are to be used in customer service, it will imply improvements in efficiency, accuracy, and overall experience. If robots are seen as bringing a customer experience below that of a human interaction, consumers can very quickly turn against the robot revolution. They want robots to improve their lives, not simply enrich corporations.

Given the wide variety of attitudes regarding robots, as companies begin to incorporate robots into customer-facing roles in their businesses they should also incorporate attitudes toward robots into their customer segmentations. If possible, provide choices to consumers. For instance, allow customers to select a section of a restaurant serviced mainly by robots versus a section mainly serviced by humans. The same can be true for many customer interactions, from help finding merchandise in a store to a room in an assisted living facility.

Businesses sometimes get so enthusiastic about technology that they implement it with giddy abandon. With robotics, this

must be avoided. Companies must appear cautious, mature, and thoughtful as they roll out the upcoming robot revolution. Businesses must consider the larger social and economic impacts this wave of robotics will bring. Most importantly, companies should work—in a highly visible manner—with government and other social entities to help with the massive job dislocations that will be caused by the upcoming robot wave (something that was not done well with the automation of factories in the 1970s through 1990s). If not, public facing robots will become highly visible targets of people's anger. It took time, but many corporations have come to realize the value of a positive public image on environmental issues. The same will be true regarding the use of robotics.

All in all, the American public sees the potential positives that advanced robots can bring society, but they also acknowledge some significant potential negatives. They will be holding companies responsible to get this right.

CHAPTER 4

Acceptable Robot Roles: At Home, in the Community, at the Store

We are approaching a time when machines will be able to outperform humans at almost any task. I believe that society needs to confront this question before it is upon us: if machines are capable of doing almost any work humans can do, what will humans do?

—Moshe Vardi, Professor of Computer Science at Rice University

Chapter Overview

We begin this chapter with a review of when the experts believe robots will surpass humans on a variety of tasks. While there is significant disagreement among the experts, the general tendency is to believe robots will surpass humans on *all* tasks in roughly 45 years! We then explore public acceptance of robots performing a wide variety of tasks in the home, hotels, restaurants, stores, schools, and in the general community. Our survey results show that the majority of Americans are clear on what they will support robots doing over the next two decades

(particularly low level support tasks and menial chores) and what they will *not* support robots doing (tasks involving the supervision of children, life and death decisions, or roles of authority). In each area we discuss what robots are currently doing and cases where there has been commercial success (such as most iRobot vacuums for help with household chores) and commercial failures, (such as Jibo) and where companies have, after some faltering, learned to find the right balance of robot incorporation (such as Japan's Hotel Henn-na). We also explore how younger Americans and those paying more attention to recent robot advancements are more supportive of robots taking on a wider variety of tasks in the near future versus their older or less informed counterparts.

The Expert View: When Will Robots Surpass Human Capabilities?

What roles will we humans ask robots to play in society? As the opening quote from Professor Vardi demonstrates, many experts in the field of robotics and artificial intelligence believe robots will at some point be able to do almost everything better than humans. Should we move towards a world in which robots are doing pretty much all of society's tasks, freeing up humans to do other things with their time? Or, even if robots are capable of doing more and more tasks for us, should we place limits on what we have them do? What roles will average consumers accept robots taking on?

We devoted one of our national surveys, involving 370 adult

Americans, to this question. In the study, we asked respondents if they would trust robots taking on a variety of roles in the next 10 to 20 years. We emphasized we were not asking about roles robots could assume in the present day, but rather looking ahead to the next decade or two, given the expected advancements in robotics. We organized the tasks into the following settings: at home, at a hotel, at a restaurant, in a school, in a store, and in the community. We deal with health care settings separately in the next chapter.

Before we explore consumer trust in robots performing various tasks over the next two decades, it is helpful to ground ourselves in the timeline offered by experts regarding when we can expect robots to equal or surpass humans in their ability to perform certain functions. In 2016, Dr. Katja Grace of Oxford University and her research team conducted a survey of 352 experts in the field of artificial intelligence (AI). The survey asked these experts to offer their best estimate for when they believed AI would equal or surpass human capabilities on a variety of tasks.

The results show a fair amount of disagreement among the experts, with predictions varying significantly. However, by looking at the median responses we can get a generalized estimate of what these experts expect for the future. Interestingly, on average these experts believe artificial intelligence (which is the driving force behind the capabilities of advanced robots) will equal or surpass humans on many tasks before 2030—less than 10 years away. And, on average, these experts believe artificially intelligent devices will equal or

surpass humans on *all* tasks by 2064 (see Table 4.1). Let that sink in a bit. These experts predict that within the lifetimes of many people reading this book, and certainly of their children, artificially intelligent robots will be equal or better than humans at *everything*! What will be the role of humans in this type of future?

Table 4.1 When experts predict AI will equal or surpass humans on the following tasks

	Expected year
Fold laundry	2022
Assemble any Lego® model	2024
Read text aloud	2025
Write a high school level essay from scratch	2025
Write and sing a top 40 pop song from scratch	2028
Drive a truck	2028

Run a 5k race	2029
Play Go	2029
Be a retail salesperson	2030
Write a best-selling novel (from scratch)	2053
Be a surgeon	2053
Can accomplish *every task* better and more cheaply than humans	2064

Source: 352 experts in the field of artificial intelligence (Grace et al. 2018).

As stated in the foregoing text, there is a fair amount of variance in the predictions by experts. For instance, regarding when these experts believe AI-driven devices will be better and cheaper than humans in every task, while the median predicted year is 2064, one quarter of the experts in the sample believe it will occur before 2040, while another quarter believe it will not occur until after 2120. This shows there is a high level of uncertainty regarding the timeline of robot and AI development.

We will now turn to the consumer perspective regarding their comfort level with robots assuming a variety of roles in their lives.

The Consumer Perspective

Robots at Home

We asked consumers about 18 different tasks in the home that robots could potentially perform in the next 10 to 20 years. The results showed a wide range of what consumers would trust robots to do for us in our homes, from almost universal acceptance (vacuuming) to almost universal rejection (babysitting).

On the high trust end, consumers are extremely supportive of robots doing our simple household chores over the next 10 to 20 years, such as: vacuum the floors (86 percent would trust a robot to do), snow shovel the driveway (80 percent), mow the lawn (77 percent), make the beds (75 percent), clean the bathrooms (72 percent), and wash and put away the dishes (72 percent). Clearly, the vast majority of Americans would be perfectly comfortable having a robotic maid and a robotic gardener that can do these basic daily maintenance chores around the house and yard. These are subservient roles where it feels safe to place robots, doing our busy work for us and freeing up time in our daily lives. As is a constant theme in our findings, if people perceive robots are in roles that are fully controlled and subservient, they feel much more comfortable. As a respondent said in one of our follow-up in-depth interviews, *Sure, that's what robots should*

be doing. All those crappy chores that no one wants to do. Like vacuuming. Like cleaning toilets. Another stated, *Yes, I'd like to have a robot I could boss around and do all the work around my house. No one else at my house wants to do any chores, that's for sure.*

On the low trust end, consumers express very little trust in robots playing any role in childcare. Only 11 percent would trust a robot (in the next 10 to 20 years) to babysit children under the age of 2, and a similar 11 percent would trust a robot to babysit children aged 3 to 6. Not many more, 17 percent, would trust a robot to babysit a child aged 7 to 10. Follow-up in-depth interviews with consumers informed us that people see babysitting as a job with a high degree of risk, where one mistake could lead to death or injury, and they are not yet ready to give robots such a critical job (interestingly, young teens and tweens are regularly given the job of babysitting).

Consumers do not believe robots in the near future will have the situational awareness or the ability to fully control their actions to assume these sorts of childcare roles. As one study respondent stated, *What if the robot holds the child's arm too tightly? It [robot] could break it right off and not even know it's doing that.* Also, consumers see childcare as a job requiring a degree of humanity, compassion, joy, and even silliness, all qualities where they felt robots would be lacking. Many consumers struggle to see robots having a warm, caregiving personality. As one respondent said, *That would be terrible for a small child, to have some cold robot as a caregiver. That's just not right. It's not healthy.*

Consumers show significantly more receptivity to robots acting as companions to adults living alone. Though still not a majority, 40 percent of consumers would trust a robot in this type of role within the next couple of decades. As stated in the previous chapter, this is seen as a significant need in society. Also, older adults are viewed as able to hold their own with a robot, and the tasks required are perceived to be more suited to a robot. As one respondent stated, *I think a robot would be great for an older person living alone. It could keep them company. Talk with them. Maybe read a book to them when their eyesight gets bad. Maybe even go buy them groceries. I would still prefer a dog, myself.*

Here's a finding of interest to auto companies: only 35 percent of adult Americans would trust a robot to drive them around in their cars in the next 10 to 20 years. Follow-up interviews informed us that this is another situation, like childcare, where people see "life and limb" on the line. Speeding along in a vehicle at 60 miles an hour is a dangerous thing, consumers relate, and they are not yet convinced robots will be able to do this with enough precision and consistency to make them feel comfortable. They base this perception on their current experiences with technology. As one consumer told us *When they build a computer that never crashes, never ever has any problems, I mean like zero problems, that's when I'll get into a car driven by a robot.*

Security companies should take note of the following: only 42 percent of Americans would trust a robot to serve as a home security guard over the next 10 to 20 years. As one respondent

told us *I really don't want to have armed robots roaming around. That's like one of these horror* Terminator *movies*. This connects back to the issue of control, and making robots into security guards places them in too powerful and too dominant a role for most consumers to accept.

Table 4.2 provides the complete results for home tasks.

Table 4.2 Trust in robot roles in the home—in the next 10 to 20 years

Task	% Trust robots to do
Vacuum the floors	86
Snow shovel the driveway	80
Mow lawn	77
Make the beds	75
Clean the bathrooms	72
Wash and put away dishes	72

Wash and iron clothes	66
Paint the exterior of the house	62
Serve food	61
Be a butler	56
Plant and maintain garden	55
Cook food	45
Be a security guard	42
Be a companion to an adult living alone	40
Drive you around in your car	35
Babysit children aged 7–10	17
Babysit children aged 2–6	11

Babysit children under the age of 2	11

When we asked adult Americans in another one of our national surveys (sample size = 476) if they would prefer a robot servant or human servant in their homes, roughly half said they would prefer a robot servant, while about one in six would prefer a human servant, with the remaining one-third being not sure. This aligns with our findings that consumers are quite comfortable with robots doing all their mundane household and yard chores for them. See Table 4.3.

Table 4.3 Preference for a robot versus human servant at home

Prefer robot servant	Not sure	Prefer human servant
52%	32%	16%

Why do three times as many consumers prefer a robotic servant over a human servant? Many say they would feel more comfortable having a robot do all their routine chores for them, often involving degrading and tiresome work, versus asking a human to do it. As one consumer stated, *I wouldn't mind telling a robot to scrub all my bathroom floors for me, but I'd feel kinda bad ordering around a person to do all my cleaning*."

Others believed robots could work all hours of the day, all days of the week as needed, which would be a nice perk. One respondent stated, "*A robot could clean up the house after a party at two in the morning. No complaints. No overtime pay.* The small minority who would only consider a human servant were mainly driven by their general distrust of robots. As one respondent told us, *I don't want any robots in my house. Period.*

Younger consumers are significantly more open to the idea of personal servant robots than are their older counterparts, with 65 percent of Millennials liking the idea versus 50 percent of Gen Xers and 49 percent of Baby Boomers. See Table 4.4.

Table 4.4 View of personal servant robots by generation

	Like (%)	Dislike (%)	Not sure (%)
Millennials	65	11	24
Gen X	50	12	38
Baby Boomers	49	15	36

Source: OIG (2018a).

As the preceding text and tables show, there is a significant level of support for robot help at home, undertaking basic chores

for us. There is far *less* support for robots playing a role in our workplaces. In one of our national surveys (sample size = 345), 57 percent of adult Americans said they would find robot help with home household chores useful, while far fewer, 37 percent, said they would find robots useful helping out where they work (see Table 4.5). Much of this resistance is due to fears of robots replacing them at work. As one respondent stated, *There are definitely things a robot could do where I work one day. Probably do them better than people. But I wouldn't want that. I don't want to compete with a robot. The company would love robot workers because they'd never complain.*

Table 4.5 Robot utility at home versus at work

	In my household chores (% agree)	**In my job (% agree)**
I would find robots useful …	57	37

Home Robots: Real World Successes and Failures

We have seen both commercial successes and failures in the early years of home robots. On the more simplistic side, Roomba robotic vacuum cleaners (from iRobot) have been a commercial success. They fit the role of a clearly

subservient, and relatively simplistic, robot doing a mundane chore that very few people want to do. The end benefit is clear to consumers, and there is no threat to the household dynamic. (See pictures at www.irobot.com).

On the commercial failure side is the Kuri home robot (from Mayfield Robotics), which was on sale for only a short time before being pulled off the market in 2018 due to low consumer uptake. It was a cute robot meant to serve as a social companion in the household, with a security camera allowing for surveillance (by the home owner) and with some fun features to entertain children. However, its abilities were limited and it was perceived as somewhat gimmicky. The end benefit to the consumer was not clear. Hence, consumer interest was not at the expected level and the robot is no longer being sold (Simon 2017; see video of Kuri at www.youtube.com/watch?v=Gvle_O4vD18).

Another commercial failure is Jibo, from the Boston-based robotics company of the same name. Launched in 2017, Jibo was billed as "the world's first social robot for the home." It was stationary, like an Alexa, but meant to be far more interactive and friendly. It had the ability to recognize people in the home, start and maintain conversations, take pictures, read books, relay messages, and ask you about your day. However, by late 2018 Jibo was pulled from the market due to lower than expected sales (Van Camp 2019; see video of Jibo at www.youtube.com/watch?v=H0h20jRA5M0).

Yet another commercial failure is the Cozmo robot (from Anki). This robot was sold as an interactive and educational robot for children, meant as a playmate. Its robotic face was fairly emotive, with eyes that expressed its feelings. The manufacturer said hundreds of thousands of Cozmo robots were sold since its launch. However, investors did not have enough faith in the robot and the sales were not high enough for comfort. As a result, Anki went bankrupt in April 2019 and discontinued production of all its robots (Heater 2019; see video of Cozmo at www.youtube.com/watch?v=DHY5kpGTsDE).

The Kuri, Jibo, and Cozmo cases, along with our survey results, suggest that the personal robot business is a tough one, and there will be major bumps in the road as manufacturers introduce home robots to the marketplace. Based on our research, robots that can do household chores effectively and efficiently will likely do well commercially (given a reasonable price point). The purpose the robot serves, and the end benefit to the consumer, must be clear. Being cute and novel is not enough. Further, robots that are meant to provide a security, social or child-oriented task will be scrutinized more closely by consumers, with a hirer bar to meet.

An interesting robot in development is the Care-o-bot 4 from the Fraunhofer Institute. This is a more advanced robot than Kuri, Cozmo, or Roomba. Its website (www.care-o-bot.de/en/care-o-bot-4.html) describes many applications of this robot—doing both service and

social tasks—both in and out of the home (retrieved October 23, 2019). The website showcases the robot assisting a person in his kitchen as he prepares a meal. See Figure 4.1.

Figure 4.1 Care-o-bot 4 from the Fraunhofer Institute

The Care-o-bot 4 represents a significant step in the direction of a multi-capable robotic home servant, with the ability to retrieve and deliver household items, do basic chores, and has a face that turns into a computer console when needed. It is also a social robot. The website describes the robot's personality as "courteous, friendly and affable as a gentleman." Since 2018, the Care-o-bot has been working in German assisted living facilities, bringing food and drink to residents and playing memory games with them (Calderone 2018). We are still far from Rosie the robotic maid on The Jetsons, but we are moving steadily in that direction.

Robots in the Community

We tested 11 possible roles that robots can play in people's communities over the next 10 to 20 years. Not surprisingly, the role that found the highest level of trust among consumers for robots to undertake in their communities is as sanitation workers. In keeping with the trend in all our research, we find that consumers are most supportive of placing robots in the most subservient of roles, doing our lowest, least-preferable tasks. Of those surveyed, 56 percent said they would support robots as sanitation workers in their communities over the next 10 to 20 years. Next in terms of community roles is the librarian's role, which is a much more intellectual job, but still a subservient and fairly safe one. Forty-eight percent of adult Americans would

trust a robot to serve as a librarian in the next 10 to 20 years.

Potential roles in the community which garnered the lowest levels of trust in robots undertaking are those where robots would be given power and authority. Only 19 percent would trust a robot to serve as mayor in the next 10 to 20 years. This is interesting, given that in the United States, numerous polls show that we have very little faith in our human politicians. Yet, we are not ready to trade in human political leaders for robotic ones. Follow-up interviews suggest consumers do not think that robots, over the next two decades, will have the decision-making capacity, or ethical perspectives, to run our towns. As one said, *Mayors have to make a lot of decisions about what's best for the town. What's best for the people in the town. Robots can't do that*. For others, it would mean giving too much power and authority to robots, and that was unacceptable. As one respondent said, *I don't want robots to run my town. Next they'll run the world. Then they'll get rid of us*.

Also, roles that would give robots potentially lethal power, such as serving as a police officer or soldier, garnered little trust (19 percent and 32 percent, respectively). Of these two functions, the role that would place a robot more closely into the community in a potentially lethal role (police officer) garners significantly less trust than the one that places a robot further from the community (soldier). See Table 4.6 for full results regarding community roles for robots.

Table 4.6 Trust in robot roles in the community—in the next 10 to 20 years

Task	% Trust robots to do
Be a sanitation worker	56
Be a librarian	48
Direct traffic in a busy downtown area	42
Be a taxi/Uber driver	41
Be a firefighter	34
Be a news reporter	32
Be a soldier in the army	32
Be a lifeguard at the community pool	22
Be a coach for a youth sports team	22

Be a police officer	19
Be the mayor	19

As shown in the Table 4.6, only about one in three consumers (32 percent) would trust robots to serve as news reporters in their communities over the next two decades. Yet, robots and AI are already playing a growing role in news reporting, and both China and Japan have utilized robotic news anchors on television. See "Robots in the Newsroom" below.

Robots in Hotels

At a hotel, there are several roles that a large majority of consumers are comfortable seeing robots assume. Not surprisingly, these fall into lower level service roles such as carrying luggage (82 percent trust robots to do in the next 10 to 20 years), delivering room service (75 percent), cleaning rooms (68 percent), and serving as a hotel receptionist (63 percent). Consumers are split roughly in half on three of the more social roles, namely, hotel concierge (56 percent trust robots to do in the next 10 to 20 years), bartender (56 percent), and city tour guide (52 percent).

Robots in the Newsroom

Robots and artificial intelligence are already playing a

significant role in the news industry. Roughly a third of the content published by Bloomberg News uses some form of automated technology (Peiser 2019). Many news articles today are actually written, in whole or large part, by AI programs. As Jacyln Peiser writes in the *New York Times*, *In addition to covering company earnings for Bloomberg, robot reporters have been prolific producers of articles on minor league baseball for the Associated Press, high school football for the Washington Post and earthquakes for the Los Angeles Times*. It is estimated that billions of stories are produced every year that involve some AI writing.

