Robots

John Jordan

The MIT Press

Cambridge, Massachusetts

London, England

This book was set in Chaparral and DIN by Toppan Best-set Premedia Limited. Printed and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Names: Jordan, John M. author.

Title: Robots / John Jordan.

Description: Cambridge, MA : MIT Press, [2016] | Series: The MIT Press essential knowledge series | Includes bibliographical references and index.

Identifiers: LCCN 2016008323 | ISBN 9780262529501 (pbk. : alk. paper)

eISBN 9780262335638

Subjects: LCSH: Robotics—Popular works. | Robots—Social aspects—Popular works.

Classification: LCC TJ211.15 .J67 2016 | DDC 629.8/92—dc23 LC record available at https://lccn.loc.gov/2016008323

ePub Version 1.0

3 Robots in Popular Culture

Mythos

An ongoing history of efforts to create artificial life—to replicate, enhance, or surpass human characteristics—dates back thousands of years to the golem, with cuckoo clocks, Mechanical Turk, and Vaucanson's duck following later. What could motivate such a persistent quest? Humans might have sought validation as creators, to be on a level with whatever deity or other maker their religion names. Robert Geraci, a religious studies professor, suggests another explanation: the story of Adam and Eve is deeply ingrained in Western culture. The myth goes on to posit that humanity, from that time forward, has lived in a state of having fallen from grace. Thus the quest for artificial life can be seen as an attempt to escape that imperfection, and potentially bring about a new era.[1]

And the quest is not merely Judeo-Christian. Respected Japanese robot designer Hiroaki Kitano stated the case in strikingly similar terms—his naming of the robot's origin is critically important here—suggesting that the mental model is widely held: "In his gestation, [the humanoid robot] PINO symbolically expresses not only our desires but humankind's frail, uncertain steps toward growth and the true meaning of the word human."[2]

Technology has long been viewed as both an impediment (by Shakers and Amish among others) and an aid to a higher state of being. Geraci identifies the "digital utopians" of the homebrew computer age who thought the decentralization of computing and thus knowledge could help bring about flatter, more egalitarian power structures. He then traces the idea of "apocalyptic AI" through a variety of expressions, including transhumanists who see artificial life as a step beyond humanity's imperfect (they would not call it

"fallen") state. Science fiction and popular scientific writing blend in amplifying this theme. The roboticist/novelist Hans Moravec writes of "mind children" (AI robots) defeating humans in a Darwinian struggle,[3] while Ray Kurzweil uses characters from the future in several books to explain his notion of the "Singularity."

Deep religious concepts, including salvation, eternal life, and some state of otherworldly perfection are all informing our discussions of robots just as surely as are considerations of battery life, machine vision, and path-planning algorithms. As Geraci asserts, "The sacred categories of Jewish and Christian apocalyptic traditions have thoroughly penetrated the futuristic musings of important researchers in robotics and artificial intelligence." Given that these ideas have emerged in disparate areas—online gaming, popular culture, all sorts of computerized user interfaces, autonomous vacuum cleaners, drone warfighting, high-frequncy stock trading, automated factories—the study of robots provides a fascinating keyhole into contemporary existence. "To study intelligent robots," Geraci concludes, "is to study our culture."[4] Going one step farther, the Carnegie Mellon roboticist Illah Reza Nourbakhsh argues that more than culture is involved: "the robotics revolution can affirm the most non-robotic quality of our world: our humanity."[5]

The other mythology we should acknowledge derives from the place of technology in American culture, dating from the earliest days. The history of the United States is unique in several regards: its relationship to Europe, its sheer size, its vast mineral wealth, and its contestation. In no other country has there been a replacement of indigenous people at such scale, by such a wide variety of immigrants. A core piece of Americana is the role of a physical frontier, the westward-moving demarcation between "civilization" and the unknown. Even after California and the interior West were populated, the idea of a dividing line waiting to be explored and colonized remained potent. The Apollo moon landing was situated squarely in this narrative, and then science fiction even more aggressively incorporated the idea, most straightforwardly in the opening to nearly every *Star Trek* television show ever broadcast:

"Space: the final frontier. These are the voyages of the starship *Enterprise*. Its five-year mission: to explore strange new worlds, to

seek out new life and new civilizations, to boldly go where no man has gone before."[6]

The conquest of the North American frontier, and the inhabitants thereof, was largely accomplished with technological innovation: rifles, railroads, barbed wire, and the telegraph in the nineteenth century, followed by irrigation, air-conditioning, and interstate highways in the twentieth.[7] Technology helped establish a physical frontier, then itself became a metaphorical frontier (serving many of the same purposes) once the territory was settled.

