A Mobius strip of scientific imagination

How deep does the relationship between science fiction and science go?

Paige Brown

The 1896 science-fiction horror novel *The Island of Doctor Moreau*, by H. G. Wells, tells the story of a shipwrecked Englishman, Edward Prendrick, who ends up on a remote island inhabited by the titular doctor. Moreau has secluded himself away to conduct gruesome vivisection experiments on animals to make them look and behave like humans. Although his experiments have been partially successful, Moreau is frustrated by his beast people's stubborn flesh: "As soon as my hand is taken from them the beast begins to creep back". Wells was inspired to write the novel by Charles Darwin's book *On the Origin of Species*, published in 1859. Wells's exploration of morality and the consequences of manipulating traits, such as intelligence, was well ahead of its time. He could not have known, although he might have hoped, that science would someday explain Moreau's observation that the animals' bodies seemed to be programmed a certain way, despite his efforts to break that programming. We now know that the beast people's cells would have been genetically and epigenetically locked into non-human expression programmes.

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Like *The Island of Doctor Moreau*, many other science fiction stories have pre-empted the future, either by design or accident. Jules Verne's novel *Twenty Thousand Leagues Under the Sea* anticipated nuclear-powered submarines, and his novel *From*

the Earth to the Moon, written in 1865, uncannily predicted many aspects of the Apollo 11 mission, including a take off from Florida, USA, and the use of an aluminium spacecraft. Neil Armstrong made reference to Verne in the final telecast of Apollo 11 on 23 July 1969, when he said, "100 years ago, Jules Verne wrote a book about a voyage to the Moon. His spaceship, Columbiad, took off from Florida and landed in the Pacific Ocean after completing a trip to the Moon. It seems appropriate to us to share with you some of the reflections of the crew as the modern-day Columbia completes its rendezvous with the planet Earth and the same Pacific Ocean tomorrow."

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More recently, *Star Trek* is noted to have inspired the development of mobile telephones, the internet, video conferencing and multipurpose medical devices. "We would consult the ship's computer for information on alien cultures, history, or science," William Shatner, who played Captain James T. Kirk, wrote in his book *I'm Working on That: A Trek From Science Fiction to Science Fact*. "Now an estimated 520 million people have daily access to a huge databank of information that they also consult regularly about anything and everything. It's called the World Wide Web."

Star Trek, like *The Island of Doctor Moreau*, is also noted for its exploration of moral themes. This trend is present throughout the science fiction genre, from Victor

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Frankenstein and his monster, to Darth Vader in the *Star Wars* films. The fantasy elements of science fiction have long allowed authors to safely explore the ethical and social implications of scientific and technological advances and how they might influence the human condition. "We point to *Frankenstein* as sort of setting the mould," said David Kirby, senior lecturer in science communication studies at the University of Manchester, UK. "Even recent movies like *Rise of the Planet of the Apes*, which is about stem cells in many ways, and animal experimentation, have sparked debates."

But how do modern science fiction writers go about describing the future and the potential consequences of scientific advance in the modern information age? Much that was once science fiction has either been invented or is on the cusp of becoming real, whether we are ready for it or not.

European science fiction writer Mack Meijers does things the old-fashioned way—"Observation of people and research of tools," he said—by looking for patterns in current technology and doing research to map out potential future scenarios. Jules Verne purportedly made an engineering analysis for his book *From the Earth to the Moon*, which could be one of the reasons for his accurate description of how mankind would eventually reach our satellite. "Our modern technology isn't all that impressive," Meijers said. "It's just tools. How we use

tools—the process of discovery that leads to the making and enhancing of tools—that is an integral part of science fiction writing. And today, imagining possibilities has become a lot easier because in our tool making we have enabled ourselves to see further than that which we know. Someone like Jules Verne had it harder in that regard.”