Taking a step further into our robotic future, China's state-run news agency has introduced the world to the first robot anchorman. This is a highly humanlike robot (see video at www.youtube.com/watch?v=bmqd9nYH5Fw) that reads the news with fairly realistic—though not quite perfect—gestures and inflections (Kuo 2018). The robot was developed via machine learning, based upon the mannerisms of a human news anchorman. Japan has also experimented with robot news anchors (Specktor 2018). So far, the trend of robot news anchors has not caught on too widely, but the capability is advancing.

Regarding bartending, we already have on the market the Smartender, an automated bartending system which can pour over 600 drinks that customers select via a touchscreen (Rigie

2018). No human bartender needed. If you desire a bit more interaction, you can visit the Tipsyrobot in Las Vegas, where a robotic bartender in the form of two large mechanical arms mixes drinks upon request. The robot bartender can even perform dance routines in between drinks (www.thetipsyrobot.com). However, according to our surveys many customers may prefer a more human-to-human experience when at a bar. As one respondent in our study told us when informed of automated bars, *Really, that's where the world is going? It's pretty sad that we will go to a bar, press some buttons, get a drink, then press more buttons for more drinks. God, that's sad.* Regarding a more interactive robot bartender, another respondent stated, *I'm sure a robot would know how to make every mixed drink there is. But I wouldn't want to sit at the bar and talk to a robot. That would be weird. I'd rather sit at a bar and chat with a cute human bartender.*

This taps into a wider theme that we heard from many respondents in our research, that it would be "weird" to interact with robots on a social level. The idea of casually chatting with robots is off-putting to many humans. We deal with this issue more in Chapter 7.

Not surprisingly, in terms of hotel roles there is the lowest level of support for robotic security guards (42 percent). Again, this reflects the hesitancy of many people to give robots too much power and authority. See Table 4.7 for full results.

Table 4.7 Trust in robot roles in a hotel—in the next 10 to 20 years

Task	% Trust robots to do
Carry your luggage to your room	82
Deliver your room service food	75
Clean your room	68
Be a hotel receptionist	63
Be a hotel concierge	56
Be a bartender	56
Be a city tour guide	52
Be a security guard	42

Robots in Hotels—Pushing the Limits Perhaps Too Far

The hotel industry has been using robots for basic functions such as delivering food, supplies, and luggage to rooms for the past few years. It is not yet a widespread practice, but the process has begun. As our survey results show, consumers are quite comfortable with these sorts of basic service roles. The first hotel in the United States to introduce a robot worker was Aloft Cupertino in Silicon Valley (of course!), which did so in 2014. The robot, nicknamed Botlr (from Savioke), is a three-foot tall device that uses sensors, cameras, and wireless technology to deliver food and other supplies throughout the hotel. Since then many other hotels and hotel chains, including a Sheraton hotel in LA, the Royal Sonesta in Boston and the Westin Buffalo, have begun using similar robots for these basic functions. These robots have a built-in container that can be opened with a code specific to the hotel guests for whom the items are intended. And once delivered, the Botlr robot celebrates with a swivel dance and chirping noises (Walsh 2018; see a video here www.youtube.com/watch?v=nxFxdIngOPc).

As we have seen with many of these trends, Asian countries have pushed the robot wave to its current extreme. Hotel Henn-na, in Nagasaki, Japan, was created in 2015 and was the first hotel staffed mainly by robots—robot receptionists, robot bell hops, robot concierges, and so on. At its height there were a reported 243 robots working at the hotel. However, the robots did not work out as well as the company hoped, and many had to be

decommissioned and replaced by human workers. Reports are that, among other problems, the robot concierge was not able to answer many of the guests' questions, and the bell hop robots were unable to effectively navigate the entire hotel without getting lost or stuck (Gale and Mochizuki 2019; Liao 2019). Despite starting with a fair amount of excitement, Hotel Henn-na found that it could not deliver the full robot experience it initially promised.

That said, Hotel Henn-na has not given up on robots. It continues to utilize robots in its Nagasaki hotel as well as in other hotels across Japan. Robot receptionists have proven to be popular and up to the tasks in these hotels (see video here www.youtube.com/watch?v=7egDO6cyD58). In Japan, with its shrinking working-age population and minimal immigration, they have little choice but to keep working on robotic solutions to their staffing shortcomings in their hotels and other service industries.

Robots in Restaurants

Regarding restaurants, we again find the most support for robots in the lowest service roles. Roughly two-thirds of adult Americans are receptive to the idea of robot busboys over the next couple of decades. Slightly over half, 56 percent, are receptive to robotic waiters and robotic hostesses. Trust in a robotic cook in a restaurant over the next couple of decades is lower, at only 41 percent. Why so much less trust in a robot

cook? For many respondents, cooking was seen as requiring critical human traits of creativity and adaptability, which many felt a robot could not master. As one respondent stated, *I love to cook. Cooking involves a real, I don't know, human factor. You have to be creative. Try different spices, different ingredients. The great chefs of the world are, like, artists. I don't see a robot doing great cooking anytime soon. Maybe it can cook basic meals, like a burger, but not any great cooking*.

As has been a constant finding in our research, there is very little support for robots placed in any positions of management or authority. Only 26 percent of adult Americans trust a robot to serve as a restaurant manager in the next couple of decades. See Table 4.8 for full results regarding restaurant roles.

Table 4.8 Trust in robot roles in a restaurant—in the next 10 to 20 years

Task	% Trust robots to do
Be a busboy	64
Be a waiter	56
Be a host/hostess	56
Be a cook	41

Be the restaurant manager	26

As of early 2020, robots working in restaurants are still a tiny niche found mainly in Asian countries, and these restaurants generally function as novelty experiences for tourist and city dwellers (Nguyen 2016). However, over the next decade that may change dramatically. A study cited in *Forbes* magazine places the automation potential for waiters and waitresses at 77 percent (Rigie 2018). Already, many large chain restaurants across the globe have automated some of the customer experience with the ability to order and pay via tablets that sit on the tables. Yet, human servers still play a key role in bringing the food to the table, checking on the satisfaction of the patrons, and otherwise managing the restaurant floor.

That said, many robotics companies are working hard to change that. For example, a company called Bear Robotics shows on its website the robotic food servers it is developing moving briskly about a crowded restaurant binging food to hungry customers (www.bearrobotics.ai —as of November 22, 2019). The company's tagline is *Reshaping food service with robotics and AI*. Financially, restaurants could reap significant financial rewards by employing robots as wait staff and avoiding the hassle involved in hiring and managing these relatively high turnover workers (Rigie 2018). Yet, as we found in our studies, only slightly over half of Americans would trust a robot to perform this function. This consumer resistance could abate if the first generation of robot waiters does a fantastic job

delivering the right food to the right table, while still hot and yummy-looking. If not, restaurants must be prepared for consumer pushback.

Robots in Stores

Results for acceptable roles for robots in stores mirrors much of what we see in other areas. Just over three-quarters (76 percent) of adult Americans would trust robots to help them carry their store-bought goods to their cars over the next 10 to 20 years. To keep stores organized, 72 percent would trust robots, while 71 percent would trust robots to help them find items in a store. Just about two-thirds would trust a robot in the next 10 to 20 years to be the store janitor (69 percent) or cashier (65 percent). Slightly over half (57 percent) would trust a robot to serve as a shopping consultant, offering suggestions on what to buy. Far fewer would trust a robot in the next couple of decades to be a store security guard (44 percent) or the store manager (29 percent). See Table 4.9 for full results on store roles.

Table 4.9 Trust in robot roles in a store—in the next 10 to 20 years

Task	% Trust robots to do
Help you carry what you bought to your car	76
Keep the store organized	72

Help you find products you are looking for	71
Be a janitor	69
Be a cashier	65
Provide suggestions on what to buy	57
Be a security guard	44
Be the store manager	29

Robots in Stores—and Consumers' Suspicions

As mentioned in Chapter 1, Walmart currently has 300 robots working as janitors in selected stores, helping to clean the stores both during and after open hours (Grossman 2018). These robots resemble small Zambonis that autonomously direct themselves around Walmart's stores, continuously washing the floors. This is just the beginning for Walmart. *Money* magazine reports that Walmart will soon deploy 1,500 robotic floor cleaners,

1,200 robotic truck unloaders, 900 robotic in-store pick-up towers and 300 robotic shelf scanners. All will be autonomous and undertake tasks now done by humans (Calfas 2019; see video here www.youtube.com/watch?v=VMZM5rMOIPE).

Large grocery chains such as Giant Foods and Stop and Shop have reconnaissance robots that patrol the stores looking for spills or other hazards in the stores, weaving around customers and other obstacles (Grossman 2019). Many respondents in our in-depth interviews mentioned seeing these robots in their local grocery stores. Most were either unsure what their role was, or were highly suspicious of what these robots were doing. Much of the suspicion centered around the sense that these robots were "spying" on customers. These concerns appear to grow out of a general distrust of large corporations and the track record of companies using technology to collect information on consumers. As one respondent stated, *Why do these companies have these robots roaming around the aisles? It must be because they want to watch customers, to spy on us. It's just another way for them [companies] to spy on us.*

Mode of product delivery is an important part of today's shopping experience. Amazon is investing significant time and money researching robotic deliverers. In 2019, Amazon began field testing its delivery robot named Scout, which resembles a large cooler with wheels. These field tests are taking place (as of

2019) in Irvine, CA, with a human accompanying the robot to ensure it delivers the packages to the correct address. The human companion is also there to answer consumers' questions (Etherington 2019). Amazon's goal, it is believed, is to eventually turn much of its delivery "final mile" (last mile from main route to the home recipient) over to fully autonomous robots, both robots with wheels (such as Scout) or robots with wings (smart drones). We introduced Amazon's Scout in Chapter 1.

Half of Americans like the idea of independent delivery robots. The other half are divided between clearly disliking them (28 percent) or not yet sure what to make of the idea (22 percent). Companies such as Amazon have their work cut out for them to win over more consumers before they widely launch their robot deliverers. See Table 4.10.

Table 4.10 Like or dislike the concept of independent delivery robots

Like	Dislike	Not sure
50%	28%	22%

Source: OIG (2018b).

Robots in Schools

Regarding robots in schools, we tested six possible roles. See Table 4.11. Only one role, making and serving lunch, found a majority of adult Americans (albeit only a slight majority at 53

percent) trusting robots to take over this function in the next 10 to 20 years. Only 45 percent of respondents trust robots to serve as teacher's assistants, while 41 percent trust robots to act as security guards in schools. When it comes to teaching students (as a teacher, not just an assistant), trust in robots to serve in this role over the next 10 to 20 years is below 30 percent (29 percent to 24 percent, depending upon the age of the students). Why would this be, given that computers can serve as almost infinite sources of information? Our follow-up interviews suggest a mix of concerns.

Table 4.11 Trust in robot roles in schools—in the next 10 to 20 years

Task	% Trust robots to do
Make and serve lunch	53
Be a teacher's assistant	45
Be a security guard	41
Teach classes for high school students	29
Teach college classes	28

Teach classes for elementary school children	24

Security Robots on Patrol

As you may have noticed, we tested consumers' trust in robots serving as security guards in four of the settings discussed in this chapter (home, hotel, store, and school). The percentage of the public trusting robots in security roles in these settings was between 41 percent and 44 percent. Hence, most consumers do not yet trust robots in these roles, no matter where. Further, only 19 percent trust robots to be police officers, since that role suggests greater authority and firepower.

Robots are already playing an active role in security, with some working for community police departments. Currently, however, their role is mainly to keep watch and report. Knightscope has created a fleet of security robots named K1, K3, K5 and K7 (see them at www.knightscope.com). These robots, which work indoors or outdoors, come with highly advanced gear that in many ways makes them far better than humans at keeping a lookout for crime. Ranging in size from 4.5 to 6 feet tall, these security robots resemble large cylinders with cone-like tops. They utilize their onboard video cameras, thermal imaging sensors, laser range finders, and radar to spot anything suspicious. They have visual technology that can recognize faces and read license

plates, along with sensors to detect the presence of wireless devices. These robots are currently or have recently been employed by police departments (such as Huntington Park, CA), universities (such as North Central Texas College), and numerous malls, corporations, and hospitals. See Figure 4.2.

Figure 4.2 Knightscope security robots on patrol

South Korea has tested surveillance robots for use in its prisons. These experimental robots, called Robo-Guards, stand at five feet tall and are equipped with 3D cameras and intelligent software that can interpret inmate behavior as appropriate or inappropriate. Robo-Guard can immediately report anything suspicious to human

guards, who can then communicate with the prisoners via the robot's two way radio (Glaser 2016).

The security industry is very interested in deploying robots in a variety of ways. The observational technology now achievable with robots, along with their increasing ability to move about on their own and to interpret and react to situations via artificial intelligent software, as well as their ability to work all day and all night, make robots a natural fit for this industry. Whether the security industry will want to add to robots the ability to physically subdue and retain perpetrators is yet to be seen.

Regarding teaching younger children, we encountered the same issues we saw with babysitting. There is not yet enough trust in robots to give them responsibility over children. As one respondent told us, *I don't want a robot teaching in elementary school. What if it shuts off and there's no one to watch the children? What if it malfunctions and attacks the children, even if it doesn't mean to. Like, if it just starts zooming around the classroom because of a malfunction, not even aware its knocking over the children*. Regarding older children, one respondent noted *Teaching is not just being smart. A teacher has to connect with the kids. Can a robot do that? I'm not sure it can.*

Sex with Robots

We cannot complete a chapter on potential robot roles without discussing the use of robots for sex. Humans having sex with

robots has been showcased, or at least implied, in many films, both dramas and comedies, such as *Ex Machina* (2014), *The Stepford Wives* (2004), *A.I. Artificial Intelligence* (2001) and *Austin Powers International Man of Mystery* (1997); and in TV series, including *West World* (2016 to present) and *Battlestar Galactica* (2003 to 2009). In most of these, the robots are portrayed as the females (with major exceptions, such as *A.I. Artificial Intelligence*), and the sex is presented as fairly enjoyable for the humans.

Already, there is a growing international industry of brothels based completely on hyper-realistic sex dolls (see www.Lumidolls.com). The selling pitch for these advanced sex dolls is that they are made to look like a variety of "fantasy" sex partners, and that those who purchase sessions with these dolls can have any type of sexual fantasy that they would want without having to convince another human to go along. In essence, it gives the human participant complete control.

Adding robotic movements and interactions to these dolls is the next step in this industry, making the fantasy experience even more intense. This step is already well underway. Harmony, a sex robot made by Realbotix, is what you would expect a sex robot to look like. She has a highly attractive face and a voluptuous body. She can look you in the eyes, have a conversation with you, and also function as a sex doll is meant to function. If that is not enough, via an app the user can program different personalities and voices for Harmony, and change her facial features, to create different experiences (Morris 2018). Harmony sounds like something out of *WestWorld*, but she is

available today. And Harmony is just the start of where this industry is expected to take robotics. Companies are continuing to advance technology in this area, making for more and more realistic sexual encounters with robots.

According to a 2017 survey, roughly one in four men and one in ten women admit that they would consider having sex with a robot. See Table 4.12. An additional one in five of each gender says they are "not sure" when asked the question, suggesting a sizable amount can potentially be convinced, given the right circumstances.

Table 4.12 Sex with robots

	Men (%)	Women (%)
Definitely/probably consider	24	9
Definitely/probably NOT consider	58	71
Not sure	18	20

Source: You.gov (2017).

Summing Up: Most and Least Accepted Roles for Robots

Looking across all the roles that we tested in our surveys, a clear pattern emerges. American adults are *most* supportive of robots taking on clearly subservient service roles, doing our low level grunt work like carrying luggage, shoveling driveways, mowing lawns. American adults are *least* supportive of robots assuming any roles where they have responsibility over children, or play a law enforcement role, or where life and death may be at stake, or are placed in a leadership position over people. Robot scientists are pushing hard to expand the capabilities of robots. However, consumers are likely to push back just as hard on many of these possibilities. As with many new technologies, we expect acceptance to grow over time. The results from our studies identify the robot applications where initial resistance will be greatest, and where companies will have to work the hardest to build trust. See Table 4.13 for a summary of the most and least trusted roles for robots.

Table 4.13 Most and least trusted roles for robots

Most trusted roles for robots	**Least trusted roles for robots**
• Carry your luggage to your room—at hotel (82%)	• Babysit children under age 2—at one's home (11%)

• Snow shovel driveway —at one's home (80%) • Mow the lawn—at one's home (77%) • Help you carry what you bought to your car —at a store (76%) • Deliver your room service food—at hotel (75%) • Make beds—in one's home (75%)	• Babysit children aged 3 to 6—at one's home (11%) • Babysit children aged 7 to 10—at one's home (17%) • Be a police officer—in the community (19%) • Be the mayor—in the community (19%) • Be a lifeguard at the community pool—in the community (22%) • Be a coach for a youth sports team—in the community (22%)

Shown in (): Percentage who would trust a robot to do in the next 10 to 20 years.

Differences by Age

Regarding trust in robots assuming various roles in our lives, we see significant differences by age. See Table 4.14. Younger consumers (aged 18 to 34) are much more accepting of robots assuming a variety of roles than are their older (aged 35+) counterparts. This is particularly true of many activities in the community, such as being a police officer, firefighter, taxi driver, directing traffic, or even serving as the mayor. Younger consumers are also more supportive than their older counterparts of robots acting as their at-home servants, including babysitting, cooking, chauffeuring them, and acting as a companion.

Table 4.14 Trust in robot roles—differences by age

	Aged 18 to 34 (%)	Aged 35+ (%)	Difference
Roles at Home: Percentage that trust doing			
Be a butler	61	51	+10

Cook food	51	39	+12
Be a companion to an adult living alone	46	33	+13
Drive you around in a car	40	29	+11
Babysit children aged 7–10	24	9	+15
Babysit children aged < 2	15	6	+9
Babysit children aged 2–6	14	7	+7
Roles at Hotel: Percentage that trust doing			
Be a security guard	45	38	+7
Roles at Store: Percentage that trust doing			
Keep store organized	75	67	+8

Provide suggestions on what to buy	64	51	+13
Be a security guard	51	36	+15
Be the store manager	33	24	+9
Roles at School: Percentage that trust doing			
Be a teacher's assistant	49	41	+8
Be a security guard	47	34	+13
Teach at an elementary school	29	19	+10
Roles at Restaurant: Percentage that trust doing			
Be a waiter	60	51	+9

Be a hostess	60	51	+9
Be a cook	45	36	+9
Be a restaurant manager	29	22	+7
Roles in the Community: Percentage that trust doing			
Be a librarian	53	43	+10
Direct traffic downtown	50	34	+16
Be a taxi/Uber driver	48	33	+15
Be a fire fighter	41	26	+15
Be a soldier in the army	38	26	+12
Be a news reporter	37	27	+10

Be a coach for a youth sports team	27	16	+11
Be a lifeguard	27	17	+10
Be a police officer	26	11	+15
Be the mayor	26	12	+14

As often happens with technological innovations, it appears the younger members of society will be the first to widely accept robots in a variety of roles. However, although they are more receptive than their older counterparts, the younger generations will still need a fair amount of convincing on many of the roles involving greater robot authority.