In mythological terms, frontiers can apply neatly to science, knowledge, and innovation: a Google search of "frontiers of science" returns 31 million hits. Although many countries have active robotics research programs, among them Japan, France, Germany, and Sweden, the U.S. robotics effort should be situated in proximity to this rich mythological past of unique ideals: conquest, expansionism, and one other trait. For lack of a better word, let us call it "solutionism."

In one reading, this neologism refers to a particularly U.S.-centric attitude, often accompanied by some naïveté, holding that most problems have solutions, often technological ones. More acerbically, the cultural critic Evgeny Morozov calls solutionism "an intellectual pathology that recognizes problems as problems based on just one criterion: whether they are 'solvable' with a nice and clean technological solution at our disposal."[8] Whichever reading you accept, there is something in the U.S. ethos that seems to encourage tinkering, rather than a more "realistic" view of the world that accepts that some things just cannot be fixed.

With these two long-term backdrops in place, let us turn to the place of robots in Western culture, primarily science fiction literature, cinema, and television. It's difficult to recall an emerging technology with deeper roots in science fiction than robotics. From the very origin of the word, the history of robotics coincides with, and was heavily shaped by, images and legacies of books and movies. To the extent that science fiction is a relatively young genre, and that cinema and television are young media, this path of cultural influence is unprecedented. Its consequences, however, are substantial and largely invisible. As robotics becomes a much more feasible and familiar field, understanding its cultural origins

becomes a necessary step in defining what robots are, what humans want, and how the two entities interact.

R.U.R.

R.U.R., the play that introduced the word "robot," was a critique of mechanization and the ways it can dehumanize people. It premiered in Prague in 1921 and was one of the most performed plays of the twentieth century, being translated and performed in "almost all the civilized countries of the world," as one 1962 analysis put it.[9] As its author Karel Čapek told a magazine,

> The old inventor, Mr. Rossum (whose name translated into English signifies "Mr. Intellectual" or "Mr. Brain"), is a typical representative of the scientific materialism of the last [nineteenth] century. His desire to create an artificial man—in the chemical and biological, not mechanical sense—is inspired by a foolish and obstinate wish to prove God to be unnecessary and absurd. Young Rossum is the modern scientist, untroubled by metaphysical ideas; scientific experiment is to him the road to industrial production. He is not concerned to prove, but to manufacture.[10]

Thus the very word now so much in general circulation was a cultural critique of both the human desire to replicate his own form, much in the manner of Dr. Frankenstein, as well as the logic of industrial production.

The contrast between robots as mechanical slaves and potentially rebellious destroyers of their human makers echoes *Frankenstein* and helps set the tone for later Western characterizations of robots as slaves straining against their lot, ready to burst out of control. The duality echoes throughout the twentieth century: Terminator, HAL 9000, *Blade Runner*'s replicants. The character Helena in *R.U.R.*is sympathetic, wanting the robots to have freedom. Radius is the robot that understands his station and chafes at the idiocy of his makers, having acted out his frustrations by smashing statues.

Helena:
Poor Radius. ... Couldn't you control yourself? Now they'll send you to the stamping-mill. Won't you speak? Why did it happen to you? You see, Radius, you are better than the rest. Dr. Gall took such trouble to make you different. Won't you speak?

Radius:
Send me to the stamping-mill.

Helena:
I am sorry they are going to kill you. Why weren't you more careful?

Radius:
I won't work for you. Put me into the stamping-mill.

Helena:
Why do you hate us?

Radius:
You are not like the Robots. You are not as skillful as the Robots. The Robots can do everything. You only give orders. You talk more than is necessary.

Helena:
That's foolish Radius. Tell me, has any one upset you? I should so much like you to understand me.

Radius:
You do nothing but talk.

Helena:
Dr. Gall gave you a larger brain than the rest, larger than ours, the largest in the world. You are not like the other Robots, Radius. You understand me perfectly.

Radius:
I don't want any master. I know everything for myself.

