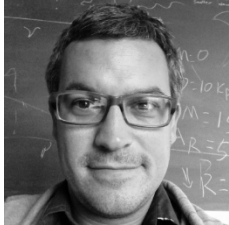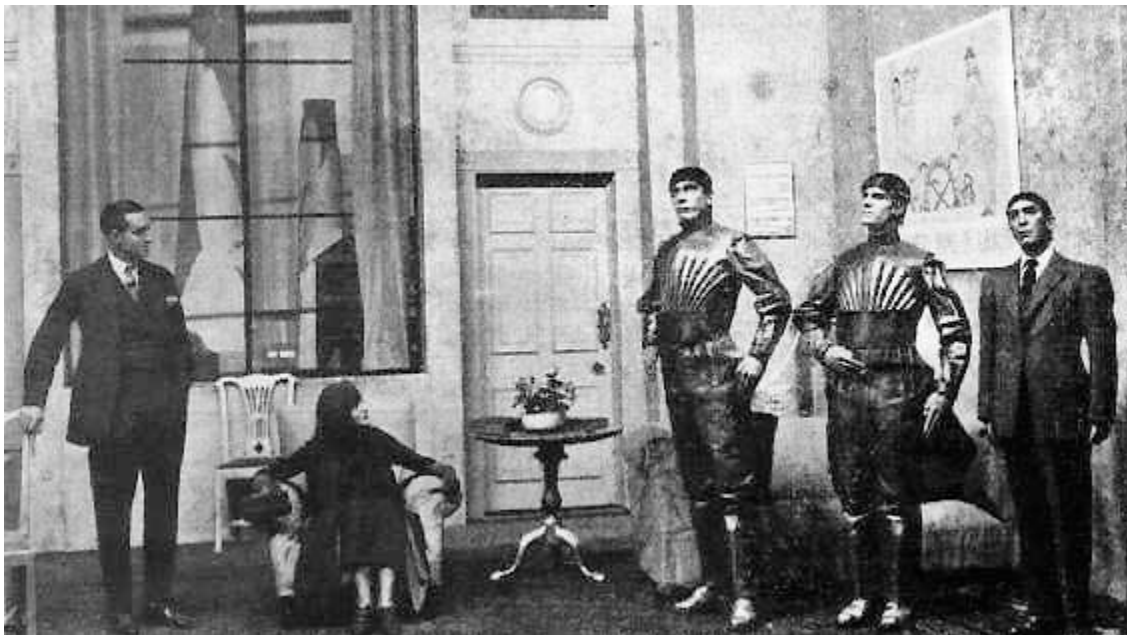# Robot Dramas: Autonomous Machines in the Limelight on Stage and in Society

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By **Aaron Dubrow**
Media officer for the National Science Foundation covering advances in computing, IT, cyberinfrastructure and engineering.

A scene from the 1921 play, *R.U.R.* showing robots interacting with humans. The play was the first to use the word "robot" (which in Czech means "drugdery").

Like most Americans, I grew up on a steady diet of fictional robots.

They were occasionally friendly or cooperative, often murderous, typically clumsy and tone-deaf to human emotions and needs. Despite these flaws, I acted out scenes from Star Wars with my C3PO action figure, practiced my digital voice and performed the Robot on the middle-school dance-floor. There was definitely something alluring about these harbingers of our high-tech future.

There were real robots then and had been since General Motors began using the Unimate in the early 1960s, but they always seemed closer to factory machinery than us -- more Ford, less Vicky from Small Wonder.

We're edging into an era when we'll increasingly coexist with robots and other intelligent machines, some of which may look like us. ("Robot" is a broad term, but it applies to any machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.)

Not only are there more of those industrial robots (about 1.5 million today), there are 10 million Roombas in our homes, porter-bots in our hospitals and hotels and social robots in our nursing homes. In Japan there are even robot spectators at baseball games tele-operated by remote fans.

My interest in the emergence of a robot class is not idle. I serve as a media officer for the National Science Foundation, or NSF, the federal agency that funds a significant percentage of the fundamental research carried out at universities and laboratories across the country. (NSF-funded scientists have brought us search-and-rescue robots, Google and, in no small part, the Internet.)