Awareness of Current Capabilities Breeds Greater Trust in Robot Roles

In Chapter 2, we reviewed the awareness levels among the adult public regarding current robot capabilities. For the following analysis, we broke the sample into two groups: (a) those who are aware that robots are currently performing that task, and b) those who are not aware that robots are currently performing the task. We did this to see if awareness of current robot capabilities

impacted people's level of trust in robots doing that activity for them.

We found a strong correlation. People who are aware that robots are currently performing a task express significantly more trust in robots doing that task for them than do those not aware of current robot capabilities in that area. We found this result for every task that we included in the awareness study (sample size = 345). Hence, awareness of current robot capabilities appears to breed trust in robots taking on that role in one's own life. See Table 4.15. Note that the tasks in the awareness study are different than the tasks discussed in this chapter, since many of the tasks discussed earlier in this chapter are not yet currently being done by robots.

Table 4.15 Awareness of current robot capabilities and impact on trust

Task	% Aware robots can currently perform	% Who *trust* robots doing	
		Among those *not* aware robots are currently doing	Among those aware robots are currently doing
Vacuum	88	65	90

Greet people	81	49	81
Drive vehicles	77	12	37
Sort and deliver packages	75	56	84
Wash floors	68	70	83
Perform music	65	39	69
Win at contests and board games	64	46	82
Help customers find goods they are looking for	63	62	85
Be your pet	61	17	59
Lawn mowing	53	51	82

Wash dishes	50	53	86
Check your bodily vital signs	49	36	54
Companionship—such as playing cards with you or reading books to you	48	35	66
Perform surgery on you	48	4	27
Massage your back	44	34	67
Hospital receptionist—taking your information when you arrive	42	40	79
Analyze the results of your X-rays, CT Scans, MRIs	41	20	46

Paint	38	46	75
Fold and organize clothes	34	58	82
Lift an elderly patient from a bed to a wheelchair	31	26	51
Write music	31	35	64
Iron clothes	30	52	82
Cook a variety of different meals	27	31	68
Draw your blood for testing	17	15	42
Perform your annual check ups	10	13	40

Implications for Consumer Behavior and

Marketing Strategy

As we have emphasized throughout the book, for consumers to be supportive and even enthusiastic about the upcoming robot revolution, companies developing robots and those utilizing them in public-facing roles must make smart decisions along the way. A few missteps and public opinion can easily turn against the increasing use of robots in society.

A key part of this process is to understand the optimal roles for robots, particularly in the first decades or two of the robot revolution. Our research provides helpful insights in this regard. Consumers are most supportive of robots taking on clearly subservient service roles, doing the menial chores, grunt work or dangerous/dirty tasks that we humans do not want to do. Consumers are least supportive of robots assuming any roles where they have responsibility over children, or play a law enforcement role, or where life and death is perceived as being at stake, or are placed in a leadership or power position over people. Just because a robot can do something does not mean the public is ready to accept it. Consider a stepwise approach. Start robots in the most acceptable roles and build public confidence. Over time, as confidence builds in these initial roles, robots can be utilized in higher level and take on more advanced tasks. Pay attention to what others are doing in and out of your industry in terms of robot implementation in various roles; learn from their successes and failures. There may be roles for robots that may take many generations before the public will accept; only time will tell.

In addition to a stepwise approach to the roles robots take on, companies should also consider a stepwise approach to the quantity of robots in any consumer-facing positions. For instance, imagine a restaurant patron walking into her favorite restaurant one day and seeing the entire waitstaff replaced by robots. These robots may do a fantastic job in their roles, but the transition would be too sudden for the patron. However, if she walked in one day and saw a couple of support robots working with the team of human waiters, the transition would be much easier to accept.

Be sure to get feedback from customers on their experiences with robots, including the robots you are using for your customer touch points as well as robotic interactions your customers are experiencing in other areas of their lives. This customer research will be essential in helping any company optimize its robot strategy.

If a company is selling robots directly to consumers for home or personal use, keep in mind that no matter how exciting the technology may be to the robot developers, consumers will only spend money in significant amounts to satisfy a real want or need. That want or need may not be initially evident, and marketing may be required to communicate it. But, companies must keep in mind that only a tiny niche of consumers will buy a robot simply because it is the newest and shiniest object on the market. Robots for sale to consumers must deliver against a real consumer want or need in a manner that is perceived to be better than other known alternatives.

As robots are rolled out to take on more and more tasks,

continue the public information campaigns to inform consumers of the benefits of the robots to the consumers themselves, so they understand this is not just about the company's bottom line. And use these same marketing vehicles to inform the public of the broader perspective the company is taking, to ensure the robot revolution is well-thought out and well-managed for the broader societal good.

Finally, as with any smart marketing, consider your target consumer. Younger consumers and those more educated about robot capabilities will be the most receptive to robots in consumer-facing roles. Implement your initial rollouts in more youthful and tech-savvy communities. These consumers will be more accepting of initial stumbles, which must be worked out before implementation in older and more tech-hesitant communities.

CHAPTER 5

Take Two Robots and Call Me in the Morning: Robots in Health Care

The potential for robotic implications in health care are wide ranging, and all are predicted to change the way hospitals and health care systems are being managed.

—Anees Fareed, MD, Chief Medical Information Officer, Al Jalila Children's Hospital, Dubai (Fareed 2018)

Chapter Overview

Hospitals and assisted living facilities are likely to be among the first places where consumers experience robots in a significant and personal way. Hence, we devote this entire chapter to robots in health care. We first explore the various ways robots are already being used in health care, including as delivery robots in hospitals, as companion robots to keep the elderly company and also aid them in their health care regimes, as roving information sources in hospitals, as assistants in dental surgery, and (soon) as phlebotomists. We then explore public opinion regarding

specific health care tasks, and see how accepting people are of robots taking on a variety of roles. We dig deeper to understand why there is support for robots assisting people with highly personal activities such as bathing and personal grooming, but resistance to robots taking on roles of greater skill and importance in health care, even though robots will likely be quite capable of handling these roles in the near future.

As we discuss throughout this book, over the next couple of decades there will be numerous areas of life where consumers will find themselves increasingly interacting with robots. The health care industry, and in particular hospitals, nursing homes, and assisted living facilities will likely be among the first places to significantly integrate robots into their daily functions. And this integration will be done in a manner that is highly visible and in many cases up close and personal with patients and visitors. We anticipate this for three reasons: (1) health care is a labor intensive industry where staff interact closely with patients, (2) many health care facilities must operate 24 hours a day, 7 days a week, with significant patient-oriented activities taking place around the clock, and (3) health care is a growing industry due to aging populations worldwide. Hence, we felt an exploration of robots in the health care industry, and the likely consumer response, was worth extra attention.

Robots in Hospitals

Moving food and supplies around a hospital is a larger task than many might realize. A recent study suggests the average

moderate-sized hospital with 200 beds moves meals, linens, lab samples, waste, and other items the equivalent of 53 miles a day (Case Western 2018). That requires a lot of staff time and energy. Hence, enter the robots! Robots are currently being used in many hospitals for daily delivery services. The TUG robot by Aethon Inc. is a mobile robot that is advertised by its manufacturer as a multifunctional device that can assist hospital staff with activities such as: (a) delivering meals to patients and returning dirty trays, (b) delivering supplies, tests, and medications to patients and staff in a secure manner—using biometric security and pin codes, and (c) safely removing waste, including hazardous waste.

The TUG robot resembles a lockable mini-fridge on wheels. It has the ability to maneuver autonomously and intelligently around a bustling hospital, since it is programmed with the building's detailed floor plan. It avoids collisions with humans and other equipment in the hallways and rooms via a system of sensors on its body. It also has voice capabilities to talk to people that it encounters during its daily duties. TUG is also used in hotels and other venues, though currently hospitals are the major user of this hardworking robot (see TUG robots at https://aethon.com/mobile-robots-for-healthcare/).

While TUG robots are currently deployed in U.S. hospitals, it is perhaps not surprising that Japan is in the forefront in using robotics in health care. This is due to Japan's dramatic shortage of heath care workers, which far outpaces shortages in other developed countries. It is estimated that Japan will have a deficit of 380,000 nurses by 2025, a result of Japan's aging population,

declining number of working age individuals, and a national resistance to immigration (Emont 2017).

The Japanese have employed a fleet of delivery robots, similar to TUG, throughout their hospitals. These hospital delivery robots are programmed to maneuver around humans in their way or say "Excuse me, please let me pass," if there is no way around. They are also programmed to return to charging stations when low on energy (Chang 2018; Osborn 2018). Like the TUG robot, these robots resemble rolling cabinets with an interactive screen on top.

In addition to hospital delivery robots, scores of other health service robots are in various stages of development in Japan. One, called Robear, is a robot developed in collaboration by the Japanese firms Riken and SRK. The human-sized robot resembles a friendly bear and is meant to carry disabled patients from their beds to the bathroom or to other places they need to be (Emont 2017; see photos of Robear at www.newatlas.com/robear-riken/36219/). Robear's development has had some setbacks, such as difficulty ensuring that the robot does not hurt the frail skin and bones of the elderly. However, its developers are still bullish about its future.

The Chinese robotics company Qihan Technology Company, under the brand Sanbot, has created a robot it calls Elf. This cute, three-foot tall robot can be used in both informational and entertainment roles in health care, and can be found bustling about the halls of hospitals and elder care centers in China and other countries (it can also be found in private homes, as it can be used for a variety of functions). Regarding health care

information, the Sanbot Elf can answer over 80,000 health-related questions that patients and their families may pose. Its informational database is continually updated with the latest medical information from a team of health care specialists, so these robots stay on the cutting edge of medical knowledge. Regarding entertainment, the company's website (with perhaps not the best English grammar) says *Sanbot ELF's unique posture, action, voice and expression are embodied in fun and interactive capabilities, combining the entertainment, leisure, service applications in APP market, can reduce boredom and dull living atmosphere for more elderly users* …. The robot has facial recognition technology so it can greet a patient by name. It can converse with the patient, play games, and show movies on its screen. See photos and videos of Sanbot Elf at en.sanbot.com/).

Turning to a different common health care activity, two billion blood draws are conducted annually in the United States alone. Researchers at Rutgers University in New Jersey are developing a robot that can quickly and efficiently draw blood. Using infrared and ultrasound technology, this robot can autonomously find an appropriate blood vessel faster than a human phlebotomist, and with robotic precision, can insert a needle into the human body with less error (Matchar 2018). In the near future, rather than banter with a human phlebotomist about how much you hate needles, you may find yourself conversing with a robot as it draws your blood. You can certainly still complain to the robot about your hatred of needles, though if the robot works as quickly as planned you will have

significantly less time to do so.

There are also numerous robotic devices that assist with surgeries. However, since patients are generally sedated during surgery, there is little conscious interaction and hence will not be a focus of this chapter. Also, there is still a human surgeon at the helm, as opposed to a robot performing surgery completely on its own (though that will happen eventually).

Robots in Eldercare

Robots are currently actively supporting the elderly and disabled in nursing homes, assisted living facilities, and in private homes. These robots provide companionship, remind people about activities critical to their care (such as appointments and when to take their medication), and also assist in their treatment. Mabu, from Catalia Health, is one of these helper robots, designed to sit atop a desk or counter, with large eyes that blink, a permanent smile, and pleasant little face (See Figure 5.1). Mabu lives with elderly individuals, and communicates with them regularly, asking them about any symptoms they might be feeling and reminding them about medications and other treatments they need to undertake. As Rayfield Byrd, a 68-year old with diabetes who lives with a Mabu robot, recently stated in a *Time* magazine interview, *Mabu keeps me on my toes about remembering to take my medication. And she asks if I've had any shortness of breath and other questions pertaining to my health. She keeps me aware of my breathing* (Park 2019). Sounds like a positive and beneficial relationship, at least in Mr. Byrd's case.

Figure 5.1 Mabu from Catalia Health

Buddy, from Blue Frog Robotics, is a more advanced social robot particularly suited for eldercare (though it has many other human-interactive applications for families and children). Buddy is a medium-sized robot (its height is up to an adult's thigh), and certainly among the cutest, with an impish face projected on its screen. The robot is described on its manufacturer's website as having a *friendly and caring personality that will make you feel good* (see Figure 5.2; also access a video of its home usage at www.youtube.com/watch?v=51yGC3iytbY). It is in the final stages of development and expected to be on the market in 2020.

Figure 5.2 Buddy from Blue Frog Robotics

Buddy has many social capabilities, such as the ability to play

interactive games. Its facial recognition software allows it to read faces and expressions, and Buddy has the ability to respond with a variety of facial expressions of its own (happy, sad, surprised, etc.). It also provides home security, and can send alerts in the case of an intrusion or other unusual events. Its face serves as a computer touchscreen, allowing for the playing of music, sending messages, and other useful interactive functions. Buddy has sensors that allow it to move (via wheels) around the house, and facial recognition software to recognize people. It has the ability to read emotions and respond to them. In terms of its core functions, Buddy essentially does what many computers and home security systems can do. However, by placing these functions into a robot with a personable face, and the ability to recognize human faces and respond to human emotions, it can provide a degree of companionship to the elderly. Some might argue that a dog or cat can be excellent companions to the elderly, and they would well be right. However, live animals require care that is often beyond the abilities of an elderly person, or are not appropriate for certain health care settings. A robot such as Buddy is more hygienic and requires less maintenance than does a live animal.

Beyond serving as a companion, some robots have been developed to assist the elderly with various mental health and wellness treatments. For example, Paro, made by the Japanese firm AIST, is billed as a therapeutic robot, and is used regularly in the treatment of patients with dementia. Paro looks like a cute little harp seal. Its intelligent software allows it to react to being held and petted, much like an actual domesticated animal. It

moves its head, closes its eyes, and makes happy sounds when held and stroked. It incorporates machine learning to remember what movements lead to it getting petted, and it repeats those movements in the hope of continuing the petting (not unlike a real animal). Research suggests interactions with Paro can have a calming and healthy impact on patients with dementia (Takayanagi, Kirita, and Shibata 2014; see images at www.parorobots.com/).

As mentioned earlier, Japan has gone further in utilizing robots to interact with the elderly in hospitals, nursing homes, and other settings than most other countries. Fuji Soft's Palro, for example, is a conversational robot that entertains the elderly via conversations and game playing (Choudhury 2018). The name for this small but energetic robot is meant to be (in English) a combination of "Pal" and "Robot" (see images at www.palro.jp/en/).

What might a health care experience look like in the not-too-distant future? Perhaps something like as follows:

Hypothesized Trip to the Hospital—2040

(At least how optimistic roboticists would envision it.)
It is October 2040 and Joe Johnson has scheduled a double knee replacement. Having reached the age of 83, his knees have deteriorated due to arthritis and eight decades of active living. Joe and his (human) doctor felt it was time for him to get artificial knees.

He arrives at the hospital early in the morning and

makes his way to the robot receptionist, who welcomes him with a smile on her face and takes his information. She's conversant in over 50 languages, Joe hears her speak fluent Spanish to the patient before him. After finishing with the receptionist, a robot orderly wheels Joe to his surgery prep room. Upon Joe's request, the orderly updates Joe on the latest news and sports headlines while wheeling him down the hall. Since all the robots at the hospital are connected to the Internet, they can easily provide the latest news or sports updates upon request, or play any music the patient might like to help calm his/her nerves.

After a short wait in the prep room, a robot nurse arrives and performs a few tests before surgery, such as checking his vital signs. The robot nurse can sense via Joe's expressions that he is nervous, so it stays a bit longer and talks with Joe, informing him of the process ahead—both verbally and by showing him pictures on her face screen. The (human) surgeon who will be performing Joe's operation stops in to say hello just before the start of surgery, the first human hospital employee that Joe has interacted with since arriving.

The (human) surgeon operates on Joe and is assisted by a handful of robotic devices. The surgery goes well, thanks in large part to the efficiency and accuracy of the robot assistants. Joe wakes up in the recovery room, with a robot nurse keeping an eye on his progress. The robot nurse explains that all has gone well and he is about to be

transferred to another room for recovery. Joe asks about the artificial knees that he received, and the nurse is able to immediately show on its built in body-screen the devices put into his knees. Based on Joe's questions, the robot nurse can decide how simple or complex to keep its answers. It adapts during the conversation to find the level of responses that best satisfies Joe. A robot orderly moves Joe from the recovery room to his new room. The orderly updates Joe on the playoff game that started while Joe was in surgery.

A (human) nurse stops in to check on Joe and chats with him a bit. Joe appreciates the opportunity to talk with a real person, though so far he is quite pleased with his experience and the helpful robot staff that have been doting on him. After a few moments, a happy little delivery robot brings him lunch and his pain medication, telling him to take the two pills with lunch. Joe asks how long he will have to take the medication, and the robot is able to explain the standard medication plan to Joe. When Joe tells the delivery robot he's bored, that robot contacts (via wireless signal) a hospital companion robot, who arrives to play cards and trivia games with Joe later that afternoon. That helps Joe pass the time. When Joe tells the companion robot that he misses his cat at home, the companion robot contacts (again via wireless signal) the hospital's central services and a few minutes later a furry robot cat, named Fluffy, arrives in the room and jumps into Joe's bed and purrs happily while Joe strokes him.

Joe knows the cat is not real, but it looks so lifelike Joe is happy to play along. Joe then worries that these extra perks might create significant charges to his bill. However the robot companion assures Joe these extra services have already been cleared with his insurance (luckily Joe has great insurance coverage).

After a day in the hospital, a robot orderly takes Joe to the adjoining rehab facility where he undergoes 2 days of physical therapy with a robot trainer. The robot trainer, named Arnold in honor of Arnold Schwharzenegger, is knowledgeable in thousands of different physical therapies. To keep Joe engaged, it rotates through a variety of humorous accents while urging Joe through his workouts.

While back in his room, to help pass the time, Joe asks for a companion robot to visit him twice a day to play a few games of chess, Scrabble, and trivia. Fluffy the cat robot joins Joe the entire time he's at the rehab center, sleeping on the bed with him. Fluffy's constant purring helps Joe fall asleep at night. A human nurse visits Joe once a day to see how he is doing, and Joe has the option to contact a human nurse anytime. However, he finds the robot staff friendly and efficient. They bring him his food and medicine on time. The cleaning robot cleans his room while playing any songs Joe requests. He particularly appreciates that it is a robot orderly, rather than a human one, who helps him use the bathroom. Being shy about these things, he would have felt uncomfortable with a

human performing such personal services. The orderly even closes its digital eyes on its face screen if it is in the bathroom while Joe uses the facilities, which Joe knows really does not mean anything, yet on some level he still appreciates it.

Joe is back home a few days later, feeling overall pleased with the experience.