> Helena:
> That's why I had you put into the library, so that you could read everything, understand everything,[11] and then—Oh, Radius, I wanted to show the whole world that the Robots were our equals. That's what I wanted of you.
>
> Radius:
> I don't want any master. I want to be master over others.[12]

Helena's compassion saves Radius from the stamping mill, and he later leads the robot revolution that displaces the humans from power. Čapek is none too subtle in portraying the triumph of artificial humans over their creators:

> Radius:
> The power of man has fallen. By gaining possession of the factory we have become masters of everything. The period of mankind has passed away. A new world has arisen. … Mankind is no more. Mankind gave us too little life. We wanted more life.[13]

Humans were doomed in the play even before Radius led the revolt: when mechanization overtakes basic human traits, people lose the ability to reproduce. As robots increase in capability, vitality, and self-awareness, humans become more like their machines: humans and robots, in Čapek's critique, are essentially one and the same. The measure of worth, industrial productivity, is won by the robots that can do the work of "two and a half men." Such a contest implicitly critiques the efficiency movement that emerged just before World War I, with its time-and-motion studies, which ignored many essential human traits.

The debt of *R.U.R.* to Shelley's *Frankenstein* (1818) is substantial, even though the works are separated by almost exactly a century. In both cases, humans show hubris by trying to create artificial life. (Recall that even today, Rodney Brooks refers to robots as "our creatures.") Whether humans get the recipe wrong, as in the earlier novel, or make beings smarter than the humans who spawned them, as in the case of Čapek's play and its offspring, humans pay the price

for aspiring to play God. In both works, the flawed relationship between creator and creature drives the plot, and in both cases, the conflict ends in bloodshed.

Few people today know *R.U.R.* More know Asimov's robot novels, but in either case, robotics is a special branch of technology in that, in the archetype, it aspires to approximate humanity, whether through biomimicry, flawless logic, or economic superiority.

Robots at the Movies (and Elsewhere)

This dualism between robots as slaves and robots as potential overlords, rebelling against the constraints of servitude, plays out remarkably consistently in the twentieth-century West. Only six years after the premiere of Čapek's play, the German director Fritz Lang released *Metropolis*. The work remains widely recognized as one of the most influential movies ever made, not least because it contributed heavily to Nazi Party ideology. Many themes carry over from *R.U.R.* including confusion among humans as to the true identity of a robot among them, a looming revolt of the dehumanized industrial workers, and romantic attraction between human and robotic species. In the end, the mechanical Maria (who has been instigating the workers to rise up and destroy their machines) is discovered and burned at the stake, while the robot's human counterpart escapes after being kidnapped and helps broker a peaceful resolution between workers and factory owners. The silent film originally ran about two and a half hours, took 310 days to shoot and involved 36,000 extras. Despite its length and confusing plot, it remains a film landmark. The portrayal of the robotic Maria as deceitful and rebellious tracks closely to the prototype established by Čapek.

The next memorable character appeared in 1939 in one of the most beloved films in cinematic history. The portrayal of the Tin Man in *The Wizard of Oz* aligns closely with other robot figures we will encounter in that he is the result of a series of mechanical prosthetics installed when, as woodsman, he injures each of his limbs, one by one; but the tinsmith, in giving him also a tin body, forgets to give him a heart. The Tin Man escapes the Frankenstein associations in

part because of the incremental nature of his mechanization, and because the focus of the film (and the book from which it was made) is not on his strength or logic, but on his desire for feelings. The character has become an icon, appearing in other novels, pop songs, and advertising campaigns decades after the movie's release.

Also in 1939, at the New York World's Fair, Westinghouse demonstrated a 7-foot aluminum-skinned robot named "Elektro." The robot could smoke cigarettes, count on its fingers, and speak by way of a 78 rpm phonograph record embedded inside. A year later, the robot was joined by a metal dog named "Sparko" that could sit, beg, and bark. Elektro was recently restored and resides in the Mansfield, Ohio, Memorial Museum, having been built at Westinghouse's Mansfield facility.

Roughly a decade after *Metropolis*, science fiction as a genre was in the midst of both a growth in popularity and the development of robots as critical elements of both plot and theme. Although the arrival in the 1940s of what became known as the "big three" of science fiction—Arthur C. Clarke, Robert Heinlein, and Isaac Asimov—helped establish the genre as a marketable and recognizable body of work, it was in the writings of Asimov that robots gained new status and robotics was foreseen as a discipline alongside mechanics or dynamics. In a series of short stories written between 1939 and their collected publication in *I, Robot* in 1950, Asimov introduced the notion of a "positronic brain," a computer that operated at a sufficiently high level that artificial beings could express a consciousness recognizable to humans.