In particular, NSF serves as the lead organization for the National Robotic Initiative, the goal of which is to accelerate the development and use of robots that work beside, or cooperatively with, people.
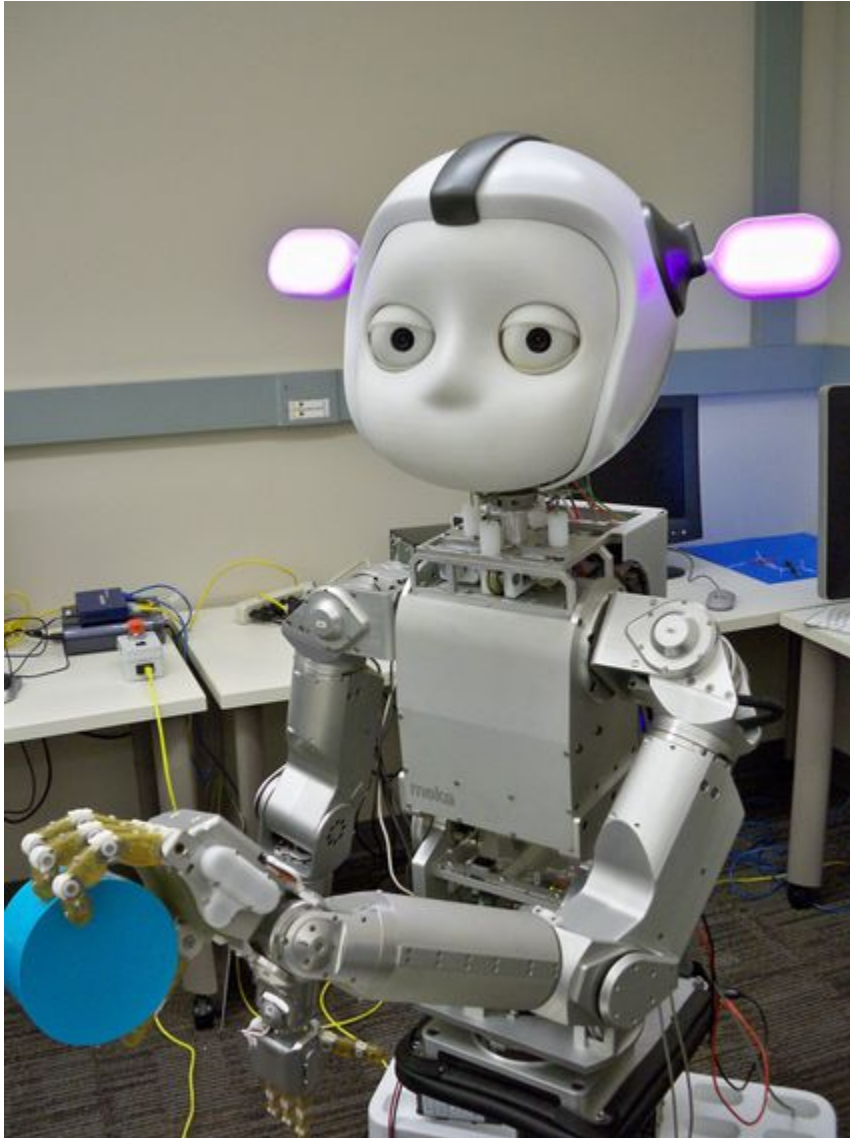
Simon the robot, developed by Georgia Tech researcher Andrea Thomaz, learns from human users.

NSF isn't the only one helping to develop collaborative or 'co-robots', as they're cutely called. NASA, the National Institutes of Health and the U.S. Department of Agriculture are just a few of the other initiative partners. DARPA and Google have large research programs in this area, too, and hundreds of private companies are working in this space. But NSF is the agency tasked with funding the fundamental research that will help determine what the robots of the distant future will look like, what they'll be able to do and how we'll interact with them.

"The purpose of [the National Robot Initiative] is the development of this next generation of robotics, to advance the capability and usability of such systems and artifacts, and to encourage existing and new communities to focus on innovative application areas."

reads the document NSF published to solicit applications for research funding. It continues:

"Research to gain a better understanding of the long term social, behavioral and economic implications of co-robots across all areas of human activity are important parts of this initiative."

With an implicit assumption that robots are here to stay, and that they can benefit our standard of living and quality of life, NSF is committed to figuring out how they can best fit into our lives and how we might interact with our robot colleagues.

