1 Robot Visions

> Our dream is to create a society where it is nothing special for people to live together with robots.
>
> Akifumi Tamaoki

BEGINNINGS

For much of my childhood in Kodaira, a suburban community west of Tokyo,[1] I had to watch television at our neighbors' homes. We only acquired a black-and-white set in 1964 to watch the Summer Olympics, by which time the fields and chestnut orchards surrounding our house were being razed by tract-home developers and the gravel roads paved. Our neighbors had bought their sets to watch the wedding of Crown Prince (now Emperor) Akihito (b. 1933) and Shōda Michiko (b. 1934) in April 1959. By 1964, nearly half of the roughly 25 million households in Japan owned a television, the wealthier among them a color model.[2]

Once we had a TV, I began to watch two cartoons that starred robots: *Tetsuwan Atomu (Astro Boy)* and *Tetsujin 28 [Nijūhachi]-go (Ironman 28,* aka *Gigantor)* (figure 1).[3] Both were preceded by comic book versions and broadcast on Fuji TV from 1963 to 1966. Gigantor is remotely controlled by a ten-year-old boy detective whose father created the robot. The boy and the robot share a deep emotional bond that underscores the familial aspects of real-world human–robot relations in Japan, a theme I will reiterate in each chapter. I discuss Astro Boy at length in chapters 4

Figure 1. Tetsuwan Atomu (Astro Boy). From http://xn—o9j0bk5542aytpfi5dlij.biz/atom_td/.

and 5, but it is worth noting in this connection that in addition to human friends, the boy-bot has a nuclear robot family of his own.

When interviewing Japanese roboticists, our shared childhood fascination with robot cartoons helped to break the ice and spark illuminating digressions. I also noticed that virtually all of them had either a picture or a figurine of Astro Boy somewhere in their office or lab.[4] Later, I learned that many of their students and younger colleagues, while familiar with Astro Boy—arguably Japan's most famous cartoon robot—watched *Doraemon* during their childhood. Doraemon is a blue and white, bipedal robotic cat with a huge smile that lives with a human family and is especially close to the preteen son (see chapter 5).[5]

These cartoon robots, like most of their counterparts in science fiction and the hundreds of "robot films" produced since *Metropolis* (1927) by Fritz Lang (1890–1976),[6] are dexterous and possess superhuman powers. In comparison, actual, tangible robots seem clumsy, slow, and underwhelming. For example, the state-of-the-art robots participating in the June 2015 DARPA Robotics Challenge[7] "accomplished tasks at a glacial pace" and often toppled over. Like the video of that event, footage of actual

robots moving are typically speeded up significantly, sometimes ten to thirty times their original speed. They are also heavily edited to create the illusion of smooth, coordinated movement.

The industrial robots employed in the automotive industry in Japan, Europe, and the United States are efficient and precise, and supercomputers equipped with AI (artificial intelligence), like IBM's Watson (1997) and Google DeepMind's AlphaGo (2016), can beat human chess and Go players, respectively. Futurists such as Vernor Vinge (b. 1944) and Ray Kurzweil (b. 1948) speculate that robots with the sensorimotor versatility of the average human will fully evolve between 2029 and 2045—an outcome they refer to as "the Singularity," the moment in the future when humans and machines will converge.[8] Paul Allen, cofounder of Microsoft, is more guarded and argues that the "amazing intricacy of human cognition should serve as a caution to those who claim the Singularity is close." "Heady stuff," he declares, "but a very long time coming" (Allen and Greaves 2011).

Some skeptics dismiss the possibility of the Singularity altogether. For example, Sofge (2014a) contends that it should be recognized for what it is: "a secular, S[cience] F[iction]-based belief system."[9] Although a Singularity Institute in Japan was established online in 2014, its five founding members are not well known, if known at all, among Japanese roboticists (Japan Singularity Institute 2014).[10] Kurzweil, in contrast, is a member of (and has been honored by) the Institute of Electrical and Electronics Engineers (IEEE), the international organization to which most active roboticists belong.[11] Singularity, as a state of being or form of existence, does not seem to have much of a profile or following in Japan. Generally speaking, what Japanese roboticists and their public- and private-sector supporters are interested in pursuing is not the *convergence* of humans and machines, but rather the *coexistence* of humans and robots.[12]

WHAT IS A ROBOT?

In their 1952 "critical review" of the concepts and definitions of culture, anthropologists Alfred Kroeber (1876–1960) and Clyde Kluckhohn (1905–60) collected 156 examples. Today anthropologists tend either to consider the term *culture* self-evident—we always already know what we mean by

it—and/or to provide new variants for any one of those 156 examples (Kroeber and Kluckhohn 1952). And so it is with the term *robot*.

Masahiro Mori (b. 1927), the Japanese roboticist who first introduced the concept of the "uncanny valley" (which I will discuss and demystify in chapter 6), claimed in an interview that

> you can't define a robot. It's the same as trying to define Mt. Fuji. If a steep hill suddenly protrudes from the flatland, you can draw a line to show where the mountain starts, but Mt. Fuji becomes higher so gradually that you can't draw a line. Robots are like Mt. Fuji. It's hard to separate what is a robot from what is not. [Honda's] ASIMO is so near the peak, anyone can easily call it a robot. But what about a dishwasher? It can automatically wash dishes, so you might call it a robot. The line is blurry. (Mori, cited in Kageki 2012)

Similarly, Illah Nourbakhsh, a professor of robotics and director of the CREATE Lab at Carnegie Mellon University, writes in *Robot Futures* that one should "never ask a roboticist what a robot is. The answer changes too quickly. By the time researchers finish their most recent debate on what is and what isn't a robot, the frontier moves on as whole new interaction technologies are born" (Nourbakhsh 2013: xiv).

With these caveats in mind, I will provide a working definition of *robot* by first considering its etymology. The English word *robot* derives from the Czech *robota* (drudge laborer). Coined by litterateur Karel Čapek (1890–1938) and his artist brother Josef Čapek (1887–1945), the word first appeared in the former's play, *R.U.R. (Rossumovi Univerzální Roboti [Rossum's Universal Robots])*, published in 1920. A science fiction melodrama with comical passages, *R.U.R.* is about a factory (Rossum's Universal Robots) in the near future where artificial humans are mass produced, from protoplasmic batter, as tireless workers for export all over the world. To make a long story short, new-model robots, provided with emotions and able to experience anger at their perceived exploitation, revolt en masse. They kill all but one human, a traditional artisan. Since the formula for the batter has been destroyed, robots cannot reproduce themselves in the factory. Instead, the artisan encourages an emotionally enhanced robot couple he calls "Adam and Eve" to go and repopulate the world with their own kind.

The R.U.R. robots are indistinguishable from flesh-and-blood humans except that they lack ethnic differences. This fact, the director of Rossum's

realizes too late, means that unlike humans, for whom ethnic and national differences provide a pretext for war, the monoethnic R.U.R. robots are able to unite en masse to slaughter all humans (Čapek [1921] 2004: 46). Two distinct categories of robot bodies are assembled at Rossum's factory: female and male. The factory's director explains why female models are needed, in effect distinguishing sex from gender.[13] He notes that the factory is simply responding to customer demand for robots that conform to gendered occupations: female robots are needed as "waitresses, shopgirls, secretaries" (22).[14] Čapek's robots thus reinforce the self-evident (and binary) construction of the sexual and gendered division of labor in human society. Not only do robots today look different from one another, and even have nationality, most are also gendered (see chapter 4).

