

GROWING UP WITH SCIENCE FICTION

By Carl Sagan

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'Science fiction has led me to science,' says Cornell University astronomer Sagan, who writes about the impact of sci-fi on his life and on our society.

By the time I was 10 I had decided — in almost total ignorance of the difficulty of the problem — that the universe was full up. There were too many places for this to be the only inhabited planet. And, from the variety of life on earth (trees looked pretty different from most of my friends), I figured life elsewhere would seem very strange. I tried hard to imagine what that life would be like, but despite my best efforts I always produced a kind of terrestrial chimaera, a blend of existing plants or animals.

About this time a friend introduced me to the Mars novels of Edgar Rice Burroughs. I had not thought much about Mars before, but here, presented before me in the adventures of John Carter, was another inhabited world, breathtakingly fleshed out: ancient sea bottoms, great canal pumping stations and a variety of beings, some of them exotic. There were, for example, the eight-legged beasts of burden, the thoats.

These novels were exhilarating to read. At first. But slowly, doubts began to gnaw. The plot surprise in the first John Carter novel which I read hinged on his forgetting that the year is longer on Mars than on earth. But it seemed to me that if you go to another planet, one of the first things you check out is the length of the day and the year. Then there were incidental remarks which at first seemed stunning but on sober reflection proved disappointing. For example, Burroughs casually comments that on Mars there are two more primary colors than on earth. Many long minutes did I spend with my eyes closed, fiercely contemplating a new primary color. But it would always be something familiar, like a murky brown or plum. How could there be another primary color on Mars, much less two? What was a primary color? Was it something to do with physics or something to do with physiology? I decided that Burroughs might not have known what he was talking about, but he certainly made his readers think. And in those many chapters where there was not much to think about, there were satisfyingly malignant enemies and rousing swordsmanship—more than enough to maintain the interest of a city-bound 10-year-old in a long Brooklyn summer.

The following summer, by sheerest accident, I stumbled upon a magazine called *Astounding Science Fiction* in a neighborhood candy store. A glance at the cover and a quick riffle through the interior showed me it was what I had been looking for. With some effort I managed to scrape together the purchase price, opened the magazine at random, sat down on a bench not 20 feet from the store and read my first modern science-fiction short story, “Pete Can Fix It” by Raymond F. Jones, a gentle account of time travel into a postnuclear-war holocaust. I had known about the atom bomb — I remember an excited friend explaining to me that it was made of atoms — but this was the first I had seen about the social implications of nuclear weapons. It got you thinking.

I found I was hooked. Each month I eagerly awaited the arrival of Astounding. I read Verne and Wells, read, cover-to-cover, the first two science-fiction anthologies that I was able to find, devised scorecards, similar to those I was fond of making for baseball, on the quality of the stories I read. Many ranked high in asking interesting questions but low in answering them.

There is still a part of me that is 10 years old. But by and large I'm older. My critical faculties, and perhaps even my literary tastes, have improved. In rereading L. Ron Hubbard's "The End Is Not Yet," which I had first read, breathless, at age 19, I was so amazed at how it had declined in the intervening years that I seriously considered the possibility that there were two novels of that title, by the same author, but of vastly differing quality. I can no longer manage credulous acceptance as well as I used to. The plot of Larry Niven's "Neutron Star" hinges on the astonishing tidal forces exerted by a strong gravitational field. But we are asked to believe that hundreds or thousands of years from now, at a time of casual interstellar space flight, such tidal forces have been forgotten. We are asked to believe that the first probe of a neutron star is a manned rather than an unmanned spacecraft. We are asked too much. In a novel of ideas the ideas have to work.

In Douglas Trumbull's technically proficient science-fiction film "Silent Running," the trees are dying in vast, spaceborne, closed ecological systems on the way to Saturn. After weeks of painstaking study and agonizing searches through botany texts, the solution is found: Plants, it turns out, need sunlight. Trumbull's characters are able to build interplanetary cities but have forgotten the inverse-square law. I was willing to overlook the portrayal of the rings of Saturn as pastel-colored gases, but not this.

I have the same trouble with "Star Trek," which I know has a wide following and which some thoughtful friends tell me I should view allegorically and not literally. But when astronauts from earth set down on some far distant planet and find human beings there in the midst of a conflict between two nuclear superpowers — which call themselves the Yangs and Coms, or their phonetic equivalents — the suspension of disbelief crumbles. In a global terrestrial society centuries in the future, the ship's officers are embarrassingly Anglo-American. In fact, only two of 12 or 19 interstellar vessels are given nonEnglish names, Kongo and Potemkin. And the idea of a successful cross between a Vulcan and an earthling simply ignores what we know of

molecular biology and Darwinian evolution. (As I have remarked elsewhere, such a cross is about as likely as the successful mating of a man and a petunia.) I have similar problems with films in which spiders 30 feet tall are menacing the cities of earth: Since insects and arachnids breathe by diffusion, such marauders would asphyxiate before they could savage their first metropolis.