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Joan Slonczewski, professor of microbiology at Kenyon College, Gambier, OH, USA, is an active writer of science fiction and teaches an undergraduate course in biology in science fiction. She explained that she comes across new ideas all the time. While coauthoring the textbook *Microbiology: An Evolving Science*, for example, she became inspired to explore future trends in virus research within one of her novels, *Highest Frontier*, published in 2011. Slonczewski was particularly impressed with the properties of ribonucleic acid viruses, especially the human immunodeficiency virus (HIV), which is the most effective agent known for integrating genes into the human genome. In *Highest Frontier*, Slonczewski extends these properties into a new form of gene therapy, with HIV used as a “human improvement vector”, which people take regularly to obtain the health and performance enhancing genes necessary for new space explorations. “*Highest Frontier* was written a while ago, but just this past year we’ve seen reported the first cure of a cancer patient using an HIV-derived vector,” Slonczewski said. “And now, today, HIV, as I predicted, has become the number one most exciting vector for gene therapy. There are treatments in the works now, in experimental stages, using HIV-derived vectors.”

Slonczewski also credited the science fiction writer Octavia Butler, who came up with an entirely new view on evolution and genetic diversity in her trilogy *Lilith’s Brood*, published between 1987 and 2000. “In her book *Dawn*, Butler presents an extra-terrestrial intelligent species whose reproduction requires them to interbreed with other species,” Slonczewski explained. “And the reason is that they engineered

themselves to perfection so fast that they lost genetic diversity. And therefore, to survive change, they have to find another species to interbreed with, and in a very messy way, exchange genes and traits.” At the time Butler wrote the book, scientists still clung to a model in which genes are mainly transferred from individuals to offspring. But now, Slonczewski noted, biologists understand that horizontal gene flow occurs between many species. “I think that Butler really predicted that [...] view of horizontal gene transfer. She presented a biologically realistic view of the dilemma that organisms face in propagating their own genes while making compromises, having to take in the genes of other organisms.”

When Nobuhiko Hata, technical director of the Image Guided Therapy Program at Brigham and Women’s Hospital, Boston, MA, USA, announced the development of an endoscopic capsule that could be controlled by magnetic resonance imaging to photograph a patient’s digestive tract, a flood of press releases and media stories linked it to the 1966 film *Fantastic Voyage*. Even other researchers thought that it was inspired by the story. “I think [Isaac] Asimov’s *Fantastic Voyage* [book of the film] was a major inspiration for this kind of discovery,” Joan Slonczewski said. “Could we make intelligent microscopic computers? Could we make computers that would go into the human body and do things in the human body?” Hata, however, denies that it was specifically either the movie or its novelization that inspired his work. Rather, he commented that it was the ‘superhero’ science fiction culture that he grew up with in general that influenced his interests. “I think I’ve been surrounded by a popular culture full of humanoids and hybrid human-machines, and I think that had an association with what I’m doing,” he said. “Robots are more for me the science fiction that has inspired my research.”

Many scientists acknowledge some type of inspiration from science fiction. “I think that science fiction, at least for me personally, was a major factor in persuading me to go into science,” said Ian Lipkin, director of the Centre for Infection and Immunity at the Mailman School of Public Health, Columbia University, New York, NY, USA. “You know, I was absolutely addicted to the medium as a kid, so I know it colours what I do, and I would be very surprised if it didn’t also

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colour other people’s background in moving into thinking about science.”

Lipkin, an expert in diagnostics, microbial discovery and outbreak response, has returned the favour and lent his hand to getting the science in science fiction films right. He was the expert consultant for Oscar-winning director Steven Soderbergh’s 2011 film *Contagion*, which is about an outbreak of a deadly virus. With Lipkin’s guidance, the film emphasized a zoonotic disease, “because that obviously accounts for the majority of these emerging infections that we see,” he explained. While some science aficionados criticize events near the end of the film, where the main characters rather too rapidly develop a vaccine, Lipkin said that one of the aims of the film was to inspire research in precisely this direction. “We were trying to push the idea that vaccines shouldn’t take that long,” he said. “If we use molecular methods, cell culture methods, molecular virus systems, we can probably produce vaccines in that sort of time frame, if we need to. So even that, although it is fiction, isn’t that far off.”