R.U.R. was performed in Tokyo in 1924 under the title *Jinzð Ningen* (Artificial Human). The play, along with Lang's *Metropolis,* which was screened three years later, sparked an ongoing fascination in Japan with robots in popular culture. This interest continued apace with cartoonist Tezuka Osamu's *Tetsuwan Atomu (Astro Boy)* in the 1950s and is evinced today by the humanoids, "animaloids," and cyborgs that dominate *manga* (cartoons) and *anime* (animated films). From the 1920s to the present day in Japan, robots have been cast as both threatening *and* helpful to humans, but mostly the latter. Even before the 1960s, when the state embarked on a policy of automation in lieu of replacement migration to extend the productivity of the domestic workforce, the general trend in Japanese popular media and culture has been to characterize robots as benign and human-friendly. Čapek's graphic portrayal in *R.U.R.* of the end of bourgeois humanity at the hands of a violent robot-proletariat helped to shape the fears of "westerners" about the destructive potential of robots that persist to this day. The dystopian play did not, however, compromise the mostly favorable acceptance among Japanese of things mechanical, including robots, from the 1920s onward.[15] Today, whether benevolent or malevolent, the meaning of "robot" has become closely associated in Japan and elsewhere with intelligent machines, including humanoids, whose shapes and functions are inspired by biology and diverse life-forms.

As already noted, roboticists resist defining what exactly a robot is. Of all the many definitions available, I find the following one usefully comprehensive yet concise: A robot is an aggregation of different technologies—

sensors, lenses, software, telecommunication tools, actuators, batteries, synthetic materials and fabrics—that make it capable of interacting with its environment, with some human supervision (through teleoperation) or autonomously. Regarding this last criterion, robots are not (yet) completely autonomous. Rather, autonomy exists on a sliding scale: the level of autonomy is adjusted according to different scenarios and influences the way that humans and robots interact with one another (Beer et al. 2014: 74).

Irrespective of its level of autonomy, to be called a humanoid, a robot must meet two criteria. One, its body must resemble a human being, having something like a head, arms, torso, and legs. Two, it has to perform in a human-like manner in environments designed for the capabilities of the human body, such as an office, hospital, school, or house. As I discuss at length in chapter 4, most Japanese humanoids are gendered. In humans and robots alike, gender—femininity and masculinity—constitutes a repertory of learned and performed behaviors and gestures that are cosmetically and sartorially enhanced. Some humanoids are so lifelike that they can actually pass as human beings. These gendered robots are called *androids* (male) and *gynoids* (female).[16]

At the turn of the twenty-first century, Japanese engineers were the first to prioritize the development of humanoid robots. The bones of our human ancestors were discovered in Tanzania's Olduvai Gorge, and Japan is a cyber–Olduvai Gorge, where humanoids first emerged and where they continue to evolve. It should be clear from the array of robots featured in this book that, unlike the generic humanoids of *R.U.R.,* robot morphology is just as diverse as that of humans. They come in every size, shape, and color. All of the robots referred to in this book are enormously complex, layered systems and represent an amalgamation of research across and within many disciplines, from electrical engineering to child development studies.[17]

Some roboticists regard humanoids as nostalgic throwbacks. General-purpose humanoid robots, they say, are too complicated and expensive to use in industry and should be more practically replaced by modular robots with specific functions—which, like Lego blocks, can be joined and separated as needed for a task (Devenish 2001). Even roboticists at Japan's National Institute of Advanced Industrial Science and Technology (AIST) acknowledge that "it is not easy to develop the next-generation robot industry, especially that of biped humanoid robots. The major barriers for

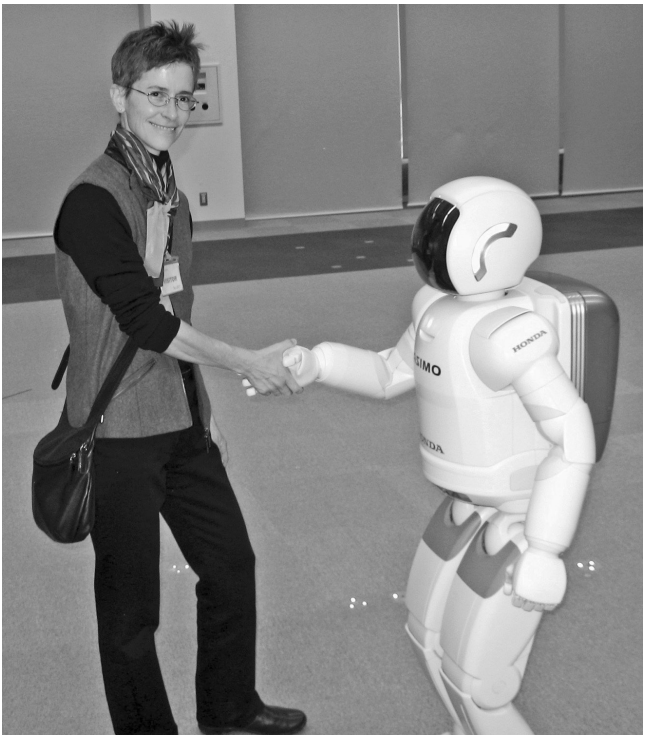

Figure 2. ASIMO and the author at Honda Research and Development Center in Wakō City, Saitama Prefecture, February 2007. Photo by Jack Yamaguchi.

industrialization include: (1) robots walking on two feet only have little commercial value, (2) the unit price is very high, and (3) if it falls, it may be seriously damaged" (AIST 2009).

Similarly, Hara Kenji, a senior analyst at the Japanese research and marketing firm Seed Planning, remarks that many of Japan's robotics projects tend to be too far-fetched, concentrating on humanoids and other "leaps of the imagination" that cannot be readily brought to market (Tabuchi 2009). These critiques are in a minority in Japan, in the sense that they are not widely publicized in the mass and social media, which instead sensationalize the latest gee-whiz humanoid robot. Honda's ASIMO (figure 2), Mitsubishi's Wakamaru (figure 3),[18] Hitachi's EMIEW,[19] and SoftBank's

Figure 3. Wakamaru interacting with two girls at TEPIA Advanced Technology Gallery in Tokyo, October 2015. Photo by author.

Pepper (figure 4) have all enjoyed their fifteen minutes of fame. Public relations videos crafted by robotics manufacturers are broadcast on television as if they were documentaries of actual, real-world human–robot interactions. Even the IEEE, the world's largest and most prestigious technical professional society, includes on its website a weekly selection of "awesome robot videos."[20] The marketing hype around the nearly four-foot-tall, sixty-one-pound Pepper and other humanoids effectively creates expectations that cannot be met, especially among consumers whose image of robots has been forged by science fiction films, anime, and comic books.

Figure 4. Pepper robots at the SoftBank store in Harajuku, Tokyo. Photo by author.

Pepper was introduced in 2014, with much media fanfare, by Masayoshi Son (b. 1957), CEO of SoftBank, as a "personal emotional robot" companion. The following year, SoftBank's website announced that "since the 20th of June 2015, Pepper has become the first humanoid robot available to Japanese households. Pepper is their new daily companion!" (SoftBank Robotics 2016a). About ten thousand Peppers have been purchased by robot hobbyists and some businesses (e.g., Pizza Hut and Nestlé) seeking a novelty attraction. Retailing for an average of $1,700 each, Peppers are sold on "a subscription contract that includes a network data plan and equipment insurance," totaling $360 per month, which drives up the cost of ownership. Robots are expensive machines. Pepper is equipped with a pricey array of technology, including multiple cameras, microphones, and depth sensors that let Pepper make eye contact and respond to touch. Due to the robot's comparatively rudimentary software, however, it responds only to a narrow range of specific preprogrammed cues, rather than to the

highly variable facial and vocal expressions made by humans. SoftBank is willing to sell each Pepper at a loss—at the price of a pet dog (Alpeyev and Amano 2016; Singh 2015)—in anticipation of an expanded market for robot companions in a few years. But will there be such a market?