Rather than inhabit the *Frankenstein* stereotype of artificial beings scheming to destroy their creators (what Asimov called "Robot-as-Menace"),[14] robots in Asimov stories consistently exhibit moral codes that were explored by way of conflicts rather than mere exposition. In the story "Runaround," published in 1942, Asimov stated the three laws of robotics, squarely in line with his emerging sense that robot stories needn't be either threatening or sentimental. Instead, he wrote in 1982, "I began to think of robots as industrial products built by matter-of-fact engineers. They were built with certain safety features so they weren't menaces and they were fashioned for certain jobs so that no Pathos was necessarily involved."[15] A concept of "robopsychology" in Asimov's work helps

human observers understand why robots made the decisions they do, for example. Complex themes such as the value of work, the attractions between humans and robots, and the relative value of a robot life versus a human one also appear regularly.

One primary genre of robotic fictional representation features aliens from space that inhabit mechanical, or biomechanical, forms. The distinctions among robot genres become important here. Robots, culturally rather than technologically speaking, tend to be mechanical entities that exhibit anthropomorphic tendencies. The word "android" dates to the nineteenth century and refers to non–human beings that have flesh-like exteriors. (Strictly speaking, Čapek's "robots" in *R.U.R.* are androids and not robots.) Cyborgs, meanwhile, are a more recent conceptualization, dating to about 1960. The MIT professor Norbert Wiener coined the term "cybernetics" to denote "the scientific study of control and communication in the animal and the machine."[16] Cyborgs are thus beings that merge artificial and organic systems of control. Although the term "cybernetic organisms" can be applied broadly to large systems, cyborgs are for our purposes typically semihuman characters that have been enhanced in some way through the application of computational/robotic capabilities.

When robots descend from outer space in popular culture, they can be any of these species. In *The Day the Earth Stood Still* (1951), an alien named "Klaatu" brings a message promoting world peace (implicitly supporting the creation of the United Nations), accompanied by the robot Gort; the robot emerges from a spaceship designed in collaboration with Frank Lloyd Wright. In 1956, Robby the Robot appeared in *Forbidden Planet* alongside future *Airplane* star Leslie Nielsen. After the original movie, Robby later appeared in other films and TV shows. Significantly, humans traveled to outer space where they encountered Robby, rather than the other way around. After 1960, humans' adventures in space became a more common theme, with several landmark films following the plot device.

Space travel proved to be one of several convenient retellings of old tales in the robot genre. The debt of many movies to Homer (including of course *2001: A Space Odyssey*) is obvious. The Swiss Family Robinson of 1812 (while sailing from Europe to Australia, they were shipwrecked in the East Indies) paid its debt to *Robinson*

Crusoe, then itself became the inspiration for a 1960s television show. Fathers and sons (*Star Wars*), coming of age, mistaken identity, and of course the Frankenstein monster threat all make repeated appearances, with the twist that robotic characters are only partially human.

In 1963, the BBC launched the *Doctor Who* television serial, in which Daleks featured prominently. These aliens were in fact extraterrestrial cyborgs that mutated into ruthless killers, given that they lacked all emotions save for hatred; their most frequent utterance is simply "Exterminate!" Like other fictional cyborgs, Daleks quickly became a touchstone in British popular culture, and have appeared in a fiftieth anniversary commemoration done by the BBC. *Doctor Who*, meanwhile, remains popular among many populations, including some U.S. teens.

The depictions of robots in popular culture began to shift after Asimov. In contrast to the nonhuman assemblies of mechanical parts typified by Gort or Robby, later robots could express a variety of emotions, interact with human characters with nuance and ambiguity, and wrestle with the complexities of their nature. Although there continued to be clear-cut evil villains, and simplistic servants, the commercial success of multiple robot-themed movies indicated a growing recognition within mass culture of the (largely fictional) possibilities of a new technology and potentially new life-form.

Although alien movies continued to appear after 1970, more and more cyborgs were situated on Earth. In *Robocop* (1987), for example, a murdered Detroit police officer is returned to life with electromechanical spare parts and given superhuman powers. Not surprisingly given the genre, the robotic creature's powers create tensions with human laws and networks of corruption; the threat of a rogue, nearly invulnerable humanoid echoes other narratives. *Robocop* was far from original, following as it did director James Cameron's robot-movie milestone, *The Terminator* (1984). Made for roughly $6.5 million, the film grossed $78 million (more than $225 million in 2015 dollars). Arnold Schwarzenegger played a ruthless cyborg, with flesh-like skin over a bionic endoskeleton. The fate of humanity hung in the balance as an unborn baby (John Connor, whose initials are obvious), who was to lead a humanist uprising, was

being stalked by Schwarzenegger's character, time-traveling from the future in the employ of the evil Skynet.

