

## SCIENCE FICTION, SCIENCE FACTS

Astromech robots in *Star Wars*

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What R2D2 and BB-8, the lovable astromechs from the *Star Wars* movies, can tell us about real robots.

Given that SpaceX is populating Earth's orbit with cars, can robots be far behind? One of the most popular visions of a future with robots in space (and everywhere else) is *Star Wars*. The word "droid" has become so ubiquitous in our collective consciousness that it is hard to believe that the word was created, and trademarked, by George Lucas. But, it is believable that *Star Wars* robots can imitate or motivate real science. As an example, NASA's personal satellite assistant was inspired by the lightsaber training droid that provided painful feedback to Luke Skywalker (1). If a minor droid in *Star Wars* can influence NASA, how feasible are R2D2 and BB-8, the two most popular robots in the series?

First, a bit of cinema history. Before *Star Wars* became a blockbuster in 1977, robots in movies generally served as either a man-made monster to be overcome or a form of stage design signifying that the action was occurring in the future. Maria in *Metropolis* (1927), Gort in *The Day the Earth Stood Still* (1951), and Gunslinger in *Westworld* (1973) were impersonal agents of destruction. Robby the Robot in *Forbidden Planet* (1956) and its TV cousin, Robot, on *Lost in Space* (1965–1968) provided comic relief via their machine-like literal-mindedness. All were anthropomorphic, with different degrees of success in disguising the costumed human actor inside the robot suit.

Robots moved beyond plot devices in *Silent Running* (1972), the directorial debut of Douglas Trumbull, who had been the special effects wizard for *2001: A Space Odyssey*. *Silent Running* introduced three, legged robots named Huey, Dewey, and Louie who performed maintenance on the space ship Valley Forge. The presence of work robots implied scientific credibility. What made these robots cinematically special was that each had a distinct personality, making them more appealing as supporting players. Dewey even had a dramatic moment of loss plus a rebirth story arc. Unfortunately, the film was not a commercial success, and the robots never became iconic like the later *Star Wars* droids.

*Star Wars* went further than *Silent Running* in embracing robots as characters, producing the first non-anthropomorphic robot, R2D2. The plot of the 1977 *Star Wars* movie not only placed R2D2 and C3PO in roles that supported the science in science fiction but also supported the fiction of the storyline. This elevation from props to real roles in the story arc was not accidental: The robots were based on human characters in Akira Kurosawa's 1958 film, *The Hidden Fortress*. *The Hidden Fortress* is set in historic Japan where a pair of bumbling peasants—one tall, skinny, and talkative and the other short, round, and pragmatic (sound familiar?)—stumble upon a spunky, head-strong woman being escorted by a reluctant samurai. As the two peasants eventually discover, the woman is a princess in danger, and the put-upon samurai is a famous general in her clan's army. If the two peasants were removed from *The Hidden Fortress*, the story would collapse because they are the central narrative thread. Likewise, if R2D2 and C3PO were edited out of the first *Star Wars* movie, then the storytelling would suffer.

*Star Wars* was the first successful movie to embed robots in both the science and the fiction narratives, but beyond the general concept of a non-anthropomorphic robot conducting repairs in space, are R2D2 and BB-8 in any way feasible?

One feasible feature of both R2D2 and BB-8 is how they communicate nonverbally, referred to in the human-robot interaction literature as either non-linguistic utterances (2) or semantic-free utterances (3). The two robots use expressive beeps and whistles for classic communication functions, such as initiating communication and signaling that they are paying attention. More delightfully, but just as important in effective communication, the beeps and whistles project mental state, e.g., disagreement with whatever C3PO is nattering about, disapproval of a main character's dubious decision, and frustration at being thwarted in its job of helping the protagonist save the

world. In real life, Robin Read has found that the types of beeps and whistles that facilitate the rebel-droid interaction can be effectively used by real robots in engaging children and adults (2).

Sadly, a less feasible feature of BB-8 is its unique spherical locomotion. The rolling motion special effects enables BB-8 to convey gee-whiz science and resourcefulness while helping Poe Dameron. It travels faster than its older sibling, R2D2, pivots omnidirectionally, and the head even detaches and reattaches as needed (how does that work?). Unfortunately, the rolling ball would be highly unlikely to move about on those desert planets that the main characters inevitably find themselves on. Anyone who has driven a car on a beach knows how quickly wheels can become buried in the sand and spin in place. Dan Goldman, an expert on animal and robot locomotion in granular media, eschews wheels in favor of sandfish, snake, and legged locomotion [see his research (4) and his work with Howie Choset (5)]. After the last *Star Wars* movie came out, Goldman's



**Fig. 1. Beached ball.** A Sphero BB-8 toy is unable to maneuver in a test bed of small glass particles.

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team immediately tried the Sphero BB-8 toy in his granular medium test-bed: BB-8 could not move (Fig. 1). A toy is not the same as a real robot, but it illustrates that what works well on a floor may not be able to budge through sand. Biomimicry may be the ultimate answer; researchers all over the world are taking that approach to robot locomotion over sandy planets as well as for mining sandy mineral deposits and burrowing through rubble.

The feasibility of R2D2 and BB-8 is questionable, and what they may inspire in the next generation of roboticists is unknown. But it does raise another question: How would a real-life repair robot in space be different from the

admittedly more fanciful R2D2 and BB-8? The answer to that question is at least partially known because there is a real astromech robot in space: NASA's Robonaut robot. The next article will explore R2D2 and BB-8 as compared to Robonaut and its sibling, Valkyrie, perhaps with a friendly *Alien vs. Predator* vibe.

#### SUPPLEMENTARY MATERIALS

[robotics.sciencemag.org/cgi/content/full/3/15/eaat1599/DC1](http://robotics.sciencemag.org/cgi/content/full/3/15/eaat1599/DC1)  
Movie S1. Test-bed with BB-8.

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## Abstract

**One-sentence summary:** What R2D2 and BB-8, the lovable astromechs from the *Star Wars* movies, can tell us about real robots.