The power of science fiction comes from its use of narrative structures to contextualize science and technologies within the social sphere, thereby making readers or viewers aware of the potential of new technologies. “The idea about contextualizing technology is that movies, because they’re stories and because the people on the screen are acting as if it’s ‘real’, can ... show people what [different technologies] can be used for, what’s good about them, what’s bad about them, and give them a sense that these could actually be technologies that we can use as well,” David Kirby said. He coined the term ‘diegetic prototype’ to describe a new technology that first exists within a fictional world.

“Sci-fi sweeps its audiences up in technologically enabled tales of adventure and drama, making the audience wish for it, and for some few, want to make it,” said Christopher Noessel, managing director at Cooper, a design and strategy firm based in San Francisco, CA, USA. “People in the audience see enabling technologies like

self-driving cars in *Minority Report*, or volumetric projections in *Iron Man* and think, 'Holy wow that's amazing. I can't wait until I get to use that stuff!' That's a consumer who's pre-trained for what's awesome, and companies can either ignore that to their future sales peril, subvert it artfully, or build on it," he explained.

Kirby and Noessel liken science fiction films to playgrounds for scientists, where science and technology can be extended beyond their current potential and uses, while making scientific and technological advancements look plausible and even necessary. By creating an environment in

which people use these within the context of a realistic story, science fiction creates an expectation in audiences that these technologies should be a part of the future. "People love real world technology that appeared in science fiction first because it gives them a sense that they are living in the future," Kirby said. In his book, *Lab Coats in Hollywood*, he tells the story of John Underkoffler, science and technology consultant for the 2002 film *Minority Report*, who built a gestural interface prototype for the film that was later developed into a real-world technology called *gspeak™*. After designing and building a prototype that

looked realistic and intuitive in Tom Cruise's hands, Underkoffler received phone calls as soon as the movie hit the big screens with funding offers for development.

Sometimes inventors and designers deliberately use science fiction technologies as models for real-world technology. For example, the Qualcomm Tricorder XPRIZE currently offers US\$10 million to anyone who can bring the *Star Trek* tricorder to life. In the past few years, a whole host of health-care applications and accessories for mobile phones have appeared on the market—many with direct

mention of the tricorder—including those that measure heart and respiration rate, blood oxygenation, pulse transit time and body temperature.

In the same vein, Max Little, a Wellcome Trust/MIT fellow in the Media Lab at MIT, Cambridge, MA, USA, is leading the Parkinson's Voice Initiative. The goal is to detect Parkinson's disease through voice recordings via patients' cell phones. This technology is based on the fact that disease symptoms of tremor, rigidity and loss of muscle control affect the vocal organs. "Part of my vision in creating these technologies is to enable a future of health care that is as speculative as those you find in science fiction, for sure," Little said. "But being a technologist, not a storyteller, means dealing with tangible realities, working with what you have available today, and these days mobile devices are ubiquitous." Beyond inspiring the development of new technologies, Little sees another role for science fiction. "Like all fiction, sci-fi is a flight of fancy, where things can happen that might not ever happen in reality," he said. "But I personally believe that 'hard sci-fi', that is, sci-fi that tries to rigorously or consistently explore the consequences of the assumptions made in building that fictional reality, offers great potential as an educational route."