As Frank Tobe[21] wrote in October 2016, Pepper has "failed in every way to (1) be a companion, (2) recognize emotional cues, (3) be able to converse reliably and intelligently, and (4) provide any level of service other than first time entertainment." His bleak assessment corroborates my own underwhelming experience interacting with Pepper on several occasions at SoftBank's flagship store in Harajuku (Tokyo). Depending on the question, the boy-bot either launched into a seamless pitch (in Japanese) for SoftBank products or froze. By August 2016, the Harajuku store had limited customer interaction with Pepper to swiping the iPad on its chest. Several robot engineers left SoftBank after they realized that the robotics division was headed by project managers with little knowledge of robotics or AI. SoftBank public relations and media hype need to be (re)evaluated against these sobering realities (Tobe 2016).

Before reality caught up with the hype, however, Americans and Europeans began to climb aboard the once ridiculed humanoid train. In 2010 Professor Dennis Hong of Robotics and Mechanisms Laboratory (RoMeLa, at the University of California, Los Angeles) declared, "I think a full-size humanoid is the Holy Grail of robotics. . . . It's a system of systems. It combines all the disciplines of robotics, from artificial intelligence to autonomous behavior to dynamics to controls to mechanical design—everything!" (cited in Ward 2010).[22] In 2009 Hong and his colleagues created the first made-in-America, full-size, autonomous bipedal robot, Cognitive Humanoid Autonomous Robot with Learning Intelligence (CHARLI). Winner of the 2011 adult-size RoboCup, the second-generation CHARLI-2 can walk in all directions as well as turn, kick, gesture, and perform simple upper-body manipulation tasks. The robot can be fitted with a variety of hands and grippers, depending on the objective of a task. At four-and-a-half feet, the lanky bipedal CHARLI-2 is gendered male. He has a white, carbon-fiber, wedge-shaped head with a black visor face and a white, carbon-fiber-formed upper torso, "pelvis," and lower arms. His upper arms, legs, and rectangular feet are mechanical in appearance (RoMeLa 2015).[23] In 2013 CHARLI-2 acquired siblings, also made

in America: Boston Dynamics' ATLAS and NASA's Valkyrie, two humanoids that are each about six feet tall and weigh over 275 pounds (while the newest model of ATLAS is a trim 178.5 pounds). Conceived for use in rugged terrain (ATLAS) and Mars exploration (Valkyrie), the two heavyweights are quite the opposite of the compact, stylish, and cute Japanese humanoids like Pepper, designed to provide humans with entertainment and companionship.

Humanoid robotics has also generated new spin-off technologies (and markets), including the synergistic development of wearable robotics, micromechatronics, solid state sensors, soft exosuits, hydraulics, novel actuators and power systems, advanced materials, computational architectures, optical systems, speech and face recognition algorithms, and innovative energy sources. "Mindware" technologies such as recognition and generalization, reasoning, learning and memory, and cognitive processes are also byproducts of humanoid robotics. Such derivative technologies are perhaps even more important (in terms of functional utility and concrete applications) than the humanoids themselves. Jointly funded since the late 1990s by government and corporate sectors, robotics and its spin-off industries and products are estimated to generate about $70 billion in revenues by 2025, double the international market value in 2015 (IFR 2016).

The Ministry of Economy, Trade, and Industry launched the five-year (1998–2002) Humanoid Robotics Project, followed by the Next Generation Intelligent Robots Project and, most recently, the Living Assist Robots Project.[24] The goal of making robots to augment the labor force and to assist with housework and elder care involves collaboration among universities, research institutes, and corporations. While the majority of robots in the United States are funded by and produced for the Department of Defense (and its agencies) for deployment with military forces,[25] in Japan robots are designed for (future) use in civilian settings, such as hospitals, offices, factories, and the family home. However, in the wake a nationalistic reinterpretation of Japan's "peace" constitution by Prime Minister Shinzō Abe (b. 1954), the field of robotics is now being enlisted in growing the lucrative weapons economy (Pfanner 2014). The Bōeisōbichō (or Acquisition, Technology and Logistics Agency) was established in 2016 to coordinate research and development for the operational needs of the Japan Self-Defense Forces.

The military uses of robots by the Japanese defense industry will not be discussed at length in this book. Suffice it to say that in terms of actual military applications and missions, the Japan Self-Defense Forces have only limited experience in using unmanned/robotic systems, including drones, and continue to benefit from cooperation with the United States (Kemburi 2016). The Japan Aerospace Exploration Agency has, guardedly, revealed its plans to collaborate with Kajima Corporation for the utilization of robots in the development of bases and habitats on the moon by 2030 and on Mars by 2040 (Yano 2016). Developing a military market for robotics is part of Prime Minister Abe's plan to revitalize Japan's economy. In the words of Tomoji Onozuka, an economics professor at the University of Tokyo, "As observed by almost all economists of the world, 'Abenomics' can be clearly classified as an investment oriented strategy and cannot escape from its dangers, therefore Japan has been obliged to slip a dangerous slope into general militarization in 2010s *[sic]*" (Onozuka 2016: 41).

NOMENCLATURE

Since humanoids figure centrally in this book, it is useful at this point to review the concept of a human-made "human," which long predates the Čapek brothers' coinage of the term *robota.*[26] *Jinzð ningen* (literally "human-constructed human") was the term used by the literary scholar Uga Itsuo, whose translation of *R.U.R.*, published in the summer of 1923, was used a year later in the Tokyo production of Čapek's play. The compound word *kikai ningen* (mechanical human) was used in reference to automata, particularly those crafted in Europe between the fifteenth and eighteenth centuries. Many science writers in Japan point to the seventeenth-century *karakuri ningyō* (mechanical dolls; literally "change form while rolling") as proto-robots or precursors to today's humanoids. The dolls were exquisitely crafted by artisans inspired by the verge-and-foliot clocks[27] that had been introduced by Jesuit missionaries and Dutch traders a century earlier. Two of the most popular types of *karakuri* were the *chahakobi* (tea-serving) doll and the *yumihiki* (arrow-shooting) doll. The former is a windup doll about fifteen inches tall, holding a tray. Placing a cup of tea on the tray causes the doll to roll forward. It stops when some-

one lifts the cup from the tray and drinks the tea. Replacing the lighter, empty cup activates a swivel-and-return function.

To describe *karakuri ningyō* as proto-robots or robots is common practice in historical overviews of Japanese robotics (whether in Japanese or some other language). This designation is misleading, however, even though both words are often used synonymously. There are clear distinctions between automatons, as exemplified by *karakuri ningyō,* and robots. Automatons are mechanical devices that perform a single set of operations; they cannot change the sequence of actions. Robots are programmed to—or are equipped with AI that enables them to—perform several sets of operations simultaneously or to alter the sequence of those operations for better efficiency. Robots, in short, can respond to information about their surrounding environment gathered by their sensory devices.