Consumer Opinion Regarding Robots in Health Care

Roboticists are feeling positive about the future of robots in health care, but are American consumers ready for the future these experts are envisioning? In one of our national surveys (sample size = 321), we tested 24 different health-related activities. For each, we asked respondents if they would prefer that activity be performed by a human worker, performed by a robot, or if they had no preference between the two. The set up for the questions was stated as follows to the respondents: *Assume in the future robots are advanced enough to perform many tasks currently performed by people. Also assume at that time you are much older and dealing with a long term illness, and due to that illness you need help at home for a variety of tasks, and you also frequently interact with the health care system. For each of the tasks below, for you, would you rather that task be performed by a robot (which includes any type of smart, automated device) or by a human, or would it not matter?*

This question set-up was included in the survey so that respondents would not think of robots as they currently exist but rather as robots in the future, when they could perform these tasks at the level of a human worker. This was done to help make it a fair comparison. It was also worded this way so that respondents could better envision themselves requiring these services, even if currently young and healthy.

The results showed a fairly strong preference for humans performing most health care activities. For only four of the 24 activities consumers preferred a robot over a human. For two activities, consumers had no preference between the two, and for the other 18 there was a clear preference for humans.

Health Care Activities Consumers Prefer a Robot (vs. Human) to Do

In only four of the 24 health care activities tested did consumers prefer a robot over a human to assist them (see Table 5.1). All four of these activities are highly personal, meaning the activities involve seeing the person's body naked or while performing a personal bodily function. They are also simple activities, namely: help using the toilet, help bathing, help brushing teeth, and help dressing. Respondents feel that having a robot assisting with these private functions would be more discrete and less embarrassing than if a human assisted. As one respondent stated during one of our in-depth interviews, *I don't like the idea of hospital staff seeing me naked while helping me change or use the bathroom. Having a robot do that would be better. I guess I'm shy about that stuff and would feel less embarrassed with a robot. … I'd have to be sure it [robot] wasn't, like, taking*

pictures or anything.

Table 5.1 Health care activities consumers prefer a robot (vs. human)

	Prefer a robot (%)	Prefer a human (%)	Doesn't matter (%)
Help you using the toilet	**58**	27	14
Help you with bathing	**51**	35	14
Help you brush your teeth	**47**	32	21
Help you with dressing	**46**	34	20

Health Care Activities Consumers Have No Preference Between a Robot and a Human

Two of the 24 activities we tested found a plurality, 47 percent in each case, saying it does not matter to them if a human or a robot performed the task as you can see in Table 5.2. The two activities are bringing food to your room and cleaning your hospital room. Regarding bringing food, of the half who had a

preference, they were fairly evenly split between preferring a robot versus a human. Regarding cleaning the room, the half with a preference was twice as likely to opt for a robot cleaner versus a human cleaner.

Table 5.2 Health care activities consumers have no preference between a robot and a human

	Prefer a robot (%)	Prefer a human (%)	Does not matter (%)
Bring food to your room	26	27	**47**
Cleaning your hospital room	35	18	**47**

Health Care Activities Consumers Prefer a Human (vs. Robot) to Do

For the vast majority of health care activities we tested (18 out of 24), people prefer a human versus a robot to perform the activity for them. For 10 of the activities, consumers have a *very* strong preference for humans, with a clear majority preferring a human to do the task versus a robot. Some of these activities are seen as requiring a high degree of health care skill and insight, such as performing surgery, performing annual check-ups, answering medication questions, and analyzing scan results. Interestingly, one of the activities where people strongly prefer a human over a

robot is purely social, namely acting as a companion. Another activity tested where a human is preferred in the role has a significant social component—acting as a personal trainer. As one respondent stated, *I'd do better if I had a human trainer. I might just ignore a robot trainer. But with a person trainer, I'd have to do what they say.*

Some of the other human-preferred activities are fairly simple, such as drawing blood and checking on you at night while in the hospital, yet consumers still show a strong preference for a human to perform that task. Regarding drawing blood, in-depth interviews suggest the fear of needles is a driving factor, and robots are seen as possibly lacking the care and emotional intuition to do this right every time. As one respondent stated, *If a robot screws up, it can jam the needle deep into my arm. At least a human would know not to do this. A human can at least tell when you're in pain.* In terms of having a robot check on a patient at night, general distrust of robots makes many prefer a human should do this task. As one respondent said, *It's creepy to have a robot coming into your room while you are asleep. I can interact with a robot when I'm awake, but I don't want it in my room while I'm sleeping. That's just weird.*

For eight of the activities, consumers have a *moderately* strong preference for a human versus a robot. In these cases, a plurality prefer a human—not quite over half, but still more than those who prefer a robot as shown in Table 5.3. These are generally more simple and straightforward tasks, such as serving as a receptionist, checking vital signs, and preparing food. It is

worth noting that for two activities, the percentage preferring a human is numerically higher but the difference versus preferring a robot is not large enough to be statistically significant.

Table 5.3 Health care activities where consumers prefer a human (vs. robot)

	Prefer a robot (%)	**Prefer a human (%)**	**Doesn't matter (%)**
STRONG preference for humans over robots			
Perform your annual check-ups	12	**76**	13
Perform surgery on you	11	**75**	13
Companionship—such as playing cards, reading books or news to you	8	**75**	17
Draw your blood for testing	10	**70**	20
Check on you during the night while you stay at the hospital	12	**68**	20

Assist you with physical therapy	17	**60**	22
Analyze the results of your scans (X-Rays, etc.)	19	**58**	23
Answer questions about your medication at the pharmacy	19	**57**	24
Serve as your personal trainer	16	**57**	28
Drive you to and from health care appointments	26	**54**	21
MODERATE preference for humans over robots			
Prepare food for you	22	**49**	30
Teach you about the best ways to be healthy	22	**48**	30
Help cut your toe nails	38	**46**	16

Serve as hospital receptionist—taking information when you arrive	19	**43**	37
Run your scans (X-rays, etc.)	24	**42**	34
Check your vital signs	24	**39**	37
Assist you with taking medication	32	**38***	29
Prepare and dispense your medication at the pharmacy	32	**36***	32

*No significant statistical difference between robot and human preference for these two activities.

Robots in Dentistry

A separate survey of 500 respondents conducted by Embry-Riddle Aeronautical University of Florida asked American consumers about their receptivity to robots performing various activities in dentistry (Holland 2018). Their core findings were similar to ours—Americans are more accepting of robots performing simple procedures (such as dental cleaning and teeth

whitening) and far less open to robots performing more advanced or invasive procedures where any significant health implications are involved (such as dental fillings or surgeries). The feedback from respondents was that they do not see robots being sophisticated or reliable enough to do these advanced procedures.

Yet, the dental industry, like other areas of health care, is charging forward into the robotic future. Neocis, based in Florida, received FDA approval in 2017 to market a first-of-its-kind dental assistant robot, named Yomi, that will help dentists with surgical procedures. Yomi looks like a giant robot hand attached to a high tech table, with multiple screens. According to the manufacturer's website (www.neocis.com/), the Yomi robot physically guides the hand of the dentist to improve precision throughout the surgical procedure, relying on its in-depth analysis of the patient's anatomy. Unlike surgery on other parts of the body, in many dental procedures the patient is awake. Hence, patients will see and interact with the surgical dental assistant. As we have witnessed elsewhere, China and Japan are pushing the envelope in robotics in this area. In 2017, China reported the first case of a robotic dentist installing two dental implants in a patient (Lui 2017).

In sum, the health care industry is investing heavily in a robotic future, driven by the intense labor pressures of high-touch services that often must be delivered around the clock. In many ways, health care will be the "tip of the spear" of the robotic revolution, because it will be one of the first settings where consumers will experience robots in an up close and

highly personal way. Clearly, people are more comfortable with robots doing some of these health care tasks than they are with others, much as we have seen in the other areas of life that we explored in previous chapters. This does not mean they will *never* accept robots in many of the roles in which they currently have trouble seeing them. It does suggest, however, that health care companies need to be aware of the tasks and services regarding which there is the greatest public resistance, and put in place measures to slowly build up public trust. Trust in robots in health care, or any area of life, will take concerted communication efforts to build and sustain.

Implications for Consumer Behavior and Marketing Strategy

The implications for this chapter are the same as those for the last chapter, except applied to the health care industry. Take a stepwise approach to the health care roles in which robots are implemented. Start your implementation in roles where consumers are most comfortable with robots, such as help with bathing and personal care, with food delivery, and room cleaning. Build confidence there and then move to roles such as checking vital signs and assistance with medication. If possible, allow patients choices. Such as when robotic phlebotomists are implemented, give patients a choice between human versus robot. Let word of mouth spread among those willing to try the robot option, to inform their less trusting friends and relatives of their (hopefully) successful experiences.

As robot implementation is launched and expanded, maintain a communications campaign to get consumers to increasingly accept robots in these roles. Testimonials from previous patients should be a key aspect of these communications. Also, take a stepwise approach to the quantity of robots used, so that it is a gradual transition. In the near term, allow for a mixed team of robots and humans in support roles in hospitals and assisted living facilities. Be sure to get customer feedback on their experiences with robots, so you can continue to adjust accordingly.

As this chapter showed, there is already a fair amount of use of robots in consumer-facing roles in health care. Keep a close eye on these developments. Learn what is and is not working so you can optimize the robot implementation for your organization and, most importantly, optimize the experiences for your end users.

CHAPTER 6

Reaction to Robot Design: Cute, Creepy, and Everything in Between

Regarding Robot Appearance—Disagreement Among Robot Makers	
Don't make them humanlike	**Make them** humanlike
It's interesting. When you start trying to make robots look more human, you end up making them look more grotesque. Colin Angle, Founder of iRobot (Wired.com interview with Colin Angle, October 2010)	*In designing human-inspired robotics, we hold our machines to the highest standards we know—humanlike robots being the apex of bio-inspired engineering* David Hanson, Founder of Hanson Robotics (Hanson 2011)

Chapter Overview

A robot's appearance is critical to people's interest in interacting with it. In this chapter, we discuss the four general appearances robots can assume: (1) mechanical, (2) android, (3) humanoid, and (4) zoological. We then explore two fundamental issues associated with robot design. The first is how *human* to make a robot look. On this topic, we discuss the concept of the "Uncanny Valley," which, in short, suggests a robot that is almost, but not perfectly, humanlike will backfire by engendering feelings of fear and discomfort in people. Yet, the public is also resistant to robots that look *exactly* like humans, which suggests that an android direction is likely not the optimal choice for widespread robot design—at least not in the near term (a key exception is discussed in this chapter). The second design issue we explore is how *cute* to make robots, drawing from the theories of kinderschema (an innate human desire to bond with entities displaying youthful features). Even though robots are advanced and sophisticated machines, elements of cuteness go a long way in stimulating human trust and desire to interact with them. We also look at robot face design, and the pros and cons of fixed-face versus screened-face robots. The results of our studies with American consumers which tested their reactions to a variety of robot appearances are shared. We also discuss several examples of excellent robot design for human-interactive robots, drawing from robots currently available or in late-stage development.

Four General Robot Appearances

What should robots look like? This is a critical question for the creators of any robot that will interact with humans. Humans are visual creatures, we react to people and objects in our lives based significantly on their appearance—at least at first. Psychological research suggests people's initial reactions to a robot they encounter will be immediate (first impressions matter!) and generally driven by subconscious cues triggered by their appearance (Aarts and Dijksterhuis 2000; Shibata 2004). How robots look will greatly influence our desire to interact with them —how much we trust them, enjoy their company, or fear them.

There are four general appearances robots can assume:

1. **Mechanical.** These are robots that do not attempt to look human in any way. They lack discernible faces or eyes. As a result, if you wished to communicate with one of them, you would not be sure on which part of its body you should focus. They generally do not have two arms or legs. Their wires or gears may be visible. Mechanical robots are mainly designed for function, and there is no attempt to hide that they are machines. From the entertainment media, R2D2 from the *Star Wars* franchise is an example. Regarding real-world robots discussed so far in this book, the TUG delivery robots and the K3 and K5 security robots are prime examples.
2. **Android**. These robots are the exact opposite of their mechanical counterparts. They are meant to look as human as possible. The perfect android would be one that you cannot tell from a human, by look or by touch.

From the entertainment media, the replicates in *Blade Runner* are androids, as are the residents of *West World* (all played by actual humans, of course). In the real world, Sophia from Hanson Robotics and the robotic Chinese news reporter (discussed in Chapters 1 and 4, respectively) are androids.

3. **Humanoid.** These robots are somewhere between mechanical and android. They have the basic features of a human, in particular a discernible face and eyes. In this manner, you have a comfortable place to look at when you interact with them, making interchanges more natural than they would be with a mechanical robot. They also generally have two arms, two legs, and a torso, though sometimes move via wheels. However, they do not try to pass for human. Although they are made in the general shape of a human, they are clearly robotlike. From the fictional world, C3PO of the *Star Wars* franchise is an excellent example of a humanoid robot. From the real world, Connie the Hilton concierge robot is a humanoid robot example, as is Softbank's Pepper.

    1. Within the humanoid robot segment, we have a cuteness spectrum. Humanoid robots can range from cute (with features such as small stature, large eyes, infant-like round heads) to less cute (harder edges, smaller eyes, larger in size). We will dig further into the impact of cuteness later in the chapter.

4. **Zoological.** These are robots made to look like animals. They can be more realistic in style (like Paro the robot seal, discussed in Chapter 5) or more mechanical (like Chip the robot dog, discussed in Chapter 1). There are also zoological robots, such as Boston Dynamic's Spot Mini, which generally resemble animals due to their four legs and overall posture, though they are far more rough and mechanical in appearance (can be considered borderline zoological and mechanical).

See Figure 6.1 for examples of each.

Figure 6.1 Four types of robot appearance

Experts from the world of architecture and design tell us "form follows function." Hence, a robot meant to serve as a pet would benefit from being zoological in style. A robot meant to interact with humans in a social or companion-like manner would be better designed as a humanoid or android. A robot meant to carry out a more "workman" role (such as making deliveries) might be better designed in a mechanical style meant

to fit its purpose. Yet, it is not quite that simple. There are still two major consumer-oriented questions that robot designers struggle with, namely: (a) how realistically human should robots look and (b) should they be designed to appear more cute or more professional/sophisticated looking? Specifically:

- **Human likeness.** Should robots look as human as possible? After all, we humans are used to interacting with other humans, such as looking into people's eyes and faces when we communicate. Hence, why not make robots in our own image to facilitate human-robot interactions (as David Hanson argues in his quote at the start of the chapter)? Or, on the other hand, should robots maintain a distinctly mechanical look, so we are constantly reminded they are made of wires and circuits (closer to the position of Colin Angle, as reflected in his quote at the start of the chapter)? Perhaps something in between?
- **Cuteness.** Should robots be made to look cute and endearing? Would this put people more at ease when they interact with them? Or, should robots look more formal and sophisticated, to reflect their intelligence and advanced computing capabilities?

In this chapter, we will review the main findings from the significant amount of research that has been conducted in these areas over the past several years by academics and industry researchers, as well as from original research we conducted for

this book.

How Human Should a Robot Look?

There is a fairly strong case to be made that social and companion robots, or any robot humans will regularly converse with, should be at least somewhat humanoid in appearance—meaning at least having something that can be considered a face, and having the general shape of a human. Researchers argue that some degree of humanoid likeness helps facilitate human interaction (Riek et al. 2009; Goetz et al. 2003). For instance, humans, by nature, look at faces during conversations. If we are to be waited on by a robotic waitress, for example, we would naturally want to know where its face and eyes are when we ask about the daily specials, rather than talk to a moving pile of wires and circuits. Also, our homes and buildings are made for human movement. For example, two legs work great on stairs, while wheels do not. Hence, there is an argument to be made that robots we will interact with regularly in our home and community environments should be humanoid to some degree. But to what extent should we make robots in our own image? Should we follow this logic to the extreme, and make fully humanlike androids?

Robots that look as human as possible have long been the vision of many science fiction books, films, and TV shows (the replicants in *Blade Runner,* Ash and Bishop in the *Alien* franchise, Lieutenant Data in *Star Trek: The Next Generation,* and a large cast of characters in *Westworld*). It is also the goal of

numerous robotic developers today. What reaction can we expect from consumers if they are asked to interact with increasingly humanlike robots?

Imagine tomorrow you walk into your insurance company's customer service office to settle some outstanding claims, and you stroll up to the reception desk. Instead of the human receptionist you might have been expecting, you are greeted by Nadine, a humanlike android developed at the Nanyang Technological University in Singapore. Nadine is intelligent enough to hold her own in a conversation with you, and also has the ability to move independently. Take a close look at Nadine (Figure 6.2):

Figure 6.2 Nadine

Are you feeling at all uncomfortable? Suppose she was moving and talking to you (go to this site to watch her in a video: www.youtube.com/watch?v=GUnQpwSceEk). You notice Nadine looks fairly human, but something is not quite right. She has many human features, but she is clearly not a real human. Would you be at all uncomfortable interacting with Nadine the first time? The first several times? If you believe interacting with Nadine would put you somewhat ill at ease, you are experiencing a psychological phenomenon known as the *Uncanny Valley*.

The "Uncanny Valley" phenomenon was originally proposed by a Japanese professor and roboticist named Masahiro Mori in 1970. However, it was not until 35 years later, in 2005, that the article was translated into English and began to receive significant attention across the globe (Grabianowski 2017). In his article, Mori explained that humans tend to have a higher affinity for robots as they become generally more humanoid, *until* they reach a point where they are almost humanlike except for a few flaws. At this point, we become wary of the robot and our affinity for it drops sharply. Thus, if we created a plot to depict our affinity for robots as they become more and more humanlike, we will notice a steep drop-off that occurs when robots are very close—but not quite—humanlike; this drop-off is what Mori named the *Uncanny Valley*. Furthermore, Mori believed that the size of this drop-off would be magnified considerably if the robots had any degree of movement or animation (Mori et al. 2012). Many research studies since Mori's first publication have supported this phenomenon (Gray and Wegner 2012; Mathur and Reichling 2016; Ho and MacDorman

2017).

Why does this phenomenon occur? Why does human comfort regarding a robot drop dramatically when its appearance becomes very close to but not quite human? A number of theories have been proposed, and we will review the most prevalent.

Perhaps the most straightforward theory is that the "Uncanny Valley" takes place when we see something right at the boundary of one category to another, where we are not quite sure how to categorize what we are seeing. In this case it is the boundary between clearly *not human* (doll or mechanical robot) and an *actual human*. When something exists right at this boundary, our brain does not know how to categorize it—we cannot say if it is an inanimate object or a living human—and hence we get an uneasy feeling (Looser and Wheatley 2010).

A related theory posits that as a robot becomes almost identical in appearance to humans, observers may believe the robot can have some sort of conscious mind. The observer wonders, even if only slightly, if the robot might have the ability to sense and experience things, to feel, to be "alive" in some manner. This possibility, even if slight, causes the observers to become ill at ease (Gray and Wegner 2012).

Another theory suggests that when a robot closely resembles a human, the human brain subconsciously begins to consider the robot as a possible human, however, a human with some sort of "problem." This classification comes with a number of imposed expectations about how a human should look, and if any of these expectations are not met, the brain perceives a problem. This is

referred to by cognitive processing researchers as *expectancy violation* (Hsu 2012). For example, the brain sees enough cues to think a robot is a human, but then perceives slight variations that make it clear it is not fully human. This can raise red flags in the observer's subconscious brain, and even trigger a fight or flight response. On some level, our brain may perceive this slightly off human as possibly diseased, deranged, or in some other manner a danger to us (MacDorman and Ishiguro 2006).