Robots on the road

In June, I had the opportunity to observe a demonstration in Washington, D.C. of one of the first "robots" we'll likely interact with: the driverless car.
[Congressman Bill Shuster](#), chairman of the House Transportation and Infrastructure Committee, invited researchers from Carnegie Mellon University to bring their [NSF-supported autonomous Cadillac SRV](#) -- one of the most advanced in the world -- to Washington. There, the driverless car chauffeured a few dozen U. S. Congressmen (and a couple of reporters) from Capitol Hill to the Pentagon and back, on urban roads and congested highways - a non-trivial task even for a human.
"I don't think the founding fathers could've ever imagined this," Shuster said at the kick-off, with the Capitol as a backdrop. "George Jetson's world is becoming a reality."

It will be at least a decade before driverless cars are available for mass use -- there are just too many contingencies for the technology to be safe in all driving conditions -- but Shuster was gung-ho on the technology and believed we should be investing now in smart roads for a driverless future.

Earlier in the week, California had passed a law allowing driverless cars on the roads. And at the Smart America Expo -- a showcase for smart, networked systems engineered to sense and interact with the physical world -- the U.S. military had shown off the [Aribo](#), the first commercially available autonomous vehicle, which they're using for transport on U.S. bases. For all of the excitement about robots and other autonomous machines, robots still carry with them more than an undercurrent of fear and distrust, evident in almost every conversation I have with friends and family about our agency's funding in this area.

For every R2D2 there is a T-800; for every KITT, a Hal.

I asked [S. K. Gupta](#) -- a professor of computer science at the University of Maryland and a renowned expert in next-generation robotics technologies -- about robots in the popular imagination. Gupta currently heads NSF's part of the National Robotics Initiative and told me he often hears concerns from citizens and other scientists about the growing role of robots in our lives.
"The first fear is basically: will a robot take my job? A lot of people are concerned about that," Gupta said.

Whereas in the past, we couldn't imagine robots surpassing humans in their ability to do certain tasks, increasingly the divide between what we humans are good at and what computers and robots are good at is eroding.

This is the premise for Erik Brynjolfsson and Andrew McAfee's recent book: ["The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies."](#) In the book, they write:

"Technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead. As we'll demonstrate, there's never been a better time to be a worker with special skills or the right education, because these people can use technology to create and capture value. However, there's never been a worse time to be a worker with only 'ordinary' skills and abilities to offer, because computers, robots, and other digital technologies are acquiring these skills and abilities at an extraordinary rate."

Nevertheless, Brynjolfsson and McAfee are optimistic about the possibility of us all benefiting from smart machines and believe it is possible to maximize the bounty while mitigating the negative effects of wealth disparity. However, they recognize that "the choices we make from now on will determine what kind of world" we end up with.

"The second type of fear comes from a different community," Gupta continued. "They're worried that robots will turn bad and kill everybody. Or even more so, that some evil human being will use robots to hurt other people."

Reflecting this concern, at a weapons treaty meeting in May, the UN Convention on Conventional Weapons held the first round of discussions on 'lethal autonomous weapons systems', also known as killer robots. Human Rights Watch and the Heritage Foundation also put out a series of recent reports to stop killer robots.

Industry is working on several standards to make sure that physical interactions between robots and humans remain safe. Likewise, Gupta said, researchers are also developing ways to monitor humans and robots in the workspace and re-plan a robot's actions in the event an imminent collision to minimize risks to humans.

The third fear, he said, is that, as humans and robots (or any digital technology) interact, we'll increasingly ignore our human relationships.

"People ask: 'Is this human-robot relationship going to comprise human-human relationships? As humans interact more with robots, are we losing our humanity?'

"All of these fears are legitimate and should be addressed by the research community to make the general public feel comfortable with robots," Gupta said. "Can we make sure robots are safe and that they enhance, rather than diminish our citizens' standard of living?

Can we build these considerations into the fabric of the technologies we're creating? We need to make sure the answers to these questions are yes."

Robot Origins

Around the time of the driverless car demonstration, I attended an art-science discussion at the National Academy of Sciences in Washington, D.C. on the subject of robots in theater. Robots and theater may seem like an odd pairing until you remember that robots got their name from a 1920 play by the Czech playwright, Karel Čapek.

R.U.R. -- which stands for Rossum's Universal Robots -- tells the story of the rise and fall of a race of worker robots. It is credited with establishing many of the cultural tropes about robots and for applying the name (which in Czech means "drudgery"), that sticks to this day.

Film poster for the Soviet film "R.U.R." after Karel Capek, 1935.