The fact that some automatons, like *karakuri ningyō,* look like humans (or humanoids) is a superficial resemblance that masks their differences. Robots can be, and often are, provided with many types of embodiment, humanoid being only one of them. To create a link in the popular imagination between mechanical dolls and robots is an attempt to create a "deep history" of robotics in Japan that is actually anachronistic. Such a link is also a rhetorical strategy for asserting an unmatched Japanese propensity for state-of-the-art gadgetry. The claims today of *karakuri ningyō* aficionado and artisan Han'ya Harumitsu are illustrative of this strategy: "They aren't simply dolls with moving parts, but rather constructed in line with a sensibility particular to Japan, making them quite different from the European automata to which they are often compared" (cited in Satō 2012).

In this connection, another mechanical doll identified as a proto-robot is Gakutensoku (literally "learning from the laws of nature"). Constructed in 1928, the giant figure was essentially a pneumatically operated automaton (figure 5), although it was referred to as an "artificial human" *(jinzō ningen)* in the press. Designed and manufactured in Osaka by biologist and botanist Nishimura Makoto (1883–1956), the male-gendered apparatus was nearly eleven feet tall but consisted of only a torso, arms, and a head. Nishimura believed that Gakutensoku and other artificial humans were an integral part of the natural world and not separate from it (Nishimura 1928). The inclusion of robots in a network of animate entities is an attitude shared by many Japanese roboticists today.

Figure 5. Gakutensoku. Nishimura Makoto is on the left. From http://cyberneticzoo.com/robots/1928-gakutensoku-pneumatic-writing-robot-makoto-nishimura-japanese/.

Concealed rubber tubes, compressed air, springs, and gears enabled Gakutensoku, seated on an ornate altar, to change his facial expression and move his head and hands. He held a pen-shaped signal arrow in his right hand and a torch named *reikantō* (literally "inspiration light") in his left. Perched on top of Gakutensoku's head was a bird-shaped automaton with the poetic name *kokukyōchō* (literally "dawn-announcing bird"). When the bird cried, Gakutensoku's eyes closed and his expression became pensive. When the lamp lit up, Gakutensoku started to write with the pen. The golden giant, constructed to mark the ascension ceremonies for the Shōwa emperor (Hirohito, 1901–89), whose reign had begun three years earlier in 1925, was displayed at some expositions in Japan but went missing while touring Germany in the 1930s. A replica was built in 2008 and is now on display at the Osaka Science Museum (Hasegawa 2008).

NATURE AND TECHNOLOGY, RELIGION AND SCIENCE

Nishimura's reference to Gakutensoku—and, by association, to all artificial humans—as "nature's grandchildren" highlights a radical difference between the conception of robots in Japan and in Euro-American cultures. Historians of technology and literary scholars alike have long noted that, with few exceptions, robots and artificial humans have been imagined in Euro-American popular culture, both past and present, as threatening to humans and wholly *unnatural.* A consideration of what is labeled and understood by the terms *nature* and *natural* helps explain further the unthreatening reception in Japanese popular culture of robots as natural things.

The most common Japanese term for nature, *shizen,* was more or less fixed in the 1890s, when scientific-mindedness was being newly promoted in schools and the mass media as the key to modernization. Nature remains a discontinuous field, shifting in meaning as it is attached as a prefix to different fields of interpretation, as in the case of *shizenshugi* (naturalism), *shizenhō* (natural law), and *shizen kagaku* (natural science), among other categories (Thomas 2001: 7). *Nature* and *natural* thus imply far more than what is understood today as the environment or ecology.

Like *bonsai* (ornamental, artificially dwarfed trees and shrubs), nature is a protean entity shaped by religious, social, and ritual interventions and scientific experiments alike. And like *kami,* nature exists in multiple forms. *Kami* are the vital forces, deities, or essences residing in, or embodied as, organic and inorganic things. Possessing agency, *kami* can be mobilized through rituals. They are closely identified with Shintō—literally "the ways of the *kami*"—Japan's multidimensional "ethnic religion."[28] To summarize, nature is not external to culture and society but is an immanent component or symbiotic constituent of them; moreover, the reality of nature is contingent upon human artifice and mediation (Kyburz 1997). Robots are "living things" in the Shintō universe (see chapter 5). While they may not claim to be animists, many Japanese roboticists nevertheless draw from this synergistic nature–culture "platform" in advocating not only the interchangeability of robots and humans in everyday life but also their mutual enhancement and even mutual constituency. Some, like Dr. Miyake Yoshihiro of the Tokyo Institute of Technology, believe

that artificial systems should be *incomplete,* by which they mean a kind of "active incompleteness" that occasions an emergent, cocreated network between an artificial system (such as a humanoid robot) and humans in real time (Miyake 2005, 2016). In Japan, unlike in some Abrahamic monotheistic societies or communities, religion and science are regarded as compatible and even synergistic.

During the 1930s, automata, artificial humans, robots, and cyborgs were highlighted in the mass media. "Edutaining" articles on how to build robots; science fiction stories; cartoons and comic books with robot protagonists; displays of giant robots at science expositions; and even robot revues[29] fostered a popular interest in science and technology.[30] They also complemented and contributed to the implementation of "scientific colonialism" throughout the growing empire, which by 1942 encompassed a vast swath of the Pacific Rim linked by telecommunications networks (Fan 2007; Lo 2002; Mizuno 2008; Yang 2010).[31]

The Japanese term for science, *kagaku,* was coined in 1871 and refers to a spectrum of specialized research topics and methods that produce experiment-based systematic, rational knowledge of a part of the world. Since the 1910s this was evident in the prolific use of *kagaku* (science) in the titles of popular magazines, such as *Kagaku Sekai* (Science World), *Kagaku Chishiki* (Scientific Knowledge), *Kagaku Gahō* (Science Illustrated), *Kodomo no Kagaku* (Science for Children), *Kagaku no Nippon* (Science Japan), and *Shashin Kagaku* (Photography Science), to name but a few. After the Japanese Imperial Army invaded Manchuria in 1931, the covers and contents of these magazines featured images and stories of robotic war machines and robot soldiers. Since the turn of the twenty-first century, robots—whether industrial-bots, humanoids, or androids—have been a dominant presence in the Japanese mass and popular media. With the lifting in April 2014 of the self-imposed postwar ban on exporting weapons, long one of Prime Minister Abe's key political objectives, many robots and robotic components are now being weaponized in university and corporate laboratories. Academics may be ambivalent about the military applications of robotics, yet they appreciate the financial incentives offered by the Ministry of Defense at a time of deep budgetary cutbacks in higher education (Japanese Government Asks 2015).

ROBOTS R US

When I first began to research the robotics industry in 2006, Japan was home to over half of the world's 1 million industrial robots, 295 units for every 10,000 manufacturing workers; Singapore was second with 169 units. Today, less than a decade later, South Korea is the global leader in industrial robotic automation, with 478 units per 10,000 workers as of 2016. Japan has 314 units and Germany 292 units per 10,000 workers. At 164 units, the United States occupies seventh place. China has 36 units per 10,000 workers but is catching up fast, and by 2018 it will account for more than one-third of all industrial robots worldwide (IFR 2016). Japanese companies, however, lead in the production of robots and robotic parts. Fanuc, Yaskawa Electric, Kawasaki Heavy Industries, and other companies produce half of the world's industrial robots and manufacture 90 percent of all robotic parts: gears, servo motors, and sensors (Bremner 2015).

In 2006, market researchers in Japan estimated that within a decade each household would own at least one robot, with the size of the household robot market topping 18.6 million units (Market Research 2006). More recently, in 2015, the Nomura Research Institute calculated that about half of Japan's labor force could be replaced by robots or AI devices within the next ten to twenty years, particularly those in roles such as supermarket checkouts, cleaning, caregiving, rescue operations, tourist information, and agricultural labor (Bremner 2015; Komagata and Kawanaka 2016).