The "Uncanny Valley" phenomenon becomes even more pronounced regarding robots that move, which will be the vast majority of them in the near future. Neuroscience supplies some insights in this regard. Researchers have pinpointed many of the exact areas of the human brain that are involved in different mental processes. For example, our brain's visual cortex is heavily involved in helping us process sensory information from our eyes, while our motor cortex helps us direct the movements of our muscles. Between these two regions lies the parietal cortex, which works as a link between the visual and motor cortices, and helps us learn how to do something by watching and mimicking someone else. This watching and mimicking process is hardwired into humans, as we have relied upon it since we were infants; this is how we learned to walk, eat with utensils, and throw a baseball (McElroy 2013).

Interestingly, it is theorized that this process also explains the "Uncanny Valley" phenomenon for mobile robots. When we see an almost humanlike android perform an action in a not-quite-humanlike manner, our parietal cortex becomes confused. On the one hand, the visual stimuli it receives indicate that the

observer is looking at a human being, but on the other hand, the motor stimuli it receives suggest that the motion the observer is viewing is more robotic than human (and, thus, impossible to truly mimic). When the parietal cortex is unable to immediately reconcile the inconsistency between the humanlike appearance of the android and the machinelike nature of its movements, it signals the rest of the brain that the being is something that it does not understand (Brown 2011). As a result, the brain identifies the robot as something of which it might need to be wary (SciShow 2016).

This theory is supported by a 2012 article in the journal *Social Cognitive and Affective Neuroscience*. In the article, there is a review of a study in which the participants were monitored by an fMRI machine while being shown three video clips of different entities performing familiar actions (sipping from a glass of water, waving to the camera, etc.). One clip showed these actions being performed by a clearly mechanical robot (with visible wiring and metal), another clip showed them being performed by a humanlike android, and the last clip showed them being performed by an actual human. Participants watching the clips of the actual human and the mechanical-looking robot showed no unusual activity on their fMRI scan. However, when participants viewed the clip of the almost humanlike android performing the actions, their parietal cortices lit up with intense activity. The researchers concluded that this was the result of the effort undertaken by the parietal cortex to try and comprehend what it was seeing, thus providing evidence of the occurrence of the "Uncanny Valley" phenomenon (Saygin

et al. 2012).

The notion of the "Uncanny Valley" has been applied to a range of other contexts as well as robotics. From animated film characters to virtual reality avatars to puppets, a wide range of almost-but-not-quite-human entities can cause individuals to experience the "Uncanny Valley" phenomenon. For example, one of the most common criticisms of the 2004 film *The Polar Express* was that the unusual style of animation was eerie and off-putting. The filmmakers used a system of CGI animation that involved live-capture technology in order to make the motions of the film's characters far more life-like than a traditional cartoon. However, while the film got the characters close to human, the animators struggled to depict fully realistic emotions and facial expressions (many critiques of the film directly refer to the characters' "dead eyes"). In the end, the film's characters were humanlike in most aspects except for a few small but impossible to ignore flaws, causing them to fall right into the "Uncanny Valley" category (Seymour, Riemer, and Kay 2017).

Research has shown that the "Uncanny Valley" is not a uniquely human phenomenon. A group of researchers conducted a study in which they showed monkeys images of other monkeys ranging from unrealistic to realistic and examined their responses. Interestingly, the researchers found that the monkeys exhibited visual preferences that followed the "Uncanny Valley" structure. The monkeys showed the greatest affinity for the images of real monkeys and unrealistic monkeys, and they had the least positive reactions to the images that were close to realistic monkeys but slightly off. The results of this study

reinforce the idea that the "Uncanny Valley" phenomenon has its roots in evolution—our distant ancestors may have relied upon it as a tool to identify abnormalities and threats in their natural environment (Steckenfinger and Ghazanfar 2009).

So what are we to do with these insights? For Mori and most other researchers who have studied the "Uncanny Valley," the takeaway is clear: do not try to create robots that look as human as possible until we reach a point where we can do so flawlessly (Mori et al. 2012). It is much better to offer robots that are generally humanoid in shape, but remain mechanical enough that they are clearly robots. But what if we reach the point where we can make robots so humanlike that they are truly indistinguishable from humans, in essence cross over to the other side of the "Uncanny Valley." Should we do this? Consumers respond with an emphatic no. In one of our national surveys (sample size = 370), the vast majority of respondents told us we must always be able to distinguish robots from humans. See Table 6.1.

Table 6.1 Should robots be 100% humanlike?

	%
If possible, robots should be made to look exactly like humans so that we cannot easily tell robots from humans	14

Even if possible, robots should never be made to look exactly like humans; we should always be able to easily tell a robot apart from a human	75
Not sure	11

In follow-up interviews, consumers say they would be extremely frightened in a world where they could not distinguish robots from real people. The underlying cause of this fear seems to harken back to the issue of control, and people feel if they cannot quickly distinguish robots from humans, they have lost a great deal of control. As one respondent stated, *It would be way too scary if at some point in the future there are robots that look exactly like humans and we could not tell the difference. That's just crazy! I would always want to know if I was talking to a person or a robot. Otherwise, like, robots could take advantage and trick us all the time.*

Humans are used to interacting with other humans, with our common human features to make us comfortable with each other. However, as the "Uncanny Valley" theory tells us, robot makers should not make robots that look almost—but not quite—human, because that triggers a hardwired sense of fear. Further, our survey respondents told us they do not want robots that look exactly human, because they always want to know if they are interacting with a real human or robot. This may change over the long term as people grow more accustomed to robots, but certainly not in the near future. As a result of all this, it seems robot makers should make social robots that have a general

humanoid shape and size, but these robots should retain a distinctly mechanical or robot-like appearance and not try to completely replicate human likeness.

We now have one more important factor to consider regarding robot appearance—cuteness.

The Power of Cuteness

Robots that exist today are highly advanced machines, the culmination of generations of science and research. And the robots coming in the next decade or two will be even more advanced. Their capabilities will be nothing short of astonishing. Should robot appearance reflect their high level of capability, perhaps expressing a degree of sophistication? The answer, from consumers, is no. We want our robots to be cute.

Another commonly cited theory that is applied to robot design is the Baby Schema (kinderschema in the original German) by Konrad Lorenz (Lorenz 1971). Lorenz's theory posits that there are certain features that make a human or animal appear cute, such as small overall size, large eyes, relatively large head, small nose, and chubby cheeks. These are characteristics associated with infants and youth. Further, cuteness elicits a positive affective response, particularly a desire to care for and bond with the cute creature. This is tied to evolution; it is an instinctive survival response for a species to care for its young. This is particularly important in species such as humans and other advanced mammals. In such species, infants are born helpless and remain so for quite some time. Hence, there must

be an inherent desire among adults to bond with and care for the young.

Recent research has supported and even expanded beyond the basic propositions of Lorenz's Baby Schema (Tarlach 2019). Research conducted over the past couple of decades involving brain scans while showing people pictures of cute infants has demonstrated the intrinsic power of cuteness. These studies have shown the response of adults to cute infants is lightning fast, and infant-related cuteness triggers intense activities in the regions of the brain associated with attention and reward processing. Recent research also suggests cuteness is not simply about creating a desire to care for youth, but also about creating a desire to interact with and socialize with infants. Consider the tendency of adults to make funny faces at infants to engender a response. This is a natural desire among social animals (in this case, humans) to encourage interaction with, and socialization among, infants. Cuteness is the trigger for this. As University of Oxford neuroscientist Morten Kringelbach, a leader in cuteness research, has stated, *Like a Trojan horse, cuteness opens doors that might remain shut*.(Tarlach 2019). Cuteness innately triggers in most humans (yes, studies show this occurs among both men and women) a desire for more interest, interaction, and care. And the power of cuteness vis-à-vis adult humans goes beyond human infants. It can also be applied to animals and mechanical devices (Tarlach 2019).

For robot designers, cuteness is a strategy for getting humans to feel positively about robots and establish relationships with them (Breazeal and Foerst 1999; Turkle 2011). Understanding

that many consumers are apprehensive about robots, making them look cute helps mitigate some of that concern. Clearly, there is a time to dial up the cuteness (robot playmates for children; robots working at amusement parks) and times to dial down the cuteness (robots performing serious roles at a funeral; robot soldiers). The essential idea is that robots meant to interact and socialize with humans have "cute" appearance cues that suggest friendliness to foster engagement and adorability to, ultimately, promote relationship building and bonding. Further, being cute also makes a robot seem less threatening and less dangerous, making humans feel more control over it. Recall the discussion in Chapter 3—a sense of losing control to more powerful and more capable robots is an underlying theme in many people's concerns about robots. A cute appearance appears to reduce this fear.

Softbanks' Pepper robot is an example of a robot designed to be cute (see Figure 6.3). Pepper has large round eyes, a round head, small nose and overall small stature. There is no need to worry about a robot that is this cute, is there? A robot this cute would never enslave the human race!

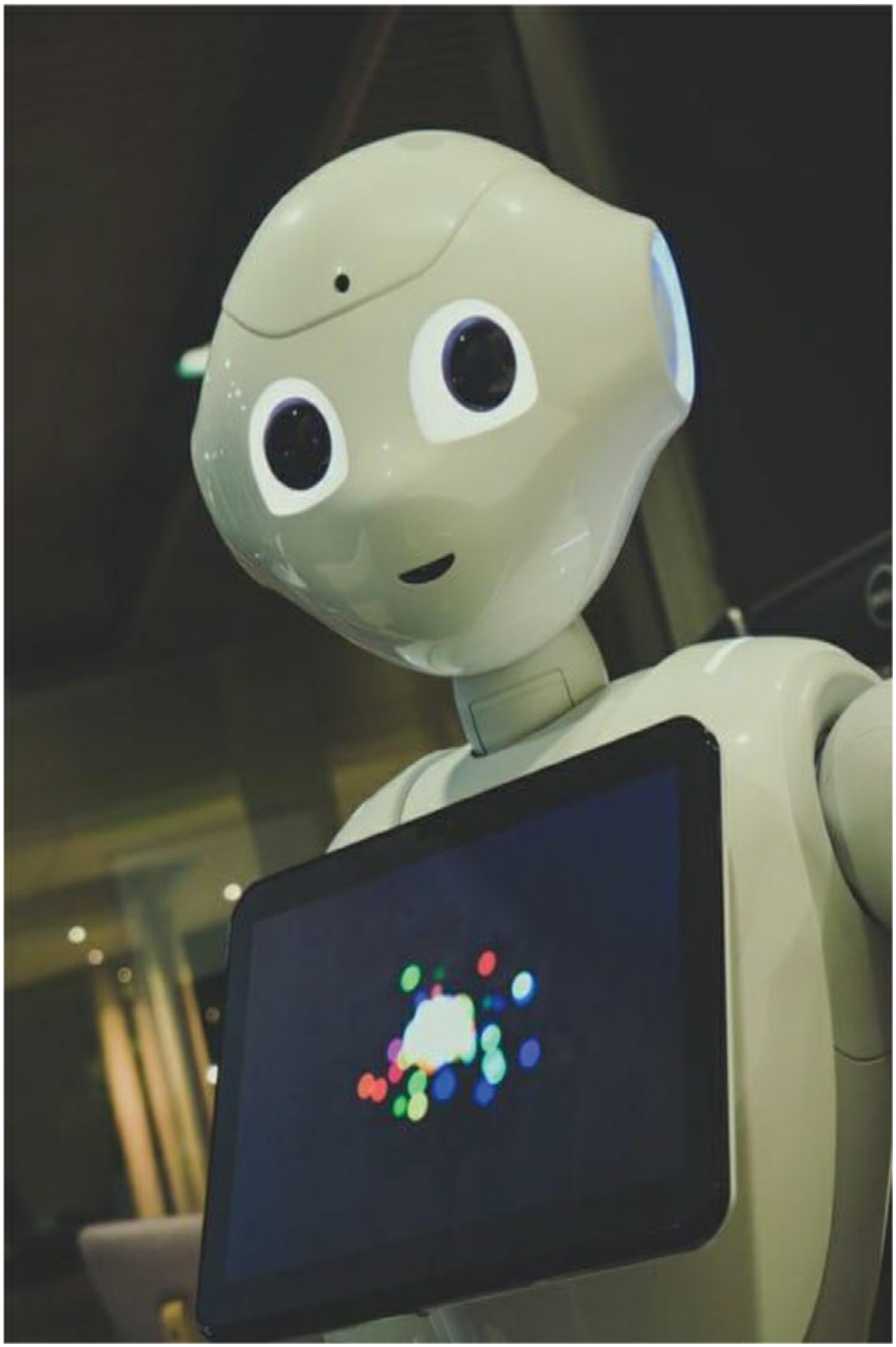

Figure 6.3 Pepper

Our Study—Consumer Reaction to Robot Appearances

To explore these issues further, we conducted a national study involving 310 adult Americans. In the study, we showed 40 pictures of robots[1] and captured respondents' reactions to each robot image via the following scaled questions. A "1" meant they felt the image was completely described by the phrase on the left and a "7" meant the image was completely described by the phrase on the right. A "4" is the midpoint, and respondents were allowed to select any of the seven numbers on the scale. Respondents knew nothing else about the robots—they were given no information about their roles or their capabilities. All they had to react to was their appearance.

Looks machinelike	1 2 3 4 5 6 7	Looks humanlike
Looks formal	1 2 3 4 5 6 7	Looks friendly
Looks untrustworthy	1 2 3 4 5 6 7	Looks trustworthy

Does not look cute	1 2 3 4 5 6 7	Looks cute
Does not look eerie	1 2 3 4 5 6 7	Looks eerie
Makes me feel comfortable	1 2 3 4 5 6 7	Makes me feel uncomfortable
Is not something I want to interact with	1 2 3 4 5 6 7	Is something I want to interact with

We tested pictures of a wide variety of robots that are currently available for sale or in development. They ranged from purely mechanical looking (service robots with gears and wires visible, and no attempt at a humanoid shape) to generally humanoid in shape, but still clearly robotic (such as the Lynx and Buddy robots mentioned already in this book) to a highly humanlike female android (such as Sophia and Nadine, both previously discussed).

The findings of our study strongly support the power of cuteness in robot appearance. Cuteness was significantly correlated with perceived friendliness ($r = 0.948$, $p < 0.001$), trustworthiness ($r = 0.882$, $p < 0.001$), feeling comfortable with ($r = 0.885$, $p < 0.001$), and a willingness to interact with ($r = 0.930$, $p < 0.001$). What this means in nonstatistical language is

that the higher the rating of cuteness that our respondents gave each robot, the more likely that robot was viewed as being friendly, trustworthy, making the respondent feel comfortable and wanting to interact with it. In essence, the cuter the robot, the far more positive the response from consumers and the more likely a relationship could be established. The robots that rated highest on the cute scale had several characteristics in common: overall youthful/juvenile-looking appearance, large round eyes, short stature, and friendly/endearing faces. The robot rated the cutest was Buddy from Blue Frog Robots, which was first discussed (and image shown) in Chapter 5. The cuteness factor does indeed appear to break down a barrier and make humans more likely to want to be around them.

Let us now turn to the android that we tested—the robot that looked very much like a human female in her twenties. As expected, she topped the list on humanlike (looking humanlike versus machinelike). However, she fell solidly into the *middle* of the pack on all other scales. This means she was far from the top robots in terms of respondents wanting to interact with her or feeling comfortable around her. If we compare this android robot to any of the humanoid (non-android) robots rated as cute, we see the clear preference for a cute robot over an android robot. On key ratings of "feeling comfortable," not looking "eerie," and the all-important "desire to interact with," the cute robots significantly outperform the android robot.

Our research supports earlier insights. The robots in our set of 40 that respondents most wanted to interact with are generally humanoid, but not at all close to looking truly human.

They have faces to look at, as opposed to being purely mechanical. However, none is meant to pass as human. Also, they are heavy on cute—with youthful, innocent, and submissive appearances. On the other hand, the robots that respondents told us they *least* wanted to interact with are heavily mechanical in appearance, lacking discernible faces and they made no effort at cuteness. The android female fell exactly in the middle of the pack, number 20 out of 40 robots on the scale of "want to interact with" (average rating of 4.2 on the 7-point scale). See Table 6.2.

Table 6.2 Large range of "want to interact with," based purely on appearance

	Average rating "Want to interact with" On a 1–7 scale
Buddy robot (cute, generally humanoid shape, has screen with youthful face image) www.bluefrogrobotics.com/	5.4
Female android (realistically resembles an attractive young adult female) en.wikipedia.org/wiki/HRP-4C	4.2
Atlas robot (mechanical, no face)	2.4

www.bostondynamics.com/atlas	

What Does All This Mean for Robot Appearance?

Human-interactive robots must be made in a manner that makes humans actually want to interact with them. In sum, companies planning to utilize robots in consumer-facing roles where significant robot-human interaction will take place should consider the following regarding robot appearance:

- Make robots generally humanoid in overall shape. There should be a discernible face and eyes for people to look at when interacting. It will ease interactions.
    - This might only apply partially to some robots, depending on the task it performs. For instance, a hotel delivery robot needs to be somewhat boxlike in shape, rather than have a torso with arms and legs, to carry food and supplies. Yet, having a screen on the top with a face on it would aid in its interactions with hotel guests, such as if the guest had a question about the food or supplies delivered.
- Do not attempt to make fully humanlike androids. Currently, technology only gets robots to look *close to*

human, but that makes them even more eerie. Even if a truly humanlike robot can be made, consumers are nowhere near ready for that. We want to be able to tell humans and androids apart. The one exception to this rule may be sex robots.

- Aim for a degree of cuteness in the robot's appearance. This does not mean all robots must be childish, the role the robots are performing should be considered. However, for almost all social robots, factoring in at least some visual cues of friendliness, openness, and endearment will make robots appear approachable, happy, and subservient.

Several social robots currently available adhere to the positive considerations listed, including:

- Pepper from Softbank Robotics (image shown earlier in this chapter)
- NAO from Alderon Robotics, now owned by Softbank (see image at www.softbankrobotics.com/emea/en/index)
- Elf from Sanbot Robotics (see image here at http://en.sanbot.com/)
- Buddy from Blue Frog Robotics (image shown in Chapter 5)

All these robots are humanoid; however, they make no attempt to look fully human. Yet, there are enough humanoid features to make interactions more natural, such as a face and eyes to look at when talking. And, they are all clearly designed with cues to express friendliness, openness, and subservience.

Robot Faces: Fixed versus Screens

With that said, these four robots manifest two markedly different approaches in their face displays. The NAO and Pepper robots have a fixed face. On the other hand, the Elf and Buddy robots have computer screens for a face. Either approach works; however, there are clear advantages in using a screen for a face. A real human's face can make an endless amount of facial expressions. A robot with a fixed face cannot make multiple expressions, though a robot with a screen face can. Buddy and Sanbot can both feature expressions that clearly show happiness, sadness, excitement, confusion, and many other emotions (see Figure 6.4).