Theater is *not* an arena where the NSF is funding robot research. However, artists, musicians and producers are often early adopters and innovative users of emerging technologies. Moreover, artists create the narratives that subtly influence our perceptions. In the case of science fiction, this influence often shapes the development of the phenomenon they depict -- think Jules Verne's submarines or Arthur C. Clarke's depictions of space colonization.

What could Rostrum's Robots and their contemporary theatrical descendants tells us about our robot future?

The evening began with a primer on "R.U.R." from Dennis Jerz, professor of English at Seton Hill University. Rossum's robots were not "buckets of bolts," as commonly thought, but rather "lab meat," akin to clones or synthetic humanoids.

Most of the Rossum's robots were bland and unthinking, content to work in factories to improve the humans' standard of living. But some robots were altered at the request of a pro-robot activist in such a way that they develop self-awareness. This consciousness leads to a robot revolt, where all of the humans but one are killed.

In a twist worthy of O. Henry, after the human race has been decimated, the altered robots begin to feel attachment to their failing bodies and to each other. Only then do they realize they don't know the recipe for making more robots.

In the final scene, they beg the sole living human to teach them the secret of life, which, in a melodramatic turn, ends up being love.

But before Jerz, the resident robot historian, began his analysis of "R.U.R.", he shared a song by the New Zealand-based comedy band, "Flight of the Concords" called, "The Humans are Dead."

"This robot trope is so universal, so familiar, that these performers didn't have to make complete sentences," Jerz said after it played. "With that kind of deep-seated cultural idea, when we don't examine it, we lose a lot of potential to learn."

[Watch Jerz's presentation.]

These deep-seated ideas are far from simple. Rather, the mythologies and anxieties surrounding robots take several forms and continue to evolve to this day, in part through films, novels and works of theater.

Three Robot Performances (plus a few more)

Adrienne Mackey, founder and artistic director of Swim Pony Performing Arts in

Philadelphia, was the first of the three producers to describe their transhumanist works. In 2010, Mackey's company produced a play called "Survive!" the main 'character' of which was a humanoid interface named AMA.

AMA was the Universe's answer to the Voyager spacecraft, which had travelled to the outer cosmos with a message for any who would find it. AMA was represented not as a body, but as a presence, manifest in everything that the audience encountered as they travelled through the maze-like set.

Though "Survive!" did not contain robots in the traditional sense, it used a "human-ish interface" as a way for audiences to explore ideas motivated by science and technology.

"Culturally we're obsessed with beings that cross this human-inanimate boundary," Mackey said. "I think it's because this kind of robot is a way for us to reckon with the expansive inanimate that surrounds us, for us to contain questions about difficult concepts -- like sentience, technology and the cosmic scale -- in forms that we aren't quite so afraid to interact with."

[Watch Mackey's presentation.]

David Saltz, head of theatre and film studies at the University of Georgia, premiered a different kind of robot performance in 2012.

"Commedia Robotica" starred a foot-tall robot named Zeeb Zob, who had been "trained" to perform Commedia dell'arte, a highly stylized form of classical Italian theater.

"Our goal was to teach the robot to be a good actor," Saltz said of the experimental play.

Commedia dell'arte consists of a set of highly defined characters who, by convention, use precise pre-determined gestures and postures to communicate. Saltz was able to program Zeeb Zob to strike these poses and to move onstage in realistic, human-like ways.

The production included a range of techniques for moving the robot, including a 'roboteer' who performed live actions in real-time that were communicated to Zeeb Zob, and pre-recorded and programmed gestures.

In "Commedia Robotica", Zeeb Zob rehearses with an initially reluctant actress for a play-within-a-play: a commedia dell'arte performance. Over time, Zeeb Zob develops romantic feelings for his co-star. When he expresses these feelings, a human engineer waiting in the wings rips out his electronic guts, at which point the actress realizes she'd fallen for the robot, too.

"At what point does a robot, a human-crafted machine, develop its own agency and become a performer? And who's performing?" Saltz pondered.

[Watch Saltz's presentation.]

The vast majority of robots that have been used in performances, including Saltz's, have been puppets or automata. But the new generation of robots that Saltz and others are working on will have the capacity to perform autonomously and to learn from their interactions.

"Acting is reacting," Saltz said. "For me, the holy grail is to create robots that respond dynamically to their environment."