The trend for the entertainment industry to consult scientists is increasing, not only to make technological innovation depicted in film convincing, but also to get the science right. David Hughes, assistant professor of entomology and biology at Pennsylvania State University in Philadelphia, PA, USA, has nearly become a celebrity in science communication and entertainment circles for his research on the *Ophiocordyceps unilateralis* fungus. This fungus can turn ants into virtual zombies through modification of their behaviour to enhance its own survival and successful life cycle. After telling journalists and bloggers about his research, Hughes became a consultant for several Hollywood films and a new PlayStation video game called *Last of Us*. "I got involved in this by having my work covered extensively in the media,"

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Sidebar A | David A. Kirby's top ten list of scientifically accurate movies

Destination Moon (1950)
2001: A Space Odyssey (1968)
The Andromeda Strain (1971)
Jurassic Park (1993)
Contact (1997)
GATTACA (1997)
Deep Impact (1998)
Minority Report (2002)
Finding Nemo (2003)
Contagion (2011)

Hughes said. "Some producer just followed up with me from Paramount and wanted to discuss a script about *World War Z*. In our discussion of, 'well, if natural selection was in charge of these zombies, what would we expect to see?' I said, 'well, if that was the case, I'd expect to see collective behaviour, cooperation, things that we know happen through kin selection, so we'd expect to see zombies cooperating, allowing them to do things that individually, a zombie couldn't do.'" Such actions are precisely what movie-goers can see happening in the 2013 apocalyptic horror film directed by Marc Forster.

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Hughes also discussed host choice and virulence with the producer, resulting in the biological and behavioural aspects of the zombie infection in the film. "In general, I've just been trying to interject details of biology into the script as much as possible," Hughes said. "I think increasingly the audience is becoming so sophisticated that it's now the case that storytellers, whether they're developing a PlayStation game or a movie, are taking their inspiration from science and trying to delve into it as much as possible [...]. And I think that if we do that well enough, then the entertainment industry can really take a lot of inspiration from that, and at the same time we get our message across, which is that science is incredibly interesting."

Hughes, like other scientists who work as consultants and even authors, sees an increasingly important role for science in science fiction. 'Diegetic prototypes' of new

technologies are inspiring research funding and development. Science fiction fantasies from 10 years ago are turning into new medical diagnostics, communication technologies, and even space missions. But getting the science right also allows screenwriters and authors to build increasingly complex scientific phenomena into their narratives. While a writer might come up with an idea, such as a teleporter or a hologram beamer, without needing to understand how it could work, an understanding of science is needed to get the details of things such as disease transmission and epidemiology right. "The biological side of things is not always intuitive," Hughes explained. "I would say, and many people would berate me for this, but physics and chemistry are relatively simple," he said. "When you do work in rainforests, and you think about disease transmission, there's this ridiculously complex environment with millions of different species and processes interacting at the same time ... It's complicated enough for biologists to understand this, so it's insurmountably complicated for scriptwriters to get it. A guy sitting in a room trying to come up with a film script can't think his way through this." Because audiences demand increasingly sophisticated and realistic narratives, it seems that Hollywood is striving for more and more authenticity in their scripts (Sidebar A). "Especially in the West, authenticity equals science," Kirby said. "So if you want to ground your story in something plausible, you use science to do that."

Applications of science to the entertainment industry are beneficial beyond celebrity or raising public awareness, but the road goes both ways. Marc Baaden and colleagues at the CNRS Institut de Biologie Physico-Chimique, Paris, France, use video-game graphics technology to visualize complex molecular interactions in biology. "The idea with the video-game technology is that it makes it very easy for us to write our own tool that does what we want it to do, without having to learn programming from scratch," Baaden said. He explained that the visualization of biological interactions is also attractive and inspiring to students and future scientists. "For everything you do, you have a picture in your mind," Baaden said. "But if you can have an intermediate picture on the screen, and you can work with it, you can turn it around, you can add some information, you can modify things

and see how it reacts, I think it helps you form a more precise picture in your mind.”

The power of science fiction to both socialize and teach science through stories or imagery may be the reason for the strong historical connection between these two fields. In fact, scientific research can be just as speculative as science fiction, although it is constrained by limits on time, budget

and equipment. Science fiction is limited only by imagination, but often has its roots in the present. Many of today's scientific and technological advances might not exist without the work of visionaries of both science fiction and science fact and their influence on one another. From science to science fiction and back again: a Mobius strip of imagination.

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