I believe that the same thirst for wonder is inside me that was there when I was 10. But I have since learned a little bit about how the world is really put together. I find that science fiction has led me to science. I find science more subtle, more intricate and more awesome than much of science fiction. It also has the additional virtue of being true. Think of some of the scientific findings of the last few decades: that there are particles which pass effortlessly through the solid earth so that we detect as many of them coming up through our feet as dawn from the sky, that the continents are moving on a vast conveyer belt with the Himalayas produced by a collision of India with Asia; that Mars is covered with ancient dry river valleys; that chimpanzees can learn languages of many hundreds of words, understand abstract concepts, and construct new grammatical usages; that all life on earth runs off one particular molecule that contains all the hereditary information and is able to make identical copies of itself; that in the constellation Cygnus there is a double star, one of whose components has such a high gravity that light cannot escape from it (it may be blazing with visible radiation on the inside but it is invisible from the outside). In the face of all this (and there is much more, equally fascinating), many of the standard ideas of science fiction seem to me pale by comparison. I see the relative absence of these findings in science fiction, and the distortions of scientific thinking often encountered in science fiction as terrible wasted opportunities. Real science is as amenable to exciting and engrossing fiction as fake science, and I think it is important to exploit every opportunity to convey scientific ideas in a civilization based upon science but somehow unable to communicate what science is about.

However, the best of science fiction remains very good indeed. There are stories that are so tautly constructed, so rich in the accommodating details of an unfamiliar society that they sweep me along before I have even a chance to be critical. Such works include Robert Heinlein's "The Door into Summer"; Alfred Bester's "The Stars My Destination" and his "The Demolished Man"; Jack Finney's "Time and Again"; Frank Herbert's "Dune," and Walter M.

Miller's "A Canticle for Leibowitz." You can ruminate over the ideas in these books. Heinlein's asides on the feasibility and social utility of household robots exceedingly well over the intervening years. The insights into terrestrial ecology that are provided by hypothetical extraterrestrial ecologies, as in "Dune," perform, I think, an important social service. "He Who Shrank," by Henry Hasse, presents an entrancing cosmological speculation which is being seriously revived today, the idea of an infinite regress of universes — in which each of our elementary particles is a universe, one level down from the previous one, and in which we are an elementary particle in the next universe up. A rare few science-fiction novels combine a standard science-fiction theme with a deep human sensitivity. I am thinking, for example, of Algis Budrys's "Rogue Moon," Ray Bradbury's "The Martian Chronicles" and many of the works of Theodore Sturgeon — including "To Here and the Easel," a stunning portrait of personality dissociation as perceived from the inside. Isaac Asimov's story "Breeds There a Man" provided a poignant insight into the emotional stress and sense of isolation of many of the best theoretical scientists. Arthur Clarke's "The Nine Billion Names of God" introduced many Western readers to an intriguing speculation in Oriental religions.

One of the great benefits of science fiction is that it can convey bits and pieces, hints and phrases, of knowledge unknown or inaccessible to the reader. Heinlein's "And He Built a Crooked House" was, for many readers, the first introduction to four-dimensional geometry that held any promise of comprehensibility. One science-fiction work offers as a ditty the mathematics of Einstein's last attempt at a unified field theory; another presents an important equation in population genetics. L. Sprague de Camp's "Lest Darkness Fall" is an excellent introduction to Rome at the time of the Gothic invasion, and Asimov's "Foundation" series, although this is not explained in the books, offers a useful summary of some of the dynamics of far-flung imperial Rome. Time-travel stories — for example, the three remarkable efforts by Heinlein, "All You Zombies," "By His Bootstraps" and "The Door Into Summer" — force the reader into contemplations of the nature of causality and the arrow of time. These are all works you ponder over as the water is running out of the bathtub or as you walk through the woods in an early winter snowfall.

Science-fiction ideas are widely dispersed, and found today in somewhat different guises. For one, we have science-fiction writers such as Asimov and Clarke providing, in nonfictional form, cogent and sometimes brilliant summaries of many aspects of science and society. Some contemporary scientists are introduced to a vaster public by science fiction. For example, in the thoughtful novel "The Listeners" by James Gunn, we find those directing a major radio search for extraterrestrial intelligence 50 years from now comparing their progress with the ideas of my colleague Frank Drake: "Drake! What did he know?" A great deal, it turns out. We also find straight science fiction transmogrified into a vast proliferation of writings, belief systems and organizations. One science-fiction writer, L. Ron Hubbard, has founded a successful cult called Scientology.