What about the humanoid robot market? When the aforementioned Frank Tobe, cofounder of ROBO-STOX LLC and *The Robot Report,* had his stock inducted into NASDAQ in 2014, he arranged for an industrial robot (by Universal Robotics), and not a humanoid, to ring the closing bell: "I wanted something that existed in the real world. . . . I didn't want a humanoid robot because those are academic and they don't exist in the real world" (Anandan 2014). Many Japanese would disagree. Humanoids, like ASIMO and Pepper, do exist in Japan's "real world," though their presence is not, and perhaps never will be, as extensive as that of industrial robots. They serve as technological indices of the country's dominance in the field of robotics and related industries. Japanese robotics companies, supported by the government and by the Abe administration especially, are creating humanoid and

animaloid robots, aimed at senior citizens and children, to provide companionship and perform domestic tasks. This does not mean that robots of all stripes are sharing sidewalk space in Tokyo with human commuters. Most are still in the prototype stage and mainly interact with humans in settings like corporate showrooms, shopping malls, department stores, science museums, and closely monitored situations within select schools, nursing homes, and hospitals. Humanoid robots are rarely visible outside of these supervised settings, and certainly not in ordinary households.

Why, then, are humanoids so prominent in multilevel discussions about caregiving and companionship—and why now? What especially interests me in this book is the way in which humanoid robots, and prototypes thereof, are used as a rhetorical foil for highlighting social problems. Faced with a rapidly aging and shrinking population, Japanese politicians are maintaining, if by default, the early postwar precedent of automating labor. Meanwhile, conservative pundits not only disregard women as a talented and vital labor force, but also blame them for the low birthrate. As of 2016, the birthrate stands at about 1.4 children per married woman. Nearly 27 percent of the population of almost 126.4 million people, which includes about 2 million legal foreign residents, is over sixty-five years old, and that percentage is expected to increase to over 40 percent by 2050. The latest estimates show that at the current birthrate, Japan's population will fall by a third (to 87 million) by 2060 (Fighting Population Decline 2014). There are several reasons for this. Women and men are postponing marriage until their late twenties and early thirties, and some eschew marriage altogether, which is (still) the *only* socially sanctioned framework for procreation.[32] Even married couples are opting not to have children; today, house pets outnumber children. Against this backdrop, companion robot sales are anticipated to take off (Evans and Buerk 2012), although sales of SoftBank's Pepper have leveled off and many robot projects initiated a decade ago remain in the prototype stage.

During my early fieldwork in Japan between 2007 and 2008,[33] I conversed with roboticists, government bureaucrats, corporate officials, academics, and consumers and visited robotics laboratories. I also perused, as I continue to do, the ever ballooning scientific and popular literature in Japanese and English on humanoid household (or partner) robots. One prevalent sentiment expressed in conversation and text alike was the sense

that humanoid robots were regarded by the public as preferable to foreign laborers, especially caregivers, ostensibly for the reason that unlike migrant and minority workers, robots have neither cultural differences nor unresolved historical (or wartime) memories to contend with, as is the case with East Asians. Household or partner robots are fitted with AI that enables them to learn from their immediate environment, quickly memorizing the names and routines of family members or office staff. According to several opinion polls, elderly Japanese claim to be more comfortable with robot caregivers than with foreign human ones (Government of Japan 2013; Japan's Humanoid Robots 2005). Robots are perceived by some Japanese social commentators as mitigating the sociocultural anxieties provoked by foreigners. Limiting the number of nonnationals also reinforces the tenacious ideology of ethnic homogeneity. Recent opinion polls conducted among randomly selected adults suggest that an average of 60 percent of respondents have a favorable impression of caregiving *(kaigo)* robots and would like to employ them (Government of Japan 2013; Kōeki Zaidanhōjin Tekunoaido 2016). Of course, one must take into account the "bandwagon effect" of such government-administered public opinion polls. Such surveys can serve to reinforce and compel conformity to official views, as in this case. Prime Minister Abe has actively promoted the development of care-bots and a robot-enhanced lifestyle, although even market researchers who conduct opinion polls on behalf of the Ministry of Health, Labour, and Welfare acknowledge that care robots are still in the early prototype stage of development, and that safety concerns are a significant impediment to their application (Kōeki zaidan hōjin 2016).

Early on in my research for this book, it became evident that the declining birthrate, labor shortage, and rapidly aging population are being treated in large part as problems that can be "fixed" by technological solutions. In the popular media and robotics literature, these trends are mostly not contextualized or analyzed in terms of the constellation of historical, political, social, and economic conditions that occasioned their emergence. Rather, they are simply treated as surface abnormalities and not as indicative of a deeper malaise within the sociocultural system itself. Not everyone agrees with this assessment. The Shin'nihon Fujin no Kai (New Japan Women's Association), for example, attributes the low birthrate to several deep-seated, overlapping socioeconomic factors. These include the shrinking

family budget, the high cost of educating children, the dearth of public child-care facilities and after-school programs, excessively long work hours, unpaid overtime work, and the replacement of regular employees with "just-in-time workers" (Shin'nihon Fujin no Kai 2004, 2015). Others have noted that the average age at which Japanese women marry is now around twenty-nine, and that refusal to marry and reluctance to have children constitute a form of resistance or protest against a social system that continues to regard women as second-class citizens (Nishi and Kan 2006). A majority of Japanese women in their twenties and early thirties now choose to remain single; many live with their parents in order to economize. Although he coined the phrase *parasaito shinguru* ("parasite single"), a disparaging reference to these women (and men), the sociologist Masahiro Yamada (b. 1957) nevertheless observes that women's standard of living falls dramatically once they marry. Not only do they have to do all the housework, but they are sure to lose two-thirds of their disposable income (Yamada 1999). No wonder that marriage and motherhood (as well as fatherhood) are increasingly low priorities for young adults.

Despite touting "womenomics," the Abe administration continues to place a premium on technology as domestic policy. This is clearly evident in *Innovation 25,* the central government's visionary blueprint for revitalizing Japanese society—especially the household—by 2025. Introduced in February 2007 during Abe's short first term as prime minister, *Innovation 25* promotes a robot-dependent society and lifestyle that is *anzen* (safe), *anshin* (comforting), and *benri* (convenient). Implicit in this proposal is the notion that a married woman who is freed from housekeeping and caretaking chores will be more able and willing to have more children. I will discuss various features of the manifesto-like *Innovation 25* at length below and in the next two chapters. What follows is an overview of this book's constituent chapters, providing the organizing framework and context for this discussion.

PLATFORMS

A platform is a group of technologies that are used as a foundation or base upon which other applications, processes, or technologies can be devel-

oped without having to reinvent the wheel. In robotics, the term *platform* refers to either hardware or software or to both; a robot itself can serve as a platform. HUBO, for example, is a bipedal humanoid platform created in 2005 by robotics professor Jun-Ho Oh (Korea Advanced Institute of Science and Technology), whom I interviewed at his lab on April 2, 2012. Like Japan, South Korea is developing robots for many of the same reasons: manufacturing, service, entertainment, teaching, caregiving, and companionship (Guevarra 2015).