The third speaker, Peter Torpey described the production, "Death and the Powers" (which was nominated for a Pulitzer Prize in Music in 2012). The piece was developed by the Opera of the Future project at the MIT Media Lab, and was overseen by Tod Machover, one of America's leading and "most wired" composers. Former poet laureate, Robert Pinsky, wrote the text for the work.
The opera tells the story of Simon Powers, a billionaire mogul who decides, as he nears his death, to incorporate his mind and memories into a computer system, represented, in the play, by the stage set.

"This system he's developed over the course of his life is his way of achieving some kind of immortality, but not necessarily in his physical form," Torpey explained.

In addition to the anthropomorphic set inhabited by Powers and the human actors--Powers' wife and children who remain in non-digital form--the play features a cast of mobile, on-stage robots that have been choreographed to serve as a Greek chorus for the story's action. In fact, the premise of the opera is that the robots are re-enacting a passion play in a post-human future that they have been programmed to repeat in perpetuity by the long-dead Powers.

The opera touches on the possibility of uploading our lives to the cloud -- and from the cloud to our connected homes -- and of the difficult ethical and interpersonal issues that arise when we choose digital lives over non-digital ones.

"He dies and the set comes alive," Torpey said. "And then the question is: how does his family react to him in this new form? How does the world at large? And how does he change as he enters into this other realm of existence?"

[Watch Torpey's presentation.]
Other examples of robot performances abound. From the 2006 "Heddatron" -- which reimagines "Hedda Gabler" as the story of a Michigan housewife captured by five robots and forced to play the title role in the Ibsen masterwork -- to Data, a robotic stand-up comedian that premiered at a TED talk in 2010, theater producers seem to be fascinated by robots for their implicit narrative potential, their predictive capacity and their ability to discuss what it means to be human.

The future represented by Zeeb Zob is a step along a now five-decade trajectory towards natural, humanoid robots, free from any intervention (but the programmer's) that we will live, work and even perform with.

"Commedia Robotica", in that way, presents a peaceful -- one-might-say romantic -- picture of coexistence. As in Spike Jonze's "Her", we can even fall in love with our robot colleagues.

In contrast, the other two plays envision a post-physical world where consciousness is decoupled from our bodies and we merge with technology, space and the world around us. These represent a way of keeping our human-ness, but at a cost.

All three seem to be preparing us through storytelling for the moment when, decades from now, there are more robots in the world than humans.

Robot Rules

Isaac Asimov is among the cadre of artists who have most strongly shaped our pre-conceptions of robots. Writing from the 1940s to the 1980s, he portrayed many possible robot-filled futures, some cooperative, some apocalyptic. He also had the foresight to develop robot rules.
In his 1942 short story "Runaround", he introduced the Three Laws of Robotics, which, in many of his stories, were hardwired into a robot's positronic brain.

The Three Laws are:

- A robot may not injure a human being or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

At the National Science Foundation, in legislative committees and policy centers, and at social robotics research labs (many of them funded by NSF), this preventive ethics is now actively being discussed. One example of this effort is the recently-released Brookings Institute report: "How Humans Respond to Robots: Building Public Policy through Good Design."

In the report, Heather Knight, a roboticist from Carnegie Mellon University (and the creator of Data, the robot comedian alluded to earlier), describes the many ways humans and robots are currently relating to each other, both in experimental and real-world contexts, and the design decisions that govern the forms robots take and ultimately our response to them.

"This next generation of robotics will benefit from pro-active policymaking and informed, ethical design," Knight writes in the conclusion. "As social robotics researchers increase

their understanding of the human cultural response to robots, we help reveal cultural red lines that designers in the first instance, and policymakers down the road, will need to take into account."

It is these "red lines" that plays like "Death and the Powers", "Commedia Robotica" and "Survive!" (and more-widely-known films like "The Terminator" or "The Matrix") explore, typically by showing what lies beyond such a line. In better understanding the human perception of robots in our lives, designers and policymakers can make better choices to ease human anxiety, facilitate greater acceptance of robot and build robots hardwired to be safe and trustworthy.

"The goal is to create guidelines that allow social and collaborative robotics to flourish," the report stated, "safely exploring their potential for positively impacting our lives."

The TV and radio all summer were full of advertisements for "Transformers 3" -- good vehicular robots duking it out with bad vehicular robots in a battle for the fate of the Earth.

The era of the robot car was dawning. Other co-robots couldn't be far behind. The time for pro-active, grounded thinking about human-robot interactions is now.

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