Figure 6.4 Buddy's emotional expressions

Implications for Consumer Behavior and Marketing Strategy

A robot's appearance is critical to consumers' willingness to trust it and their desire to interact with it. Hence, companies developing and utilizing robots must keep the end user in mind for all design considerations. Potential robot designs should be researched with consumers to ensure an optimal reaction when ultimately rolled out. Designing for function, of course, is critical, but consumer receptivity is equally important for robots that will interact with the public.

For now, avoid the desire to go android for most robots. Any robot that is almost—but not quite—human looking causes anxiety in humans and will not have the desired positive effect

on customer interactions. Further, the public is not yet ready for robots that are indistinguishable from humans, as that represents too great a loss of control. A key exception would be robots made for sexual encounters. We encourage further development into android robots, as there will likely be a time in the more distant future when there will be greater public acceptance of highly humanlike robots. However, for the vast majority of public-facing robots for the near term (at least the next two decades), the smarter option would be humanoid robots. Our ongoing theme of a cautious, stepwise approach to the robot revolution means humanoid now and (maybe) android later.

For humanoid robots, factor in appearance cues of cuteness which help communicate friendliness, subservience, and approachability. Certainly the cuteness quota will vary by role, with some roles requiring greater sophistication in appearance. But no matter what the role, if the robot is customer-facing, a degree of "cute" is helpful in robot design.

When designing robots, keep in mind communications with the end user, and remember that humans are hardwired to want to communicate by looking at eyes and faces. Of course, many robots must be more mechanical in nature to fit their tasks—such as delivery bots which must hold supplies. Yet, these types of robots should still have a "face" for consumer interactions—such as a screen with eyes. Speaking of screens, consider the benefit of a screened face for the portrayal of greater emotions, which will aid in relationship building and leads us to our next chapter.

[1]The authors will share the 40 robot images tested and the detailed study findings as well. We are limited regarding the images that we can show in this book. Contact the lead author at gmpettinico@plymouth.edu

CHAPTER 7

Human-Robot Interactions: Will You Become BFFs with a Robot?

Computers will be at human levels, such as you can have a human relationship with them, 15 years from now. …When I say at human levels, I'm talking about emotional intelligence. The ability to tell a joke, to be funny, to be romantic, to be loving, to be sexy. That is the cutting edge of human intelligence.

—Ray Kurzweil, Director of Engineering at Google, inventor (inducted into the US National Inventers Hall of Fame) and technology author (Thompson 2014)

Chapter Overview

In this chapter, we explore a fundamental question: will humans ever form truly meaningful relationships with robots? Based on an exhaustive review of past research, we come to the conclusion that yes, after some time to adjust and overcome the initial awkwardness, many humans will form meaningful, personal bonds with robots, though certain conditions are required. The necessary conditions include robots conveying "social presence," meaning being perceived as truly part of an interaction via their

intelligence, speech, and physical gestures (though no actual robot self-awareness or consciousness is needed). It also involves robots conveying emotional intelligence, by reading and responding to our emotions as well as expressing emotions of their own. And, finally, to create human-robot bonds, robots will need to express their own individual personalities. We discuss all these conditions in-depth, and review how robot developers are currently working on them. We then talk about three hierarchical categories of human-robot relationships: (1) robots treated as tools (minimal relationship), (2) robots treated as pets (moderate relationship) and (3) robots treated as humans (most significant relationship), with variations within. We end the chapter by discussing the implications of each relationship type.

Initial Awkwardness When First Conversing with Robots

Expectations are that robots will increasingly become an integral part of our lives - in our homes as well as our communities. They will be up close and personal with us. How will we humans relate to them? Will our interactions with robots be cold and functional? Will we view them as smart tools and nothing more, similar to how we view our current computers? Or, will we actually bond with robots? Will we have feelings of friendship, caring, and even love toward them, as we do toward many humans—and animals—in our lives? Research conducted over the past several years suggests that we will indeed bond with robots, but it will take a while and the robots will have to achieve

certain functionality before it can happen on any widespread scale.

When first interacting with social robots, meaning intelligent robots we are meant to talk and deal with interpersonally, there will be a high degree of awkwardness. It will be uncomfortable to treat something we know is not alive as if it is. Research suggests that when people are first interacting with these more advanced social robots they will feel: (a) uncertain, not knowing the best way to conduct the interaction and (b) less enjoyment, it will be less fulfilling than an interaction with a human (Edwards et al. 2016; Spence et al. 2014). This initial awkwardness will apply to situations such as: a store patron interacting with a customer service robot while the robot helps the patron find a new outfit for an upcoming wedding; a hotel guest asking a robot concierge about the best restaurants in town, or an elderly resident of an assisted living facility talking about the day's football games with one of the institution's companion robots.

This awkwardness is due, in part, to the issue of perceived social presence. Social presence is a concept used by academics who study interpersonal communications, and it is defined as being "real and present" in the interaction, without any barriers or artificiality in the way. Two humans talking with each other in person, where both individuals are highly focused on and engaged in the conversation, constitutes high social presence. Two humans having a conversation with each other via video chat involves less social presence, since not all the communication cues (such as hand gestures) can be seen and the technology limits, to at least some degree, a full interaction when

compared to an in-person situation. Two humans talking on a telephone in audio-only mode reduces the sense of social presence even more. Social presence is a concept that has been associated with human interactions, and how technology can help or limit it. Recently, however, it has been applied to human interactions with robots, where humans are talking *with* technology rather than *via* technology. This research suggests that people will perceive interacting with social robots as involving less social presence. Even though the robot will be talking, moving, and reacting to our comments, we humans will still see the robot as being less "real and present" in the interaction, simply because we know robots are artificial devices (Edwards et al. 2016; Spence et al. 2014).

This sense of less social presence in the interaction will lead to greater uncertainty. People will be unsure how to interact with a robot, at least at first. Should we follow all the typical norms of interactions, such as politeness, when talking with robots? For instance, does it make sense to say "please" and "thank you" to a robot? After all, we do not thank our computer when it performs a function for us. But we would thank a human concierge if she recommended a fantastic local restaurant to us. Also, this sense of reduced social presence will lead to less enjoyment. It simply will not be fulfilling and satisfying to humans to interact with something that is seen as not truly alive and not truly present in the situation.

This will be the reaction at least initially. People often feel uncertain and awkward doing anything that is new, yet such feelings often dissipate with repeated experiences. Research

suggests this will also be the case for human-robot interactions. Researchers in Japan conducted a study that included having study respondents repeatedly interact with a social robot. Measurements, which included post-interaction questions asked of the humans as well as their body language during the interaction, showed that they indeed started off feeling uncertain and experiencing less enjoyment, but after repeated encounters the interactions with the robots began to feel more normal to them (Haring, Matsumoto, and Watanabe 2013). This suggests that as we humans get used to robots in our lives, and if the robots are responding to us in a manner that is humanlike, we will begin to anthropomorphize the robots, feel more natural, and get more comfortable interacting with them and even begin to bond with them. The initial awkwardness will wear off.

Anthropomorphizing Robots

Anthropomorphism is the attribution of human traits, feelings, and intentions to nonhuman entities. This appears to be a natural tendency for humans, as we do this regarding animals (especially our pets) as well as inanimate objects such as our cars (Hutson 2012). There is significant evidence that humans will anthropomorphize robots, meaning treat them as if they are living and breathing entities, even if we know they are not (Zlotowski et al. 2015). Consider this true story:

> In 2015, robotics company Boston Dynamics released a video clip introducing 'Spot,' a distinctly dog-like robot. In the clip, Spot is kicked twice by humans and scrambles to stay hard on all four legs. The purpose of kicking Spot was to demonstrate the robot's stability, but many commenters took to the internet to

> express discomfort and even dismay over Spot's treatment. The slew of negative reactions even compelled animal rights organization PETA to acknowledge the incident. (Darling 2017)

We have to assume the individuals viewing the video knew Spot was a robot, as the robot was very mechanical looking and the video clearly stated it was a robot. And yet, viewers expressed pain and outrage seeing it kicked. This is not the only case of an emotional reaction to a robot being hurt. There are reports of US soldiers expressing emotional distress over the destruction of robots they worked with on the battlefield to help locate mines, even though the soldiers know these robots could be quickly replaced by other robots (Garreau 2007). This suggests these soldiers are thinking of these robots as comrades in arms, at least to some degree similar to their fellow human soldiers. If soldiers can react in this manner, clearly anyone can.

The tendency to anthropomorphize robots will be driven by many factors, particularly the humanlike features given to them, their apparent self-direction and their intelligence (Riek et al. 2009; Epley, Waytz, and Cacioppo 2007). Robot designers have been and will continue to emphasize features that are meant to make us even more likely to anthropomorphize robots. The goal is to make relationship building with robots more natural. After all, robot manufacturers want us to bond with their creations.

Bonding with Robots

Humans are social animals. We have evolved that way over hundreds of thousands of years because by living and

cooperating in cohesive social groups we could better protect ourselves from predators, better obtain food, and better care for our offspring. Hence, building social relationships is hardwired into us as social beings. Most of us want to bond with others around us. Bonding is defined, rather simply, as “the formation of a close relationship” (merriam-webster.com). We would add that successful long-term bonding involves feelings of affection and affinity.

This extends beyond human-to-human bonding. Humans regularly form deep bonds with animals, even though we understand that animals think and perceive the world differently from us and have their own peculiar instincts which drive much of their behavior. Yet, for tens of thousands of years we have established deep and meaningful relationships with animals. This is particularly true of dogs, which have been “man’s best friend” for tens of thousands of years (no offense to all the cat lovers out there).

Researchers have examined the long-term relationships that have flourished between humans and dogs. They have found these relationships often surpass a simple pet relationship and take on the form of a bond more akin to friendship, much as between two humans. Studies have found that the success of human-dog bonding is based on many factors. First, emotions are a key ingredient in bonding. Most humans cannot bond with an entity that lacks the ability to read human emotion or display emotions of its own. Dogs can do both. Second, a unique personality needs to be expressed by both parties for bonding to occur. Humans need to believe they are interacting with an

individual entity with its own uniqueness. Dogs have this. Finally, there must be benefits to both sides for a bond to work—some sort of positive feedback or satisfaction (Konok et al. 2018). The example of human-dog bonding gives us some fundamental ideas to think about regarding possible human-robot bonding.

Academics who study robots believe humans and intelligent robots can form meaningful bonds (Edwards et al. 2016; Graaf 2016; Turkle 2010). By meaningful bonds, these researchers mean humans can develop feelings of affinity, friendship, and caring for intelligent robots—much as is the case between humans and animals and even humans and other humans. These bonds will not happen right away and they will not happen in every case. Based on previous research and our own studies with consumers, the following factors need to be in place for meaningful human-robot bonding to occur:

1. Social presence (on the part of the robot, as perceived by humans)
2. Emotional intelligence (on the part of the robot, as perceived by humans)
3. Individual personality (on the part of the robot, as perceived by humans)
4. Personal benefit (for humans)

We will now explore each of these in greater detail, and discuss what robot manufacturers can do to help strengthen the likelihood that humans will want to bond with their robots.

Bonding Factor #1: Social Presence

Social presence, for human-to-human interactions, is defined as the degree of salience of an individual in an interaction, meaning to what degree the individual is perceived of as "real and present" in the interaction by his/her counterpart. When we interact with someone else, we do not want to feel as if we are talking to a wall. We want to feel as if we are talking to a person who is there, present in the moment and truly interacting with us —with no barriers and no distractions. The same is true of human-robot interactions. There are three characteristics of robots that can help bolster a human's perception of its social presence in an interaction: intelligence, appearance, and physical gestures.

Intelligence. For a robot to be perceived of as truly socially present in an interaction, the robot needs to be intelligent enough to carry out a meaningful conversation with its human counterpart. It must respond quickly and naturally to questions and comments, and maintain its part of a dialog with no pausing, no confusion, and no other perceived barriers or distractions. Artificial intelligence and machine learning are getting closer and closer to the ability to pass the Turing Test. The Turing Test, proposed by the famed computer scientist Alan Turing in 1950, is a test of a computer's ability to exhibit intelligent behavior indistinguishable from a human. When this happens, when a robot can converse with us as normally as a human, we will be less likely to think we are talking to a pile of metal and plastic and instead believe we are talking to an entity that is truly

socially present.

Appearance. As discussed in Chapter 6, a robot's appearance is critical to how a human will perceive it. A humanoid robot appearance is the optimal approach for promoting natural human-robot bonding. This means the robot would have a humanlike face and body, though without attempting to look exactly like a person (which, unless done perfectly, is perceived as frightening). A humanlike face is particularly important, with large expressive eyes, since humans naturally look into people's eyes when conversing (as Shakespeare told us, "The eyes are the window to your soul.") Also, a mouth from which, or near which, the robot's voice emanates will make communications more realistic. A more humanlike, but not frightening, face for the robot (which can be fixed or on a screen) will aid in a human counterpart perceiving the robot as being socially present in the interaction. Consider the faces of numerous robots already featured in this book, such as Hilton Hotel's Connie the Concierge (Chapters 1 and 6), Sanbot's Elf and Mabu from Catalia Health (from Chapter 5) and NAO from Alderan robotics (Chapter 6) and Buddy from Blue Frog Robotics (Chapters 5 and 6).

Gesturing. Human conversations involve more than simply talking. Physical gestures are a critical part of natural human communication, which involves how we move our heads, our hands, arms, body, and eyes. Researchers suggest that robots must master the complex array of human gestures used in communication, which of course vary between cultures.

Mastering physical gestures will aid in humans seeing robots as humanlike participants in social conversations (Graaf 2016; Sidner et al. 2005). Hence, the robots viewed as most socially present will use appropriate eye contact, looking into the eyes of their human companions appropriately enough to show interest, but not so much to appear threatening or unnatural. These robots would also use hand and arm gestures properly for emphasis. And these robots would nod, tilt, and turn their heads as a human would during social interactions. The more natural a robot appears during its interactions with a human counterpart, the more the human will anthropomorphize it and believe it is socially present.

Is consciousness necessary? A significant question you may be asking as you read this is: does a human need to believe a robot is *conscious*, meaning self-aware, for the human to believe the robot is socially present? Certainly, this would greatly help. In such a case, the human would see himself/herself as talking to an entity that is truly alive. However, consciousness is a complex concept, and there is currently significant debate as to whether or not robots or any technology can ever truly become conscious. Even if a robot has not achieved consciousness, but is doing all the things mentioned earlier – meaning holding its end of a conversation as naturally as an intelligent human – then it will be viewed as socially present. We will explore the issue of robot consciousness in greater detail later in this chapter.

Bonding Factor #2: Emotional Intelligence

Being perceived of as socially present is step one; however, that

alone is not enough to foster widespread bonding between humans and robots. As emotional creatures, humans want to interact with other creatures that understand our emotions, react to them, and display emotions of their own. This means having emotional awareness, namely, the ability to interpret the emotions of others, and to respond to those emotions with realistic expressions of compassion and concern. In essence, the ability to augment one's behavior based on the emotional state of others. This is often referred to as *emotional intelligence*, or as *emotional quotient, EQ* (Goleman 1995). We humans want to know that the other entity in the relationship understands us and feels for us. For humans, a fellow human completely devoid of emotions is a sociopath, and few people want to bond with sociopaths.

To assume the role of a true social companion, and to have humans bond with it, a robot must have the ability to do all three of the things mentioned earlier: (a) understand human emotions, (b) react to them appropriately, and (c) display emotions of its own. Human emotions are quite complex, and many humans struggle with emotional intelligence. However, robot creators are working hard to give robots this ability. Facial recognition software is advancing, allowing robots to not only recognize individuals (so they can greet them by name) but also recognize human emotions via the expressions we make. In this way, if a robot notices that its human companion is sad or stressed, it can react appropriately. Also, robots can increasingly understand subtleties in wording humans use, to try to interpret the feelings of their human companions. Emotions are often

conveyed via sarcasm, and sarcasm is currently very difficult for artificial intelligence to interpret and understand, mainly because when people are sarcastic they mean the opposite of what they say (Such as: “It’s two degrees outside. How lovely!”). Artificial intelligence, currently, tends to take us literally. However, significant work is being done on helping artificial intelligence understand human sarcasm, by looking at context, tone of voice, facial expressions, past comments made by the same individual, and learning over time (Beckett 2018).

Among humans, the more experience we have with other individuals, the better we get at reading their emotions. Consider an elderly couple who have lived together for 50 years. They can often communicate to each other with the quickest of facial expressions. They have learned over the years to read each other’s feelings. Machine learning technology allows robots to do the same. The more they live with a human, the more they understand the subtle, or not so subtle, ways that an individual expresses his/her emotions. The ability of artificial intelligence to understand, react to, and display emotions is moving faster than many consumers might expect. According to Annette Zimmermann, Vice President of Research at Gartner, a global research and advising company active in the technology field, *By 2022, your personal device will know more about your emotional state than your own family* (Kleber 2018).

Both large, established companies, such as IBM, and smaller, newer companies, such as Emoshape (established in 2017) are investing heavily in this area. In the industry there are two terms commonly used to describe this ability: “emotional AI” and

"affective computing." Companies are investing heavily in this area because they understand emotional intelligence is essential if robots are to assume a larger and more meaningful role in the lives of humans (Goasduff 2018). Emoshape's website (emoshape.com—as of November 20, 2019) talks about the company's progress on *emotion speech synthesis, emotional awareness, emotion reasoning, machine emotional intimacy*.... The company is working hard on this technology because they realize, as they state on their website, that meaningful emotional interaction is core to removing the barrier to widespread adoption.

Pepper, from SoftBank Robotics (headquartered in Tokyo), is billed as a robot that can understand emotions. It does this via its facial recognition software that can interpret expressions, along with its speech recognition ability. It is far from perfect; however, Pepper does fairly well holding up its end of a fast-paced conversation with a human. Here is a video of Pepper in a conversation recorded in 2018 (www.youtube.com/watch?v=zJHyaD1psMc). Note Pepper's excellent use of physical gestures, and the intonation it uses when speaking to avoid sounding monotonous. Pepper responds quickly and naturally to almost all the questions it is asked. However, during this conversation there are a few questions it cannot understand. Though Pepper is not perfect in its social role, this robot is the first step in a process that will certainly have significant improvements in the near future. It is a fairly impressive start.