In *Blade Runner* (1982), director Ridley Scott used yet another space-travel device to create a dystopic vision of the future based on the Phillip K. Dick novel *Do Androids Dream of Electric Sheep?*[17] Cyborgs are created on Earth by evil corporations, and then shipped off to work on space colonies. Some sneak back to Earth, in violation of the law, so they must be hunted down. Known as "replicants," the androids represent yet another vision of robots as capable of dull, dangerous, and dirty work, but also capable of desiring to transcend their station and challenge humans for authority. The character played by Daryl Hannah continues the trope embodied by Maria in *Metropolis*, the alluring female android who preys on men's weakness.

What countless polls and surveys have called history's greatest space movie, however, features a robot that never appears. Arthur C. Clarke, one of science fiction's "big three," collaborated with Stanley Kubrick on *2001: A Space Odyssey* (1968), which portrayed robots in yet another light. Rather than assuming anything resembling human form, HAL 9000, the computer that runs the spaceship bound for Jupiter, has a human-sounding voice, appears to express emotions, can sense its environment (including lip-reading the astronauts when they express concern about HAL's behavior), and can also operate the ship's systems and devices. HAL cannot stop the remaining human astronaut from disconnecting its power supply in the film's crucial scene after HAL has killed all the other astronauts, and exhibits emotional regression as its computational function diminishes. In Clarke and Kubrick's portrayal, a robot is thus capable of emotion, highly intelligent, and powerful (though not all-powerful), but ultimately proves it cannot be trusted.

The film was a massive commercial success, and remains a powerful cultural monument nearly fifty years later. Ambiguity—probably the film's defining characteristic—allows viewers to re-create in HAL their personal fears, aspirations, and associations of artificial intelligence. The fact that HAL is never seen, for example, but only heard through the excellent voicing of Douglas Rain, contributes much to the film's timeless quality. Every serious robot movie that came after, and many not-so-serious ones, self-consciously relates itself to this monument.

At the opposite pole of *2001*'s HAL are multitudes of robot characters that embody neither menace nor superior intellect. From the cartoon maid Rosie on *The Jetsons* (aired in primetime in 1962–63 and in other time slots until 1987), to Wall-E, the protagonist of the 2008 Disney/Pixar film by that name, robots often proved to be useful devices for producers and directors: they could inject comic incongruity or address more serious topics at arm's length. The robots' voices and gestures could satirize human traits, but humanity was portrayed as a superior state given how many robots aspired to it. At the same time, robots are frequently portrayed doing menial tasks as at least part of their identity, implicitly freeing humans from drudgery.

B9, the faithful "environmental control" robot on the U.S. television series *Lost in Space* (1965–68), became famous for warning the "Space Family" Robinson's son Will of impending harm: even today, "Danger, Will Robinson!" is still uttered by people unaware of the original context. But by far the apotheosis of the robot-as-faithful-servant model is the Laurel-and-Hardy duo of R2D2 and C-3PO from the *Star Wars* franchise. Indeed, the shadow cast by the George Lucas creations is so long that many other films must characterize their robots in contrast to the much-loved pair of metallic icons.

R2D2, the shorter of the two, was given part of its appeal by a human actor, Kenny Baker, who controlled its movements from inside during filming. (Other shots featured a radio-controlled, uninhabited version of the robot.) The robot speaks in a machine language, translated by his compatriot, adding to the comedic dynamic, especially when the jokes are on C-3PO. With both characters, there is no possibility of robot rebellion; potentially because of the convincing nature of the futuristic space-age setting, there is no hint of human hubris at work, possibly because the robots could have otherworldly origins.

As for C-3PO, the brilliant butler-esque voicing by the English actor Anthony Daniels contributes enormously to the character's appeal. The superhuman characteristics common among cinematic robots are in this instance cerebral rather than mechanical: even though it can translate "six million forms of communication," C-3PO is in fact a coward in the rebels' battles. Its physical form is highly

derivative of Maria's metallic shell in *Metropolis*, while the dynamic between the robots is as familiar as any odd-couple or buddy movie.

Cultural Signals

Taken as a whole, what do we make of robots in Western popular culture?