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Classic science-fiction ideas are now institutionalized in pseudoscientific U.F.O.- and ancient-astronaut belief systems — although Stanley Weinbaum (in "The Valley of Dreams") did it better as well as earlier than Erich Von Daniken (author of "Chariots of the Gods?"). In "Wine of the Dreamers" by John D. MacDonald (a science-fiction writer now transformed into one of the most interesting contemporary authors of detective fiction), we find the sentence "And there are traces, in Earth mythology, ... of great ships and chariots that crossed the sky." R. De Witt Miller in his story "Within the Pyramid" manages to anticipate both Von Milliken and Immanuel Velikovsky, and to provide a more coherent hypothesis on the supposed extraterrestrial origin of pyramids than can be found in all the writings on ancient astronauts and pyramidology.

The interweaving of science and science fiction sometimes produces curious results. It is not always clear whether life imitates art or vice versa. For example, in Kurt Vonnegut .Ir.'s superb epistemological novel "The Sirens of Titan," a not-altogether-inclement environment is postulated on Saturn's largest moon. When in the last few years some planetary scientists, myself among them, presented evidence that Titan has a dense atmosphere and perhaps higher temperatures than expected, many people commented to me on the prescience of Kurt Vonnegut. But Vonnegut was a physics major at

Cornell University and naturally knowledgeable about the latest findings in astronomy. In 1944, an atmosphere of methane was discovered on Titan, the first satellite in the solar system known to have an atmosphere. In this, as in many similar

cases, art imitates life. (Many of the best science-fiction writers have science or engineering backgrounds; for example, Pool Anderson, Isaac Asimov, Arthur Clarke and Robert Heinlein.)

In fact, our understanding of the other planets has often changed faster than their representations in science fiction. A clement twilight zone on a synchronously rotating Mercury, a swamp-and-jungle Venus, and a canal-infested Mars, while all classic science-fiction devices, are all, in fact, based upon earlier misapprehensions by planetary scientists. But as our knowledge of the planets has changed, the environments in the corresponding science-fiction stories have also changed. It is satisfyingly rare to find a science-fiction story written today that posits algae farms on the surface of Venus. (Incidentally, the U.F.O.-contact mythologizers are slower to change, and we can still find accounts of flying saucers from a Venus which is populated by beautiful human beings in long, white robes inhabiting a kind of Cytherean Garden of Eden. The 900-degree- Fahrenheit temperatures of Venus give us one way of checking such stories.) Likewise, the idea of a “space warp” is a hoary science-fiction standby, but it did not arise in science fiction. It arose from Einstein's General Theory of Relativity.

The motivational connection between science-fiction depictions of Mars and the actual exploration of that planet is so close that, subsequent to the Mariner 9 mission of 1971-72, we were able to name a few Martian impact craters after deceased science-fiction personalities. Thus there are on Mars craters named after H. G. Wells, Edgar Rice Burroughs, Stanley Weinbaum and John W. Campbell Jr.—a debt to science fiction that scientists have now in part repaid. No doubt other sciencefiction authors will be added after they die.

The great interest of youngsters in science fiction is reflected in a demand for science-fiction courses in high schools and colleges. My experience is that such courses can be fine educational experiences or disasters, depending on

how they are taught. Properly planned science-fiction courses, in which real science or real politics is an integral component, would seem to have a long and useful life in school curriculums.

The greatest human significance of science fiction may be as thought experiments, as attempts to minimize future shock, as contemplations of alternative destinies. This is part of the reason that science fiction has so wide an appeal among young people: It is they who will live in the future. No society on earth today is welladapted to the earth of 100 or 200 years from now (if we are wise enough or lucky enough to survive that long). We desperately need an exploration of alternative futures, both experimental and conceptual. The stories of Eric Frank Russell were very much to this point. We were able to see conceivable alternative economic systems, or the great efficiency of a unified passive resistance to an occupying power. In modern science fiction can also be found useful suggestions for making a revolution in an oppressive computerized society, as in Heinlein's "The Moon is a Harsh Mistress."

Such ideas, when encountered young, can influence adult behavior. Many scientists deeply involved in the exploration of the solar system (myself among them) were first turned in that direction by science fiction. And the fact that some of that science fiction was not of the highest quality is irrelevant. Tenyear-olds do not read the scientific literature.

In all the history of the world there has never before been a period in which so many significant changes have occurred in so short a span of time. Accommodation to change, the thoughtful pursuit of alternative futures, is the key to the survival of civilization and perhaps of humanity. Ours is also the time of the first generation that has grown up with science fiction. I know many young people who would, of course, be interested, but in no way astounded, were we to receive a message tomorrow from an extraterrestrial civilization. They have already accommodated to that future. I think it is not an exaggeration to say that, if we survive, science fiction will have made a vital contribution to the continuation and benign evolution of our civilization.

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