Collaborating with roboticist David Hanson (Hanson Robotics Inc.), Oh and his team created "Albert HUBO" in 2006, an android–humanoid hybrid about four feet tall and weighing about 95 pounds. A self-stabilizing, headless, bipedal HUBO body was connected to a realistic head made of Frubber—a skin-like elastomer—capable of speaking and making nuanced facial expressions. "Albert" refers to Albert Einstein. The robotic doppelgänger was made to commemorate Einstein's announcement of relativity theory a century ago. It is the first robot that combines the different technologies involved in building humanoids and androids—a remarkable breakthrough, since humanoids tend to be mobile, while androids and gynoids that visually pass as human are sedentary and their mobility limited to facial expressions (Oh et al. 2006). In June 2015, another HUBO model bested twenty-two robot competitors from five countries in the DARPA Robotics Challenge, which focused on the use of robots in disaster management and rescue operations. Its unique transformer-like ability to switch back and forth from a walking biped to a wheeled machine, thereby minimizing falls, made the difference that clinched the prize money (U.S. $2 million) for Oh's team (Guizzo and Ackerman 2015).

The word *platform* has other meanings as well, including "a public statement of objectives." In conceptualizing this book, I have found it helpful to think of the term in both senses noted above: as an embodied operating system and as a collection of stated objectives. The gears animating my platform (in the form of this book) are the seven chapters, which include the epilogue (chapter 7) and this introduction (chapter 1); each chapter consists of integrated yet separate components. In technological terms, platforms can also take the form of circuit boards, which are used in electronic devices, including robots, to deliver electricity to different but interconnected components to activate them singly or collectively.

Metaphorically, a circuit board can be conceived as a network of interconnected elements, such as events, ideas, images, and rhetorics, linked by a shared historical or cultural context. The combustion or intersection of these elements can melt old connections and meld new ones, generating new sparks, new currents, and new configurations of data, which is how I envision the contents, or the components, of each chapter.

Chapter 2 discusses *Innovation 25*, the proposal for a robotized society introduced in February 2007 by Prime Minister Abe of the conservative Liberal Democratic Party during his first administration. An extension both of the Humanoid Robotics Project during 1998–2002 and Abe's *utsukushii kuni* (beautiful country) manifesto published the previous year (Abe [2006] 2013), *Innovation 25* includes an illustrated narrative of what Japan *could* be like in 2025. A central feature is an illustrated fictional ethnography, *Inobe-ke no ichinichi* (A day in the life of the Inobe family). The name of this three-generation family is based on the Japanese pronunciation of *inobēshon* (innovation). I provide a translation and critical analysis of this text and its historical archetypes in chapter 3. Several months after *Innovation 25* was introduced, a comic book version of the Inobe family ethnography was published (Eguchi 2007). As I argue, this comic book and *Innovation 25* itself are exemplary of the widespread use in Japan of *gekiga* (graphic propaganda) to communicate complicated policy issues to the Japanese public in an entertaining way.

Abe's resignation in September 2007 was followed two years later by the landslide victory of the centrist Democratic Party of Japan.[34] In part, the latter's inept handling of the triple disaster of March 11, 2011 ("3/11")—earthquake, tsunami, nuclear reactor meltdown—led to its crushing defeat in December 2012 and to the reelection of Abe as prime minister. The impact of 3/11 on the robotics industry is also considered in chapter 2. During the period between Abe's two administrations, *Innovation 25* was retained as the framework for robotics research and development. The latest supplement to that visionary proposal is the formation, in September 2014, of the Robotto Kakumei Jitsugen Kaigi (Robot Revolution Realization Council), under whose aegis Prime Minister Abe is seeking private and public funds to develop "next-generation robots" by the Tokyo Olympics and Paralympics in 2020. As I show in chapter 2, "innovation" is best understood as "renovation." Through such rhetorical devices as car-

toon graphics and a fictional ethnography of a typical family in 2025, *Innovation 25* promotes *retro-robotics* and *retro-tech,* my terms for the application of advanced technology in the service of traditionalism.

As I was analyzing the various rhetorical devices employed to persuade the Japanese public about the desirability and benefits of human–robot cohabitation, I began to wonder about the existence of a deeper backstory behind *Innovation 25,* the subject of chapter 3. Having done archival work on the period 1920–40 on a wide range of subjects, from the all-female Takarazuka Revue (Robertson [1998] 2001) to the eugenics movement (Robertson 2001, 2002, 2010a), I was struck by the similarities I discovered between the fictional cartoon family in *Innovation 25* and its wartime counterpart created under the auspices of the syndicalist Taisei Yokusankai (Imperial Rule Assistance Association [IRAA]), launched in October 1940. As I will elaborate, the historical values celebrated in the Inobe family ethnography have their origin in the "soft power" propaganda deployed during the heyday of Japanese imperialism.[35] Abe openly expresses his adoration of his maternal grandfather, Nobusuke Kishi (1896–1987), who, while serving as minister of commerce and industry, ran for elective office in 1942 under the banner of the IRAA. He twice served as prime minister between 1957 and 1960. The revision of the postwar constitution and the rearmament of Japan were two of Kishi's objectives that Abe has embraced as his own (Hayashi 2014; Samuels 2001; Suzuki 2013).

Kishi's technocratic skills were honed during a study trip to Germany in 1930. In his letter to a senior Ministry of Commerce and Industry colleague, Kishi expressed his admiration for the German devotion to "technological innovation in industries, to the installation of the most up-to-date machines and equipment and to generally increasing efficiency" (Johnson 1982: 108). Kishi was influential in adapting the German model to Japan and Manchukuo—the Japanese puppet state (1932–45) in northwest China—and thereby implementing state control over economic, industrial, and cultural policy, a strategy continued in the postwar period. His colonial policies, realized with the cooperation of the South Manchuria Railway Company, included state-of-the-art urban planning, advanced sewer systems, public parks, creative modern architecture, and global tourism (Pai 2010; Young 1999: 260). Abe has utilized similar soft power and

"Cool Japan" technologies, including cutting-edge robotics and popular cultural media, in efforts to revitalize the post-postwar Japanese economy, in part by globalizing the entertainment and tourism industries (Government of Japan 2016e, 2016f).[36] And, like his grandfather—who, in May 1959, successfully lobbied the International Olympic Committee to award the 1964 Olympics to Tokyo—Abe was personally invested in bringing the 2020 Olympics back to the Japanese capital city.[37]

In *Innovation 25,* robots are described as the means both to reverse the aging and shrinking population and labor force of Japan and to redress the reluctance of women, especially, to marry and have children. How robots are imagined to accomplish these objectives is the subject of chapter 4, which situates robotics within the sex/gender system.[38] Implicit in *Innovation 25,* and in much of the trade literature on humanoid robotics, is the notion that the elder-care, child-care, and household "maid" robots under development will lighten the unpaid workload of married women (or women contemplating marriage), making them more receptive to staying married (or getting married) and to having multiple pregnancies.

The Abe administration pays lip service to tapping the collective expertise of women, "Japan's most underutilized resource," but few concrete strategies have been implemented. Day-care facilities have remained inadequate for decades; their expansion would enable mothers to pursue careers outside the home, but so far efforts have been feeble. In 2015 the wait-list for government-sponsored day-care centers reached 23,167 households. Abe was finally compelled to deal with this issue after an anonymous mother's furious blog on February 15, 2016, sparked an online campaign for more day-care centers that garnered thirty thousand signatures (Begley 2016; Lies 2016). The title of her no-holds-barred memo to Abe, *"Hoikuen ochita Nihon shine!!!"* (Day care denied. Death to Japan!!!), needs explaining. The prime minister has frequently insisted that he is intent on shaping a society in which "all women can shine," and his "womenomics" PR posters shout "Shine!" in English. Feminists critical of the Liberal Democratic Party point out that in Japanese, a syllabic language, "shine" is pronounced *shi-ne,* or "die"! *Shine* is the imperative form of *shinu* (to die). The blogger alludes to this wordplay in her title. In her post, which I have translated as follows, "Japan" signifies the Abe administration:

What gives, Japan?