1. The directors who have advanced the cultural representation of robots include some of the industry's leading figures: Woody Allen (*Sleeper*), James Cameron (*Terminator),* Chris Columbus *(Bicentennial Man),* Stanley Kubrick, George Lucas, Ridley Scott, and Steven Spielberg (*A.I. Artificial Intelligence*). These men have made movies collectively grossing tens of billions of dollars. For them to share the use of robots as key characters suggests the massive cultural appeal of the technology/archetype.
2. Any generalizations about movie and literary characters have little in common with real robots, whether hardware (Boston Dynamics' Atlas) or software (Wall Street high-frequency trading systems): robots cannot feel pain, or understand when they inflict it. Robots do not have cognition that differentiates between humans and other mammals, or between humans and other things that move. Robots have no mechanism for aspiration. Robots, however autonomous, depend on humans for everything from battery power to software updates. Robots cannot choose except among predefined choices; they cannot "consciously" subvert their creators because robots lack self-awareness at the cognitive level.
3. The high bar for real robots to do such things as open doorknobs, traverse uneven terrain, or perform logic at the level of a child features only minimally in science fiction and cinema. Thus when people see hard tasks accomplished within the field of robotics (such as a robot folding a shirt or opening a bottle of beer), it appears underwhelming. Many observers put substantial emphasis on Asimov's three laws when they bear little resemblance to real robotic science. The cognitive scientist Steven

Pinker puts it in stark terms: “When Hamlet says, ‘What a piece of work is man! how noble in reason! how infinite in faculty! in form and moving how express and admirable!’ we should direct our awe not at Shakespeare or Mozart or Einstein or Kareem Abdul-Jabbar but at a four-year-old carrying out a request to put a toy on a shelf.”[18] AI has a long way to go to approximate such responses.

4. The distinctions among robots, androids, and cyborgs are largely immaterial to audiences. Aliens, for example, are equally plausible elements in these plots.
5. Thus the images of robots widely present in mass culture do little to help communities confront real issues of emerging technologies. Because perceptions are highly conditioned by the robot-as-menace, robot-as-pathos, robot-as-self-aware, or robot-as-servant/butler stereotypes, substantive discussions of prostheses, to take one example, have been slow to form.

To summarize, Čapek’s conception of a robot, a Czech word, embodied a metaphor of humanity as slaves to technology, with the danger that the artificial creation might rebel against its human creators much as Frankenstein’s creature did. About twenty years later, Isaac Asimov created literary robots that embodied human traits, to the point where “robopsychology” provided insight into their workings. Finally, the notion of artificial intelligence, however embodied or disembodied, is often conflated with superhuman logic that will eventually outstrip humans’ powers of thought and feeling. For all their differences, HAL 9000 and IBM’s Watson function similarly as culturally frightening figures: their superhuman capabilities can apparently nullify human capabilities and designs. In each of these cases, the power of cultural iconography can distract us from concrete, live issues: who besides Stephen Hawking should have robotic augmentation? Should labor unions invest in robots that replace human workers? Who can implement and override safety interlocks for a given class of robot? And so on.

The notion of artificial intelligence, however embodied or disembodied, is often conflated with superhuman logic that will eventually outstrip humans' powers of thought and feeling.

An Alternative: The Japanese Tradition

Note that all of the aforementioned cultural resources were explicitly Western. From *Frankenstein* through *Star Wars* and *The Terminator*, the theme of "technology out of control," as the academic Langdon Winner put it, is always present: created life often turns out to be, as Asimov said, "robot-as-menace." But it is impossible to assess the current state of robotic science and representation without including the Japanese.

Although *manga*, the distinctive Japanese comic art form, dates from the late nineteenth century, it can trace its origins to thirteenth-century scrolls. After World War II, when the nation was reforming its mythology in light of both military defeat and foreign cultural influences brought with the U.S. occupation, manga emerged as a vehicle for heroism, virtue, and prowess. One artist, Osamu Tezuka, created a character that captured his nation's imagination. Called "Mighty Atom" in Japan, he is more familiar to Western audiences as Astro Boy; one advisor thought the atomic connotations might be problematic for U.S. audiences after Hiroshima and Nagasaki. Mighty Atom has become an essential part of Japanese culture: he actually has full Japanese citizenship; Tezuka is regarded as "the god of comics," on the same plane as Walt Disney, but with elements of Arthur C. Clarke, Stan Lee, Tim Burton, and Carl Sagan also in the mix, according to his biographer.[19]

Tezuka was a fascinating character. Born in 1928, he developed his considerable artistic talent in part by drawing skillful catalogs of insects as a teenager. He later graduated from medical school (where the drawings in his lab notebooks were exquisite) but did not practice medicine. His various characters, led by Mighty Atom, were organized into a "star system" modeled on a Hollywood movie studio. They generated a massive following. Tezuka then developed

his own production team that eventually made the first TV animations in Japan. Different characters and series, including his most ambitious story called “Phoenix,” helped turn manga into a multibillion dollar industry, both in Japan and worldwide. Tezuka’s work was so skillful, innovative, and compelling that Stanley Kubrick asked him to be the art director of *2001,* but Tezuka could not commit to move his team to England for a year during production. Tezuka died of stomach cancer in 1989, still drawing until his last day.