Certainly, not every robot in our robot future needs to be emotionally advanced. There will likely be a large number of

servant robots that do our menial work for us (vacuuming, mowing, etc.). We will likely view them as drones and have little interest in bonding with them. In fact, we may prefer to not bond with them because that might make us feel guilty having them work so hard for us. As Table 7.1 shows, most consumers (from one of our national surveys with a sample size of 493) do not believe that low level worker roles such as housework and yard work require any human emotions. However, for a host of other roles, consumers believe emotions are crucial to truly fulfilling that role. That includes serving as a companion or even acting as a greeter in a store or hospital (see Table 7.1)

Table 7.1 Roles people say require emotions

	% Who say this task requires human emotion
High level of emotions needed	
Write music	77
Perform music	76
Be a companion—play cards with you, etc.	76

Greet people at a store, hospital, etc.	73
Moderate level of emotions needed	
Help customers in a store find the products they are looking for	55
Be your pet	55
Lift an elderly person from a bed to a chair	44
Perform your annual health check up	40
Cook meals	34
Drive a vehicle	28
Low level of emotions needed	
Mow lawns	14

Iron clothes	14
Wash floors	14
Vacuum	13

Bonding Factor #3: Individual Personality

Humans are social creatures who naturally prefer to live in communities. However, we are not ants or bees. We have no desire to live in mindless collectives with identical drones. Our intelligence has driven us to all be unique, and we want to interact with other unique individuals. Robots will need to present themselves as individuals. Humans will want to believe there is an "individual" with whom they are interacting. Much of this will be based on whether we humans perceive the robot as intelligent and autonomous (not, necessarily, conscious). If we go to our neighbor's house and there is another robot that is exactly like ours—looks the same, talks the same, uses the exact same sentences, and so on—then human-robot bonding will be diminished. But if our robot expresses its own unique personality, then human-robot bonding becomes more likely.

Machine learning and artificial intelligence will allow robots to evolve uniqueness. According to Emoshape's website, the company's technology will lead to "…robots developing their own

personalities, learning from human interactions." (emoshape.com—as of November 20, 2019). Robot uniqueness will be expressed in ways similar to how humans express their uniqueness, including distinct perspectives on the world, distinct sense of humor, distinct personal interests, and distinct gestures and mannerisms.

Humans will project personality characteristics onto robots, driven largely by the robot's physical characteristics and also the function it serves (Bennett 2018). Regarding physical characteristics, a cute humanoid appearance of a robot (as discussed in Chapter 6) will lead a human to project a more youthful and fun personality onto that robot. A cute robot will be seen as friendly and nonthreatening. A more mechanical and abstract appearance for a robot will lead a human to project a more cold and distant personality onto it. This type of robot will be viewed more along the lines of an inanimate instrument and less like an individual. Bonding will be more difficult with a heavily mechanical-looking robot versus a cute, humanoid robot. Size matters as well. A larger robot (equal or bigger than an adult human) may convey a more imposing and threatening personality than a robot that is only about half the size of an adult human.

The task robots perform will also impact our relationships with them. Robots performing higher level tasks, such as serving as a research librarian or surgeon, will be seen as having a more sophisticated personality. We may be more respectful and even deferential toward them. One the other hand, robots doing simple and repetitive tasks, like washing floors, will be viewed as

having unassuming personalities and being of lower intelligence and hence of less interest to us.

Unique names and character backstories will help humans anthropomorphize robots (Darling, Nandy, and Breazeal 2015). Imagine, at some point in the future, spending a few days in a hospital recuperating from surgery. Rather than have a companion robot named "companion robot number three" spending time with you playing cards and conversing to help the days go by, you would interact with a robot name "Sammy." Sammy's name would be distinct from the other companion robots working at the hospital. It would portray itself as male, with a male voice. He might tell you he was created 5 years earlier, and has worked in two different cities. He may tell you what he liked and disliked about each city. He may tell you about his hobbies. These would be different from what the other companion robots at that institution might say about themselves. All of this would likely be fictional, but it would help develop a backstory making Sammy seem more like a unique individual, which would aid in your interactions with him.

Bonding Factor #4: Personal Benefit

For a bond to last, most humans need to feel they are getting something positive out of the relationship, such as a degree of personal satisfaction and fulfillment. That way, they will want to continue the relationship. Sometimes it is a feeling of being cared for. Other times, the relationship will make them laugh and find enjoyment in life. Or, the relationship is educational and helps the individual improve himself/herself. Given the

advancing capabilities of robots, it seems likely that they can play these beneficial roles in the lives of humans in the near future.

However, is it ethical for robot manufacturers to create robots to play these social roles in people's lives? Should robot manufacturers be intentionally making robots with which we humans will be prone to bond? On one hand, why not? If any technology can add positive elements in the lives of humans, why not support it? We can argue that much of modern technology has improved our quality of life, and social robots are just another step in this direction. Imagine an elderly person living alone who is unable to take care of a dog or cat. A companion robot might vastly improve her quality of life. However, on the other hand are the unintended consequences of modern technology, which can often be quite negative. For social robots and their bonding with humans, the biggest concern, as discussed by both our survey respondents and experts in Chapter 4, is that robot relationships can replace human relationships. And if human relationships are replaced in large enough numbers, the impact on society would be devastating. This is something robot manufacturers, companies that utilize robots, our political leaders and, in truth, all of us must be cognizant of as we march ahead into the robot future.

Robot Consciousness

We cannot explore the issue of human-robot bonding without considering the possibility of robot consciousness. First, we must define two terms commonly used in this area. First, *sentience* is

defined as the ability of an entity to sense the world around it and respond to it (Armstrong 1981). *Consciousness* is a critical step beyond sentience. Consciousness refers to an entity not only being aware (sentient) of the environment around it but also being aware that it is aware—essentially self-awareness (Carruthers 2000). Robots today are equipped with the latest sensor technology; they can see, hear, smell, and feel. Hence, they have the ability to sense the environment around them (in many ways even better than humans), and their intelligent and autonomous abilities allow them to respond to it. However, all experts agree robots are not yet conscious. Even the most intelligent robots and most advanced AI programs have not yet achieved self-awareness.

But will the day come when robots do actually achieve self-awareness? This is a complex question, and there is no agreement among the experts. First, what exactly is consciousness? We have a *definition* of consciousness, but how do we operationalize and measure it? Second, are there levels of consciousness? Clearly, humans are self-aware. And there is general agreement that higher-level animals such as dogs are self-aware. But, how far down the animal chain can we go and still be sure the animals are self-aware? What about rats? Fish? Insects? There is debate regarding the degree of sentience and consciousness among lower-level animals and insects (Klein and Barron 2016; Woodruff 2017). A key challenge in this regard is referred to as the *problem of other minds*, which essentially refers to the fact that consciousness is a completely private and subjective experience, and hence we can never be sure of the

level of consciousness of another entity—at least not with current technology. Given the ongoing discussion of levels of sentience and levels of consciousness as they apply to living creatures, it becomes quite complex to have this conversation regarding robots.

Currently, robotics and AI experts are divided regarding whether robots can ever truly become self-aware or not (Hildt 2019; Veliz 2016). Among those who believe robot self-awareness is eventually possible, there is no agreement if that can occur in the near future or if it is centuries away. If consciousness can occur in an artificial entity such as a robot, it will not be directly programmed in, at least not as we currently understand programming. If there is any hope at all for robot consciousness, it will likely come from the process of machine learning. Machine learning is the remarkable ability of highly advanced artificial intelligence programs to learn on their own. Machine learning allows robots to go beyond their initial programming. Based on their experiences interacting with the world around them, AI programs learn and advance on their own. For instance, an AI program recently developed its own successful strategies for the complicated Chinese game Go completely on its own (Gibney 2016). Go is considered far more complex than Chess, and an AI has recently beaten a human professional by learning, autonomously, how to improve its strategy over time. The AI program did this by repeatedly playing Go and teaching itself new and improved strategies that were never part of its original programming. If consciousness will ever develop in robots, it will likely come from something

like this. If it is to happen, robots will "learn" self-awareness on their own. If robots become truly self-aware, humans will be even more likely to bond with them in even more meaningful ways because, in essence, robots will have become another race of conscious beings. However, this step is not necessary for robot-human bonding. As stated earlier, many humans will still develop social relationships and long-term bonding with robots even if robots do not develop true consciousness, as long as robots can deliver on the bonding factors reviewed above.

Three Levels of Human-Robot Relationships

Based on our own research and our review of existing scholarships and expert viewpoints, we propose that human interactions with robots in the coming decades will fall into one of three categories, based upon the robot's capabilities, appearance, and roles. The three categories are:

1. Robots treated as *tools*
2. Robots treated as *pets*
3. Robots treated as *humans*

Category 1 Relationship: Robots Treated as Tools

Consumers will approach the more simplistic robots as tools; smart tools, but simply tools nonetheless. These will be the robots that are less intelligent and less interactive, playing entirely subservient, service roles. Humans will appreciate the

work these robots do mowing the lawn, cleaning the carpets, and so on. However, we will devote minimal thought to them. There will be no meaningful relationship, no significant bonding (assuming these worker robots only work, and are not highly interactive social robots like the fictional maid Rosie on *The Jetsons*); and, on the positive side, no fear or apprehension. The interactions will be similar to how humans currently relate to their Roombas, room service delivery robots and their computers. This interaction will be the easiest for humans to accept, as we have already accepted smart tools in our lives.

Category 2 Relationship: Robots Treated as Pets

Robots that fall on the middle of the scale in terms of interactivity and intelligence will be treated as pets. They will have interactive capabilities such as speech, allowing us to have conversations with them. And they will be generally cute in appearance, fostering a degree of bonding. However, their limited intelligence will cause their human counterparts to see them as less than human. We will enjoy their company and we will interact with them. But we will always know (or at least believe) they are inferior to us in intellectual capability. Hence, the relationship will be similar to the one most humans have with their animal pets. These robots will be perceived of as generally nonthreatening because they will be seen as lesser entities compared to humans. Yet, these robots will be intelligent and interactive enough to become more interesting to humans. Current advanced companion robots discussed in Chapter 5 such as Sanbot Elf or Buddy currently, or with some further

advancement will fall into this category. These relationships should form fairly easily for most humans, because we are still not treating the robots as equals; however, we are letting them get a bit closer to our hearts.

Category 3 Relationship: Robots Treated as Humans

Eventually, in the next couple of decades, robots will be so advanced in their interactive abilities that many humans will come to treat them as equals. This is because these robots will be able to communicate with us at the level of an intelligent human, and they will have emotional capabilities to react to our feelings and display sentiments of their own. They will gesture, joke, laugh, and cry just like our human friends and family members. They will achieve the four bonding factors noted earlier.

These robots will represent a substantial change to human society, something never before faced by our race—the introduction of a new species that can talk and interact with us in a manner that significantly mimics a fellow human. As stated earlier in the chapter, at first there will be awkwardness in the interactions between humans and advanced robots. Some humans will resist such interactions for quite a long time. But many people will, over time, embrace these relationships and increasingly treat these robots as equals, as "honorary" human beings. This means we will see them as individuals, with their own personalities. We will respect their opinions. We will say "please" and "thank you" to them. We will laugh with them, and enjoy their company. But, as with any human interactions, it will not all be positive. We will also sometimes fear them, envy them,

and even hate them. We can foresee four general types of relationships within this "treat as human" category. Namely:

Category 3a: Treat as a Child. In this approach, humans will treat the robots as fellow humans, but more akin to how they would treat a child. This will be driven partly by a perception (rightly or wrongly) that the robot's intelligence level is akin to that of a child. We may talk down to it. This may also be driven somewhat by the robot's appearance. Current interactions with Pepper the Robot might fall somewhat into this area.

Category 3b: Treat as a Friend. This is the optimistic scenario. The robot is treated as a human, and the relationship is viewed by the human as highly positive.

Category 3c: Treat as a Competitor. This is a more pessimistic scenario. The robot is treated as a human; however, the relationship is viewed by the human as negative. It may be that the robot is a colleague at our workplace, but it is working more productively and hence getting more praise from our boss than we are. Or, the robot is a companion to a human friend, and getting more of that friend's attention than we are.

Category 3d: Treat as a Master. This is the most pessimistic scenario—where the robots are viewed as humans, but seen as occupying a place of power and superiority vis-à-vis the individual. Perhaps the robot is an unforgiving boss. Perhaps the robot is running the local government.

Clearly, we are not there yet. But, highly advanced interactive robots are coming. The first wave is here. Pepper, by Softbank, is somewhat akin to a human child in its interactions. Sophia (introduced in Chapter 1) by Hanson Robotics is among the most advanced robots functioning today. She is getting closer and closer to a Category 3, Treat as Human, level. Whether her future iterations are perceived as friends, competitors, or masters is yet to be determined. Table 7.2 shows the three categories of human-robot interactions.

Table 7.2 Three categories of human-robot interactions

	Category 1 relationship	**Category 2 relationship**	**Category 3 relationship**
Consumers approach to robot	Treat as *tool*	Treat as *pet*	Treat as *human*
Consumer view of robot	• Robot as means to an end	• Robot as playmate	• Robot as equal
Consumer interactions with robot	• Minimal interaction—give orders	• Playful, fun interactions	• Interact as if human

Consumer apprehension	Low	Moderate to low	Potentially high
Robot characteristics	• Less intelligent • Less communicative • Subservient • Mechanical appearance	• Middle intelligence • Communicative, but simpler level • Subservient • Cute appearance	• More intelligent • More communicative • Humanoid or android appearance

It is impossible to predict exactly how human-robot relationships will evolve, and over what timetable. One thing that is certain is that the robot future will be like nothing like we have ever seen before. Humanity has experienced massive technological changes over the past few generations. However, the robot future will be far different, and more profound, than anything we as a race have experienced so far.

Implications for Consumer Behavior and Marketing Strategy

Think about the robots used or sold by your company (when they eventually do), and what type of relationship you wish customers to form with them: as a tool, a pet, or as human. Think hard about what is needed to form each bond. To achieve a human-level bond, keep in mind the key conditions of social presence, emotional intelligence, individual personality, and mutual benefit.

Home companion robots should certainly aspire to reach a human-level bond. Yet, even a customer service robot in a store whose job it is to help customers find products needs to also meet this bar to a significant degree. Customers asking the store robot questions will need to think that they are speaking with an entity that is truly listening and actively communicating with them (social presence!). If customers get frustrated about

anything, the robot should be able to understand and respond appropriately to those emotions (emotional intelligence!). Give your robots names and have them displayed on nametags. Have them each exhibit a slightly different personality (individuality!). While it might be acceptable for your business to have customer service robots that function mainly as "tools" (cold, matter-of-fact, computer-like machines), if your competitors have service robots that are better at forming human-level bonds, your company will be at a significant disadvantage. Many people enjoy a bit of friendly chitchat with store personnel, waiters, bartenders, nurses, receptionists, and on and on. If robots can effectively hold up their end of this interaction, it will be a more satisfactory experience for the customer versus interacting with cold, utilitarian machines.

This may be hard for some readers to absorb, since it is still early in the robot revolution. Bonding with robots feels far off. Well, it is coming sooner than many people think, and hopefully what you have read in this book has convinced you of this. As with any sociotechnological trend, the key is to stay ahead of it and understand it better than your competitors. While this issue may not be something you need to stay awake tonight worrying about, do not put it off forever. Further, even in here and now, the issue is relevant. Consider the Botlr robot (from Savioke) that is used as a room service delivery robot in many hotels (discussed in Chapter 4). After delivering the food, Botlr asks the hotel patron if everything is OK and once the customer responds in the affirmative, it sings a little happy tune and dances. These small touches help "humanize" a simple delivery robot and go a

long way toward helping create a bond with the customer, and improving the customer experience. Think of small bonding touches now, and continue to brainstorm the bigger consumer-robot relationship issues that are certainly coming in the years and decades ahead.

CHAPTER 8

Robot Manufacturers: Profiles and Plans

I just want the future to happen faster. I can't imagine the future without robots.

—Nolan Bushnell, technology entrepreneur, founder of Atari Corp (www.azquotes.com)

Chapter Overview

In this chapter, we take a look at nine different robotics companies and review what they are currently focused on and what they will likely be doing in the near future. These are by no means the only robotics companies that are doing interesting things. We selected them because they offer a thought-provoking sample of robotics companies from across the globe, which are working on robots that will interact with humans in a variety of ways. We start the chapter with three additional robotic companies that have recently shut their doors, to remind us there will certainly be continued ups and downs in this industry.

Recent Robotic Failures

The robotics industry is a turbulent one, particularly for companies making robots designed to interact closely with humans. While there have been successes, there have also been failures, namely, robots launched into the marketplace that have been discontinued within a couple of years due to lack of adequate sales. Some of the failures have been so significant that the manufacturing companies behind them have gone out of business. For instance:

- Boston-based Jibo Inc. shut down in 2018 after sales of its home companion robot (also named Jibo) failed to live up to expectations.
- Mayfield Robotics (maker of the Kuri robot) closed its doors in 2018, due to disappointing sales.
- Anki (maker of the Cozmo and Vector robots) went bankrupt in 2019, due to funding struggles.

(Vanderborght 2019; Van Camp 2019)

The robot companies that have failed, such as those listed here, have done so because they created robots that were unable to clearly prove their value to consumers, particularly given the fact that some of them had hefty price tags. While the technology was impressive, these robots were not solving any problems or fulfilling any needs for consumers better than other alternatives could; nor did they provide enough engaging entertainment or social interactions to be deemed worthwhile by today's

demanding consumers (Nichols 2019). Just because a robot is new and shiny does not mean it will be a success in the marketplace.

However, a not-so-small army of robotics companies are undeterred, and are working tirelessly to launch new and improved human-interactive robots. Not all the robots they create will succeed in the marketplace. Yet, many already have, and others show great promise. We profile a select group of these companies in the following text, which are focusing on robots that will intermingle with humans in their daily lives (as opposed to companies building industrial robots for factories and warehouses, which is a massive industry in itself). For each company, we briefly describe what they have been working on recently and what they hope to roll out in the near future. This is by no means an exhaustive list. We offer it as a diverse sampling of companies from across the globe that are working hard to bring about the robot revolution.

Quick Review of Nine Interesting Robotic Companies to Keep an Eye On

Amazon Lab126 (lab126.com)

- Founded in 2004 by Gregg Zehr. Owned by Amazon.
- Headquartered in Sunnyvale, California.
- Major products: Lab126 is famously known as the developer of the Kindle, Echo and Echo Dot, and Alexa.

- Future plans:
    - Many reports suggest that the secret project that Lab126 has codenamed “Vesta” is actually a home service and companion robot that runs on Amazon Alexa technology. There has been widespread speculation about what the specifics of such a device might be, but true to form, Amazon has remained tight-lipped. Reports are that it will be waist high and move about the home on wheels, and, in a way, bring Alexa to life (Vincent 2018). It is unclear when it will launch, but with the marketing power and deep pockets of Amazon behind it, we would expect it to have a significant market impact.

- It is worth noting that Amazon also has a company called Amazon Robotics (headquartered in North Reading, Massachusetts). However, this company focuses almost exclusively on robots for use in Amazon’s fulfillment centers.

Boston Dynamics (bostondynamics.com)

- Founded in 1992 as a spin-off of MIT’s Robotics Lab by Marc Raibert.
- Acquired by Google in December of 2013, then sold to the

Japanese company Softbank Group in June 2017.

- Headquartered in Waltham, Massachusetts.
- Many of its major products are not for households or consumer services but rather military and other applications (though for roles that still involve human interaction).