Hey, I thought this was supposed to be the "society in which 100 million people are all dynamically engaged."[39]

Yesterday, my day-care application was rejected.

What the hell am I supposed to do—now there's no way I can work.

Something's not right with Japan: I give birth, I raise children, I work and pay taxes, and then what?

Shit! No wonder the birthrate is so low.

I have to laugh when you say it's great to have kids. Yeah, but it's impossible to get the kind of day care we need, and that's why no one's going to have kids—duh!

Since it seems that it's okay to philander, and that it's okay to take bribes, why don't you just go ahead and increase the number of day-care centers!

How many millions of yen are you spending on the Olympics?

Who cares about the Olympic emblem—just build day-care centers!

If you have enough money to pay a famous designer [for the emblem] then build some day-care centers![40]

So what am I supposed to do; I'll probably have to quit my job?

Stop screwing up, Japan!

If you're not going to increase the number of day-care centers then increase the child-care allowance to 2,000,000 yen [$20,000].[41]

You won't increase day-care centers, you only pay a child-care allowance of several thousand yen a month, and yet you claim you want to do something about the declining birthrate. You take everything for granted—how selfish can you be? You are totally clueless!

So what're you going to do if we don't have kids?

There are folks who say that if they had the money, they'd be happy and proud to have children. So will you contribute the money? Foot all child-raising expenses!?

Philandering, bribe-taking, the guys who make self-promoting PR fans[42]—if you singled out those Diet members and fired them, you'd probably be able to raise money!

Come on, Japan, do the right thing. (Hoikuen ochita 2016)

In discussing the sexist (il)logic of the premise of *Innovation 25,* I call attention to and critique the taken-for-granted nature of the sexual and gendered division of human labor and social space in Japanese society that is reproduced in and by robotics. The conception and design, including the naming, of feminized and masculinized robots epitomizes the

deliberate yet unconscious reification and reinforcement of the very same sex/gender system that Japanese women, in particular, are both resisting and redressing. As I argue in chapter 4, roboticists as an international group seem to exercise "an intellectual illusion serving unconscious needs" (Raphael 1957: 80), in that they view gendered differences, a priori, as both natural and universal.

Consumers in the public sphere provide Japanese roboticists with important data on human–robot interactions. At Expo 2005 in Aichi Prefecture, roboticists were able to closely observe tens of thousands of visitors participating in "robot interaction experiments," as a result of which a "variety of research and performance improvements . . . [were conducted] . . . that . . . advance[d] the research and development of personal robots."[43] Based on my interviews with staff and visitors, the same was true of the 2008 Robo Japan Expo in Yokohama that I attended on October 10. It is clear that major venues of humanoid-robot-based services and entertainment, from exhibition halls to nursing homes, are utilized as giant laboratories by robot engineers. In fact, Japanese society itself is arguably an enormous field site for robot research and development.[44] More recently, the playwright Hirata Oriza (b. 1962) and roboticist Hiroshi Ishiguro (b. 1963) have collaborated in creating *robotto engeki* (robot theater) as a proving ground outside the laboratory for establishing the parameters of human–robot interactions, both verbal and nonverbal, in everyday scenarios.[45] But it remains the case that despite conducting fieldwork at exhibitions and theaters, as well as commissioning market survey research, robot makers and manufacturers have not questioned their own assumptions informing the gendering of their high-tech creations.

Either overlooked or underacknowledged in both the Anglophone and Japanese-language scholarship on domestic service robots is an investigation and analysis of the type of national cultural, social institutional, and family structures within which humans and robots are imagined to coexist. I redress this oversight in chapter 5 by juxtaposing human rights and robot rights as one way to cast in high relief the social history and cultural dimensions inflecting and informing the discourse of rights in Japan. A discussion about robot rights offers insights into the definition of human rights both universally and within specific nation states, in this case Japan. As I demonstrate, robots are enlisted to uphold the idea of Japanese exceptionalism.

In this connection, I report on a series of real-world human–robot interactive scenarios: the "Contest of Life with Robot *[sic]*" series staged over the past decade in public plazas throughout Japan. Like robot theater, these popular events are intended in part to demonstrate the possibility—and naturalness—of human–robot cohabitation, especially with respect to caregiving and companionship. Japanese robot advocates also focus on initiatives related to convenience, safety, and security. The implementation of these initiatives includes the installation of nationwide surveillance networks. *Innovation 25* has set the stage for a technology-mediated "nationalist internationalism"[46] and the creation of what I term a *gijutsuteki sakoku* or "technologically closed country." This term is a play on the *sakoku* (isolationist) policy of the Tokugawa shogunate (1603–1867), which selectively closed off Japan and the Japanese to the rest of the world. I chose the cover photograph to illustrate the terrible irony of a technologically closed country: the Wakamaru robots, their batteries dead, have been removed to a locked storage facility for industrial waste recycling at Osaka University. They appear to be perplexed, even glum.

Chapter 6 begins with a return to my childhood in Japan, where I have lived at intervals for more than twenty-two years and return annually. I trace the simultaneous disappearance from public view of disabled Imperial Army veterans and the emergence of disability rights in Japan in conjunction with the 1964 Tokyo Olympics and Paralympics. The games heralded Japan's postwar economic recovery and bolstered the newly democratic country's international prestige. Similarly, the 2020 Tokyo Olympics and Paralympics have been promoted as the key to Japan's recovery following the trifold disaster of 3/11. I explore and interrogate the development and application in Japan (and elsewhere) of technological devices that are promoted as a means to transform disabled persons into cyborgs, a condition I call "cyborg-ableism." I understand *disabled,* in the broadest sense of the term, as encompassing a diversity of physical and cognitive "impairments" or "dysfunctions," including those linked to aging, that are associated with some kind or level of personal or social limitation (Wasserman et al. 2016). However, with specific respect to modes of machine-enhanced mobility, I show that cyborg-ableism is premised on a whole-body ideal and thus is a condition attainable only by certain types of human bodies. It is in the twinned context of disability and prosthetics

that I deconstruct the so-called theory of *bukimi no tani* (uncanny valley), which has taken on an uncanny life of its own.

Early in 2015, as part of the Robot Revolution Realization Council's *robotto shinsenryaku* (new strategy for robots), an executive committee was assembled with the task of staging the "Robot Olympics."[47] The committee met for the first time in January 2016 and plans to schedule a pretournament event in 2018, followed by the official games in 2020. Contrary to the expectations of some, however, robots will not be vying with one another in track-and-field sports. The competing robots, including humanoids, will be those designed to function in five fields of operation: manufacturing; service; nursing and medical care; disaster response and construction work; and agriculture, forestry, fishing, and the food industry (2020-nen robotto 2016). Of course, there are already dozens of similar international robot competitions that have been and are staged annually, such as the aforementioned DARPA Robotics Challenge (2012–15) and Robocup (1997–present).[48] The main purpose of the 2020 Robot Olympics will be to promote and showcase cutting-edge Japanese technologies, including robot taxis and wearable robots.