Mighty Atom originally appeared as a supporting element in 1951 but was featured as a title character in 1952. He appeared regularly until the 1970s, and occasionally in the years after he had become a national icon. His fictional date of birth, April 7, 2003, was marked by nationwide celebrations; four years earlier, the character had been used to help launch Toyota’s Prius hybrid vehicle in Japan. Through multiple reinforcing channels, the robot’s likeness is a familiar image in Japanese culture.

Mighty Atom’s life originates in tragedy. When Dr. Tenma, the head of the Ministry of Science lost his son Tobio in a collision between a flying car and a heavy truck, he convenes experts and builds a robot in Tobio’s likeness. When he discovers that the robot cannot mature and cannot learn to love natural beauty, Tenma gives the robot to a circus. Tenma’s successor at the Ministry of Science, Professor Ochanomizu, finds the robot, discovers he can feel emotions, and nurtures him as a foster son. The scientist urges him to use his powers for good, primarily fighting crime but also, in one episode, intervening on behalf of a Vietnamese village before U.S. planes were scheduled to bomb it. Thus the entire story is rooted in the robot’s need for human company and acceptance: robot rights are a common issue engaged in the manga.

Mighty Atom has super powers, but not in the *Terminator* vein: he stands 4 feet 6 inches (1.37 meters) and weighs 67 pounds (about 30 kilograms), but packs a 100,000 horsepower (roughly 75,000 kilowatt) atomic engine along with retractable jets in his hands and feet. Over the course of many stories, it is revealed that Mighty Atom has

- Jet-powered flight

- Multilingualism (sixty languages)
- Analytical skills
- Searchlight eyes
- Supersensitive hearing
- Hidden weapons in his back
- The ability to tell if a person is good or evil.[20]

This mix of characteristics, combined with Mighty Atom's diminutive stature, creates a myriad of plot possibilities. He can sweat while solving challenging situations, but must be altered by his foster-father to be able to shed tears. His powers were not infinite: Atom could run out of fuel, and when he ate human foods, they ended up in his machine-filled chest cavity and had to be removed. His enemies included bad people, people who hated robots, rogue robots, and alien invaders. Time travel was a frequent feature of the stories.

Much like Asimov roughly a decade earlier, Tezuka developed a code of robot law to guide Mighty Atom through his adventures:

1. Robots are created to serve mankind.
2. Robots shall never injure or kill humans.
3. Robots shall call the human that creates them "father."
4. Robots can make anything, except money.
5. Robots shall never go abroad without permission.
6. Male and female robots shall never change roles.
7. Robots shall never change their appearance or assume another identity without permission.
8. Robots created as adults shall never act as children.
9. Robots shall never assemble other robots that have been scrapped by humans.
10. Robots shall never damage human homes or tools.[21]

Several aspects of the list deserve mention. Note the similarity of rules 1 and 2 to Asimov's laws; note also that there is no parallel to Asimov's Third Law, that robots should protect themselves. Deception by robots is explicitly forbidden, three times over.

The tensions between Atom's eternal childhood, superhuman powers, moral compass, and desire for human love drive his identity. It both shaped and reflected Japanese attitudes toward robots at large. The Sony Aibo, for example, clearly reflects a sensibility in line with Atom: the appealing, nearly cuddly presentation of robots in many Japanese scenarios (Paro the seal being only one) conveys neither cold utilitarianism nor potentially demonic upheaval.

The contrast can be readily observed when comparing Mighty Atom to a contemporary Japanese manga robot, the giant Iron Man, which began appearing in 1956. Weighing 25 tons and standing 20 meters (66 feet) tall, Iron Man had been built during the war as a secret weapon but was then turned to peacetime uses. Unlike Atom, he was not autonomous but was remote controlled, usually by a clever young boy, but subject to being turned to evil purposes if the remote were stolen. Although the boy did fight evil, much like Atom, the moral neutrality of Iron Man helped delimit a larger dialectic within Japanese culture: much like that expressed in Asimov's laws, there exists a desire to have robots help humanity rather than hurt it, embodying a higher moral vision than humans can claim for themselves. Given that Iron Man at times eclipsed Mighty Atom in popularity, his presence serves as an extremely potent and useful counterweight to what Asimov might have called the "robot-as-saint" school of thought.