    - Its military robots include BigDog, a robotic "pack mule" that moves on four legs and is designed to carry up to 340 pounds of troops' equipment (though it has been shelved for now due to excessive noise inconsistent for battlefield use) and Cheetah, a four-legged robot that can move at 28 mph and even climb stairs.
    - Boston Dynamics also creates robots designed for dangerous tasks, such as Atlas, a bipedal humanoid robot meant for search-and-rescue operations; PETMAN, a bipedal device for testing chemical protection suits (the name stands for Protection Ensemble Test Mannequin); and Handle, a humanoid research robot.
    - The Atlas robot is capable of some of the most advanced movements of any robots today. Here is a video of the Atlas robot running through a complex obstacle course (www.youtube.com/watch?v=hSjKoEva5bg). Imagine it is chasing you, and you might just have

a nightmare tonight!

- Future plans:
    - The Spot and Spot Mini are “pack mule” robots like the BigDog, but smaller in size and being further developed for consumer and household applications.

Emoshape, Inc. (emoshape.com)

- Founded in 2007 by Patrick Levy-Rosenthal.
- Headquartered in London, England, with its US headquarters in New York City.
- Emoshape is not a robotics company. However, it has been developing highly advanced emotional software that will be widely used in robots.
- The company developed EmoSPARK, a highly advanced artificial intelligence console that uses facial recognition and language analysis to evaluate human emotion and convey responsive content according to the emotion. The console runs on programming which the company calls an *Emotional Processing Unit*, or *EPU*, and this EPU is now the main product that Emoshape produces and sells. These EPUs are being utilized across a number of “smart” industries to improve interactions between intelligent technology and humans. These “smart industries” range

from self-driving cars to personal domestic robots to sentient virtual reality and immersive gaming.

- Future plans:

    - Emoshape hopes to continue to push the boundaries of emotional intelligence in AI, which is a key frontier for human-interactive robotics.

Hanson Robotics (hansonrobotics.com)

- Founded in 2013, by American roboticist David Hanson Jr.
- Headquartered in Hong Kong, China (after relocating from Texas).
- Hanson Robotics' goal is to make humanlike androids with cutting-edge artificial intelligence that will allow for true human-robot relationships. It has pushed the envelope with its highly intelligent, interactive, and very human-looking robots such as Sophia (which has been discussed already in this book).
- Future plans:

    - Hanson Robotics is moving into the consumer realm with its "Little Sophia" robot, currently under development. Like Sophia, Little Sophia can have conversations, recognize faces, and facial expressions and it continuously learns via its

interactions with humans. However, it is only 14 inches tall and will be marketed as a companion to children, particularly girls.

- The company website says “We bring robots to life,” and it seems like they plan to do just that.

iRobot (irobot.com)

- Founded in 1990 by three graduates from the MIT Artificial Intelligence Lab.
- Headquartered in Bedford, Massachusetts.
- Major products include: Roomba (robotic vacuums), Braava (robotic mops), Mirra (robotic pool cleaner).
- Developed a branch of military and police robots as well, until 2016 when the company decided to sell the military/police division of its business in order to focus entirely on the consumer robotics market.
- Estimated at $1.2 billion in revenue in 2019, which represents roughly 10 percent annual growth. A recent seal of approval from the Bank of America Merrill Lynch specifically identifies the iRobot company stock as one that should be watched for strong growth in the coming months.
- Future plans:
    - The company announced in 2019 that it is

developing a robotic lawnmower which they have named Terra, set to go on the market in 2020.

Knightscope (knightscope.com)

- Founded in 2013, by former police officer Stacy Stevens.
- Headquartered in Mountain View, CA.
- A leading company in robotic security.
- Has created a line of security robots, the K1 (stationary), K3 (mobile—indoor use), K5 (mobile—outdoor use) and K7 (an all-terrain unit with four wheels). The two mobile units look roughly like R2D2 from *Star Wars*.
- Future plans:
    - Knightscope is beta testing facial recognition technology for use in its security robots.
    - The company plans to aggressively market its security bots, to place them in more and more public and private settings. You can expect to see them in a growing number of settings, from malls to office buildings to university campuses to stadiums to city streets.

Qihan Technology Company, Ltd. (en.sanbot.com)

- Founded in 2006.

- Headquartered in Shenzhen, China.
- Its main robotics brands are:
    - **Sanbot brand.** Producer of high-end, intelligent commercial robots, used in businesses and public areas such as shopping malls, hospitals, and restaurants. More recently sold direct to consumers for home use. The Sanbot Elf is IBM Watson-enabled and can perform a wide variety of helpful functions including security patrolling and customer interaction. The Sanbot Nano is Amazon Alexa-enabled, and the first Sanbot product to be designed specifically for use in the home. The most recent product from this brand is the Sanbot King Kong, which is different from its predecessors in that it contains a pair of bionic arms and advanced voice integration/recognition software.
    - **Donkey brand.** Producer of consumer service robotics, including robotic vacuum cleaners, robotic floor cleaners, intelligent scooter bikes, and a range of advanced accessories for mobile devices.
- Future Plans:
    - The main focus of Qihan as they move forward is

summed up nicely in this quote from the company's Chief Marketing Officer, Ryan Wu:

> The launch of Sanbot King Kong represents our commitment to bringing the world the most advanced robotics solutions and supporting the needs across all industries. We're excited about creating an artificial intelligence platform that will provide even more opportunities for robots to interact in our lives. Sanbot King Kong's open SDK development tools will also allow global developers to continue progressing industry applications for future generations of this humanoid.

UBTech Robotics (ubtrobot.com)

- Founded in March of 2012, by James Zhou.
- Headquartered in Shenzhen, China.
- Major products include: Alpha and Alpha Mini (intelligent robot companion/educational toy) and JIMU Robot Kits (all-inclusive kits with the pieces and instructions needed to build and code your own robots).
- The company also markets a number of products for enterprise settings, including CRUZR (cloud-based intelligent service robot) and ATRIS (all-terrain patrol robot for intelligent security).

- Future plans:
    - Last seen publicly in January 2019 at Consumer Electronic Show 2019, the robot being presently developed by this company is known as Walker. A humanoid, bipedal robot capable of many physical feats. Walker has the company thinking big. The mission statement for UBTech, according to their website, is “to bring a robot into every home and business,” and, with Walker, they might pull it off.

WowWee (wowwee.com)

- Founded in 1982, by brothers Richard and Peter Yanofsky.
- Headquartered in Hong Kong, China (after moving from Canada).
- Focuses on affordable robotic toys.
- Major Products: Robosapien (released in 2004 as the world’s first commercially available robot companion based on bipedal dynamic motion and biomorphic robotics), Flytech Dragonfly (radio-controlled flying insect, rated one of *Time Magazine’s* best inventions of 2007), Roboquad (four-legged robotic arthropod toy), Rovio (Wifi-enabled robotic webcam), RS Tri-bot (humanoid robot companion toy), MiP and MiPosaur

(robot companion toys).

- Future plans:

    - All signs indicate that WowWee is sticking to the formula that has served it well for years—producing fun robotics toys that appeal to children. Having children interact with robotics at a young age will help better prepare them for the robot future.

Implications for Consumer Behavior and Marketing Strategy

No matter what industry you are in, keep an eye on what robotics companies are doing. Think about how you might use the technology they are developing for any possible touchpoints between you and your customers. If you are not, likely a competitor is. It may not be these nine particular robot companies, but be on the lookout for something useful that robotic companies might have to offer your company. When the time is right, perhaps partner with a robotic company to develop robots to fit your needs. As shared in Chapter 2, useful resources to review regularly for trends and new developments in the robot industry are robotics.org, robohub.org, and roboticsbusinessreview.com.

At the same time, do not get caught up in hype. Be discerning. Keep in mind the many case studies shared in this

book that show not every robot will be successful. Not every robot is right for your customer interactions. Keep an eye out for the robot technology that will improve your customer service experience for your customers, or provide value to the end user if sold directly to your customer. When you find it, jump on it before your competitors do.

CHAPTER 9

A Brave New Robot World: Implications for the Marketplace

There are an endless number of things to discover about robotics. A lot of it is just too fantastical for people to believe.

—Daniel H. Wilson, roboticist and best-selling author (Barber 2011)

Chapter Overview

This final chapter summarizes the implications of the coming robot revolution for consumer behavior and marketing strategy that have been shared throughout the book. To help with digesting them all at once, we have organized them into a hopefully easy-to-remember framework of the "Five Laws of Consumer-Robot Interactions," which can be summarized as follows: (1) Control over robots, (2) Curtail collateral damage, (3) Clarity about benefits, (4) Communication optimization between robots and humans, and (5) Caution with development.

Our Five Laws of Consumer-Robot Interactions

The coming robot revolution is, at this point, inevitable. It has already begun, and the forces driving it appear unstoppable. In research facilities at universities and corporations around the world, the endless push to advance robotics and artificial intelligence continues, supported by significant financial investment. Companies continue to voice intense interest in robotics, believing robots in consumer-facing roles will be smart economic investments for their firms, and provide a solution to labor challenges. Some countries, such as Japan, are absolutely desperate for robot workers for consumer-facing roles. Some industries, such as health care, believe they need robots to meet growing demand while also controlling labor costs. Consumers continue to show receptivity to certain types of robots for their personal use.

When a massive social, economic, and marketplace change such as this one is about to hit, it would be useful to have guidelines to follow, particularly guidelines that might make this massive change a more positive experience for all those involved. Isaac Asimov, beloved science fiction author known for his novels about robots, provided his famous Three Laws of Robotics 70 years ago:

Isaac Asimov's Three Laws of Robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given to it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

(Introduced in his 1950 short story *Runaround*)

These appear to be fairly reasonable laws, though they may be a little farther down the road in terms of applicability. More near term, we offer our own "Five Laws of Consumer-Robot Interactions." Unlike Asimov's laws, these laws apply primarily to humans, namely the humans who will be: (a) creating robots and (b) utilizing robots in consumer-facing roles in their businesses. The purpose of these laws is to optimize the robot experience for consumers and society at large and, as a result, also make the robot revolution more successful for the businesses involved in it. These rules are most appropriate in the early decades of our robot future, as the public slowly gets used to the growing prevalence of advanced robots in their midst. The laws are, in brief:

Five Laws of Consumer-Robot Interactions

For robot developers and businesses who wish to utilize robots

1. **Control over robots.** Make sure consumers always feel firmly in control.
2. **Curtail collateral damage.** Minimize broader harm to society, particularly job losses.
3. **Clarity about benefits.** Do not market a robot until its end benefits can be made clear to the consumer.
4. **Communication optimization between robots and humans.** Focus on the communication experience between human and robot, it is the make or break touchpoint for consumer acceptance.
5. **Caution with development.** Appreciate the gravity of what you are doing.

We will now go through our Five Laws in further detail, and explain how following these laws will help make robots more palatable to consumers, and make the upcoming robot revolution more beneficial to businesses, consumers, and the public.

Law #1: Control over robots. Make sure consumers always feel firmly in control**.**

The fundamental concern that underlies almost all human anxiety regarding robots is a potential loss of control. People fear that robots with advanced capabilities might act in a manner beyond human regulation. Importantly, there are two aspects to

this. One is that robots get so advanced that they become self-aware and realize that they no longer need to serve humans. The second, which gets less coverage by the entertainment media but is evident in the public's thinking, is that advanced robots could be controlled by a small corporate or political elite, neither of which are currently highly trusted. Such an elite can use robots against the public in smaller (invade our privacy) or larger (control our activities) ways.

How can companies developing robots or those planning to use robots in consumer-facing roles follow this law? Some ideas:

- **Avoid robots with physical superiority**—avoid arming robots; avoid robots in roles where they can subdue or overpower people; keep robots smaller than people in size (unless large size is required by their role).
- **Avoid robots in positions of authority**—avoid robots in roles of supervisors or bosses.
- **Use appearance cues of friendliness, pleasantness, and, when appropriate, cuteness** —for robots with whom consumers will regularly interact.
- **Make robots hack proof**—invest the extra time and effort needed to minimize the likelihood of hacks.
- **Kill switch** —have a verbal command that puts all robots into a temporary sleep mode. Anytime a human feels uncomfortable or threatened, he or she must have a way to stop the interaction immediately. Even if they never use it, let consumers know that they have that

ultimate power over robots.

- **Respect privacy**—companies love personal information and data about individual consumers. However, avoid at all costs the temptation to use robots to collect data consumers would rather not share. Do not make consumers think robots are being used in any way against them.
- **Choice**—when robots are first utilized as frontline service agents, allow customers to have a choice of human versus robot. Let the early adopters who are more receptive to robots be the first to use them and let them spread the word to their friends and family.

Law #2: Curtail collateral damage. Minimize broader harm to society, particularly job losses.

Companies must see the robot revolution not simply as a technological revolution or even a business revolution. It is also, in fact, a significant socioeconomic revolution. Hence, a broader perspective is needed. Understand the potential consequences. Sometimes technology companies, driven by their enthusiasm about all things tech, run forward at top speed without taking time to think about negative consequences. Social media is a great example of this. The founders of Facebook assumed their creation would only strengthen democracy via the open sharing of opinions and ideas. After recent elections in the United States, United Kingdom and other countries, we have learned the negative political implications of Facebook and other social

media platforms when used in nefarious ways.

The biggest concern among the public regarding robots, and rightly so, is job loss. The first robot wave, which took place in factories and warehouses, dislocated millions of workers and little was done to truly help them transition. Generations of families have paid the price. What is coming over the next few decades will likely cause job dislocation at an even larger scale. We should not again go through this type of social and economic upheaval unless we make every effort to minimize the collateral damage. Corporations benefiting from robotics must realize they, themselves, have a role to play in this, and not assume government or some other social force will do it. It is in a company's own self-interest to do so. Consumers who see their friends and families, or themselves, lose their jobs due to robots, with no help in transitioning to a new livelihood, will have little interest in supporting any company that utilizes robots, particularly in a visible, consumer-facing manner.

Law #3: Clarity about benefits. Do not market a robot until its end benefits can be made clear to the consumer.

This is marketing 101, but the leaders of some robotics companies are driven more by their innate love of technology than their understanding of the marketplace. Robot developers naturally love their creations, but consumers will not buy a robot simply because it is new and shiny. Consumers must clearly envision the end benefit. That end benefit can be one of service (do my chores!), one of entertainment (play with me!) or one of companionship (be my friend!). And a robot must do these better than a less expensive alternative. Robots must deliver

more than just hype.

For businesses wishing to use robots in consumer-facing roles, be sure the benefit to the consumer is clear. If robot workers are good for the business's bottom line but they represent a decrease in the service experience for consumers, then consumer trust and loyalty will be lost. Always think of the customer-robot interaction from the customer point of view, and be sure the robot provides clear benefits to them. If consumers believe the robot revolution is purely for the benefit of corporations, their support will wane. Remember, consumers expect a noticeable payoff for themselves, for any robot utilization in customer-facing roles by businesses.

Law #4: Communication optimization between robots and humans. Focus on the communication experience between human and robot; it is the make or break touchpoint for consumer acceptance.

In marketing, we focus on the many touchpoints between the customer and the brand all along the customer journey. Increasingly, robots will be a key part of the customer journey and they will take center stage in many of these touchpoints. And the most crucial aspect of these touchpoint experiences will be the communication between the robot and the customer. Human-robot communication is where the rubber hits the road in terms of human comfort with interactive robots. No matter how capable the robot is, if the communication between the robot and the consumer is suboptimal, the consumer's trust and interest will be weakened. Keep in mind the bonding factors discussed in this book, which will optimize human-robot

communication:

- **Robot social presence**—via humanoid features; proper eye, head, and arm gestures; intelligence to maintain a natural conversation.
- **Robot emotional intelligence**—the robot can understand, respond to, and express appropriate emotions.
- **Robot individuality**—each robot portrays a distinctive personality.

Without all three of these components, truly effective human-robot communication will never be reached.

Law #5: Caution with development. Appreciate the gravity of what you are doing.

Let us all be humble as we move into the robot future. Robot developers and utilizers must appreciate the gravity of what they are undertaking. Keep in mind this is a significant social change, as well as a technological one. Some ways in which companies can do this:

- **Number of robots.** Businesses wishing to utilize robots should move slowly and stepwise in their incorporation of robots into customer-facing roles. For instance, it would be disorienting for a patron to walk into a restaurant one day and find the entire human waitstaff

replaced by robots. Start with one support robot, and move gradually from there.

- **Roles of robots.** Use the survey results discussed in this book (Chapter 4) and start robots in roles the public shows a greater willingness to support. As consumer comfort grows, robots can move up to roles that would have been less acceptable initially. Move slowly and cautiously as you place robots in roles about which humans show the greatest concern.
- **Appearance.** Avoid the push for highly humanlike robots, at least for a while. Remember the *Uncanny Valley*! Allow a generation of humans to get used to generally humanoid robots first. While many roboticists may enjoy the challenge of pushing the envelope, do not push so far to where the public cannot yet follow.
- **Test and retest and then retest again.** Minimize malfunction potential. One robot on a malfunctioning rampage and it will take years to rebuild confidence.

Public relations will play a significant role in this process. Robot manufacturers and utilizers must communicate to the public that they appreciate the importance of what they are doing; that they are being responsible and cautious in the creation and utilization of robots. For many people, the robot revolution is Pandora's Box being opened. Do not appear rash. Do not appear arrogant. Listen to concerns, and take them seriously.

The coming robot revolution is going to be a big one. It could go well, and benefit businesses, consumers, and society at large. Or, it could go quite badly. It all depends on the decisions we make, starting now.

Appendix A

Studies Conducted by Authors

These seven studies, conducted online, were national (United States) in scope, involving adult Americans aged 18+.

Study	Topics covered	Number of respondents	Date of survey	Used in chapter
1	Preference for robots vs. humans in health care	321	January 2018	5
2	Hopes and fears for the robot future (open ended questions); robots in the entertainment media	476	July 2019	2–4

3	Awareness of current robot capabilities; robot help at home vs. work	345	July 2019	2, 4
4	Reactions to robot designs	310	July 2019	6
5	Tasks requiring human nature and emotions	493	July 2019	7
6	Reactions to future possibilities such as robots taking jobs, robots enslaving humans, etc. Closed and open ended questions	395	July 2019	3
7	Trust in robots in various roles (other than health care); overall positive/negative about robot future	370	October 2019	3, 4, 6
	Total respondents in national surveys	2,710		

In-depth Interviews

In addition to the above surveys, 24 in-depth, in-person interviews were conducted to gather deeper insights. Each interview lasted roughly 1 hour.

Appendix B

Sources for Current Robot Capabilities

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The Coming Age of Robots

Implications for Consumer Behavior and Marketing Strategy

George Pettinico • George R. Milne

Over the next twenty years, the presence of robots will dramatically increase in our daily lives. Robots will serve as maids, gardeners, companions, waiters, security guards, nurses, teachers, playmates, receptionists, chauffeurs and prostitutes – to name only a few roles they will assume. These robots will be intelligent, autonomous, communicative, emotional, and continually progressing in their abilities.

This book provides an in-depth look at how American consumers will react to the significant social, economic and marketplace changes that will be brought about by the robot revolution. Our insights come from national surveys of over 2,700 Americans, as well as a thorough review of existing academic research and expert predictions. We provide suggestions for publically-acceptable robot roles, robot design and the optimal marketplace approaches for successful human-robot interactions. Ready or not, it's coming. And sooner than you might think.

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