Innovation 25 lays the conceptual groundwork for human–robot coexistence, the pursuit of cyborg-ableism, and the inauguration of a Robot Olympics. However, among the various sociocultural institutions bracketed or missing from this proposal is explicit attention to religious and spiritual beliefs and practices. As noted above, Shintō metaphysics provides a synergistic nature–culture platform for studying human–robot coexistence. Moreover, as I detail in the epilogue (chapter 7), Buddhist temples have recruited new parishioners by offering recycling and funeral services for robots and computers. This epilogue offers a reality check on robot visions and humanoid promises. The example of the now shuttered Wabot (short for "Waseda robot") House project, initiated in 2001 by Waseda University in the hills of Kakamigahara (Gifu Prefecture), is a particularly poignant reminder of the magical-thinking aspect of robot visions. I twice visited Wabot House in 2006 and 2008 at the invitation of its director, Shigeki Sugano, a professor of robotics at Waseda University, and wrote an upbeat account about my first visit in an earlier publication (Robertson 2007). I tell a very different story here. I also reflect on the implications of advanced technology, like robotics, in the service of traditional social institutions.

STATION IDENTIFICATION

Not surprisingly, Prime Minister Abe is often invoked in this book. Although the national robotics initiative began in 1998 with the Humanoid Robotics Project, it was Abe who, beginning in 2007, energetically promoted robotics as the industry that would save Japan. According to his vision, industrial robots would accelerate production; household robots would provide elder care and child care and thereby make married life and motherhood more attractive to women; and robotics spin-off ventures would generate employment and profitable investments and exports. My childhood experiences may bookend this introductory chapter, but Abe's two administrations (2006–07 and 2012–present) frame the events, policies, and various activities that dictate and shape the contents of this book.

That said, this book is not a sustained commentary on the two Abe administrations. Nor is it an exhaustive history of Japanese robotics. Rather, like all ethnographic projects, this book has a spatiotemporal framework. I conducted fieldwork and archival research on robot–human coexistence in Japan and elsewhere at various times over the past decade. That period more or less coincided with Abe's two administrations and attendant robot initiatives: *Innovation 25* in 2007 and the Robot Revolution Realization Council in 2014. The 3/11 disaster punctuated the momentum of robot research and design. Roboticists were roundly criticized in the mass media for not having rescue robots ready to be deployed (as I discuss in chapter 2). Robot laboratories, such as Waseda University's Wabot House, were closed in the wake of the disaster when funding dried up or shifted to other technological priorities, such as those that materialized in 2014, when the ban on exporting weapons was lifted.

My various publications and presentations on robots (see Bibliography) reflect the vicissitudes of the robotics industry, as evident to some extent in their titles alone. This book caps my research to date and alludes to timely subjects and themes for future interdisciplinary research. When, in the early 2000s, I began to study real-world robots and the type of society their makers and promoters imagined them cocreating and coinhabiting with humans, some departmental colleagues rolled their eyes. Today, however, unless living in isolation or off the grid, one cannot avoid noticing that robots are in the news and entertainment media everyday. The

scholarly literature on robots and robotics has expanded exponentially over the past decade, as a simple Google Scholar search will reveal. As declared in a 2014 *Boston Globe* headline, robots are the "21st century's newest must-study subject" (Fitzgerald 2014). Clearly, robotics is an increasingly prominent field in the superheated technology environment. Books about robots that focus solely on highlighting the newest gee-whiz innovations and prototypes quickly become out of date, part of an important historical archive that charts the rapid vicissitudes of the robotics industry (Hornyak 2006; Menzel and D'Aluisio 2000; Nikkei Mekanikaru and Nikkei Dezain 2001; Schodt [1988] 1990).[49]

By the same token, simply inserting "robots" as a singular category into a ready-made theoretical scaffolding homogenizes very different types of robots and their applications in local contexts. Human–humanoid coexistence has been presaged in science fiction genres and continues to be imagined in fictional terms in government policy proposals, like *Innovation 25,* and industry PR. Actual human–robot interactions in a domestic setting are few and far between, the one exception being Sony's robotic dog, AIBO (Artificial Intelligence RoBOt). About 150,000 AIBOs were sold for $2,000 each in Japan, Europe, and the United States between 1999 and 2006 (Aibos History *[sic]* 2017; see also chapter 7). More AIBOs may have been sold than any other household robot to date, but the animaloid still represents a luxury playmate for a tiny, affluent demographic. In comparison, the number of industrial robots in factories around the world will reach 1.3 million by 2018, according to the International Federation of Robotics.

With the exception of robot vacuum cleaners, personal/companion/service humanoids simply are not part of everyday home or work life in Japan.[50] Perhaps they will be in several decades. More likely is the future prevalence of robotic appliances, such as refrigerators and rice cookers that can be more easily accommodated within the small, cluttered spaces of the average Japanese dwelling. Humanoid robots are mostly available for supervised interaction at robot expos and conferences, science museums, and trade shows. Meanwhile, relatively few robots are actually utilized on a regular basis in hospitals and nursing homes, although experimental prototypes, such as Robear and Terapio, are presented in the media as if they were widely employed.[51] The PR produced and circulated

by robotics labs, policy makers, and the mass media all create scenarios suggesting that robots are already a fixture in households. A good example of this is SoftBank's photograph on their website of Pepper in a family setting. The robot is shown surrounded by members of the Asahi family: a married couple, their three children, and an elderly man (probably the husband's father). The caption (in English) reads: "The Asahi family adopted Pepper a week ago and they are delighted with him. Each family member gives him new functionalities and Pepper surprises them a little more each day" (SoftBank Robotics 2016c).[52] It is not clear if this is a fictional family composed of commercial actors or an actual family whose members agreed to be photographed with Pepper. I suspect the former. Their name, Asahi (literally "sunrise"), invokes the "rising sun" flag used by the military and also in advertising as a symbol of tradition and good fortune. Significantly, the three-generation Asahi *ikka* (family) resembles the fictional Inobe family in *Innovation 25* and its wartime counterpart, the Yamato *ikka,* whose stories I tell in chapters 2 and 3.

Throughout the chapters that follow, I demonstrate that critical attention to the public relations and marketing efforts of robot designers and companies will spotlight the rhetorical climate that sustains visionary scenarios of human–robot coexistence. Thus, while I include breaking information (up to when this book went to press), I have focused (for reasons noted above) on a temporal frame demarcated by the Abe administration. I also provide dot-connecting backstories that make possible more thickly descriptive accounts of narratives about robot technologies and human–machine interactions. It is important to reiterate that just because the concept of robot–human coexistence has few religious or ethical impediments in Japan does not mean that robots are as populous in quotidian life as they are in automotive factories: the hype surrounding robots must be separated from their actual status. So far, humanoid robots represent a very expensive industry with very little in the way of tangible, sustainable services for ordinary folks in their everyday lives.

Readers will notice that, as in my previous books, I do not subscribe to a trending "theoretical" approach and the accompanying name-dropping. My scholarly orientation is characterized by a reticulate aesthetics that is nonhierarchical (or noncanonical), eclectic, genre-crossing, discipline-crossing, and pursued, eyes wide open, with great curiosity about manifold

things. This book is about my own and others' research and stories that I have orchestrated in a coherent and meaningful score. The coherence of my story comes from the interlaced elements and not via the superimposition of a particular theoretical edifice. Of course, stories are multivalent in their meanings and neither my own nor others' concatenations of data and interpretations of evidence are the only ones possible. Neither, however, are my stories open-ended. They are crafted in a way that, after much research and thought, I feel articulates the multidimensionality of the robot phenomenon, especially as it has materialized in Japan.