Robots and Myth

Robots are technological tools. Yet few tools have such rich mythologies supporting them. Even more significantly, that mythos largely preceded the actual achievement of most of the milestones of autonomous robotics. The history is both long, dating to biblical times, and hyperreal, with the most recent advances in storytelling being used to advance and shape the narrative. There is a strand of

robot-ness that is particularly North American, and another aspect that stands independent of any given culture.

Robots are paradoxical in other ways as well. They serve as slaves, or servants, yet they are feared as potential overlords. Robots absorb many projections of perfection that people cannot attain, yet have trouble executing some basic human maneuvers. Robots offer the prospect of radical advances in leisure while raising questions of what humans will do for a livelihood.

By now, it should be well demonstrated that robots have been introduced into the cultural dialogues of both East and West in ways that differ considerably from past technologies: radios, air conditioners, automobiles, or even smartphones were never portrayed as human creations that desire to eclipse their makers, for example. The place of anthropomorphism in our discussions of what robots are, what they can do, and how they should be understood marks a key point of departure within the technological history of Western countries. All of that notwithstanding, what is the actual state of robotics?

Notes

1. Robert Geraci, *Apocalyptic AI: Visions of Heaven in Robotics, Artificial Intelligence, and Virtual Reality* (New York: Oxford University Press, 2010), 31.

2. Hiroaki Kitano, "The Design of the Humanoid Robot PINO," http://www.sbi.jp/symbio/people/tmatsui/pinodesign.htm, as quoted in Bekey, *Autonomous Robots*, 471.

3. See Hans P. Moravec, *Mind Children: The Future of Robot and Human Intelligence* (Cambridge, MA: Harvard University Press, 1988).

4. Geraci, *Apocalyptic AI*, 7.

5. Nourbakhsh, *Robot Futures*, 119.

6. Dwayne Day's plausible blog post suggests that the *Star Trek* writers borrowed from a White House pamphlet dating from 1958 that stated: "The first of these factors is the compelling urge of man to explore and to discover, the thrust of curiosity that leads *men to try to go where no one has gone before*." The piece also notes that Hollywood and the Southern California aerospace industry often cross-fertilized. See Dwayne A. Day, "Boldly Going: *Star Trek* and Spaceflight," *Space Review/Space News* (blog), November 28, 2005, http://www.thespacereview.com/article/506/1/.

7. See, for example, Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 1965); Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm* (New York: Viking, 1989); and David Nye, *America as Second Creation: Technology and Narratives of New Beginnings* (Cambridge, MA: MIT Press, 2003).

8. Evgeny Morozov, "The Perils of Perfection," *New York Times*, March 3, 2013, http://www.nytimes.com/2013/03/03/opinion/sunday/the-perils-of-perfection.html

9. William Edward Harkins, *Karel Čapek* (New York: Columbia University Press, 1962), 9.

10. Čapek quotation in London *Sunday Review*, as requoted in Karel Čapek, *R.U.R.* (New York: Pocket Books, 1973), reader's supplement, 11. "Rossum" was meant to connote logic, given that the Czech word "rozum" means "reason."

11. Čapek's dramatic work foreshadowed efforts to "teach" IBM's question-answering computer Watson how to play *Jeopardy!* roughly ninety years later by having it ingest *Wikipedia* and other online data repositories.

12. Čapek, *R.U.R.*, 49.

13. Ibid., 96.

14. Isaac Asimov, introduction to *The Complete Robot* (Garden City: Doubleday, 1982), xi.

15. Ibid., xii.

16. Norbert Wiener, *Cybernetics, or Communication and Control in the Animal and the Machine* (Cambridge, MA: MIT Press, 1948).

17. Phillip K. Dick, *Do Androids Dream of Electric Sheep?* (New York: Doubleday, 1968).

18. Pinker, *How the Mind Works*, 4.

19. The two essential English-language sources on Tezuka are Frederik L. Schodt, *The Astro Boy Essays: Osamu Tezuka, Mighty Atom, and the Manga/Anime Revolution* (Berkeley, CA: Stone Bridge Press, 2007) and Helen McCarthy, *The Art of Osamu Tezuka: God of Manga* (New York: Abrams, 2009). I rely heavily on each of these in the following discussion.

20. See "20 Facts about Astro Boy," *Geordie Japan: A Guide to Finding Japan in Newcastle-upon-Tyne* (blog), January 10, 2013, http://geordiejapan.wordpress.com/2013/01/10/20-facts-about-astro-boy/.

21. Reprinted from Schodt's translation of the Japanese in *The Astro Boy Essays*, 108.