LOOKING FORWARD

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by

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When we speak of "foresight," we're using the trendy new term for what used to be called "futurism." But neither term is particularly explanatory. Yes, they both connote seeing ahead, but they don't describe *how* that is done. In my field of science fiction, we refer to what we do as "extrapolation," and I think that's a much better term than either "foresight" or "futurism." To extrapolate, according to the dictionary, is to "infer or estimate by extending or projecting known information." Science fiction is the only area of fiction in which this is routinely done, and of all of literature—fiction and nonfiction—it's the only field in which it's regularly done on long time scales and with such rigour.

Let's begin by defining science fiction, since it's a name often misused and poorly understood by those unfamiliar with the field. The term was coined by Hugo Gernsback, a Luxembourger who immigrated to the United States and founded the first science fiction magazine, *Amazing Stories,* in 1926. (Actually, his first stab at naming this field was the portmanteau word "scientifiction," but that didn't catch on.) In any event, Gernsback's definition was that science fiction was "fiction about science." Please note that it never was, and is not today, about *fictional* science. We do *not* just make stuff up. When a benighted newscaster or

columnist says that something improbable is "just science fiction" what he or she really means is that it's "just fantasy." Science fiction is about things that *plausibly might happen;* fantasy is about things that *could never* happen—magic and the supernatural have no basis in reality.

I will refer repeatedly to Arthur C. Clarke, who is my favourite science-fiction writer, even if he *did* make a glaring mistake. In 1965, he coined what's come to be known as Clarke's Third Law, and it goes like his: "Any sufficiently advanced technology is indistinguishable from magic." That's flat out wrong: magic involves the violation of the laws of physics, most often the law of conservation of mass and energy; there *are* constraints on what even the most advanced technology can do, and good science fiction acknowledges and works within those constraints.

It really is a shame that science fiction is so often shelved in the same section of the bookstore as fantasy; they are antithetical genres, but they're paired due to a historical oddity: the first US printings of J.R.R. Tolkien's *The Lord of the Rings* were pirate editions published by Ace, a science-fiction publisher. If SF had to share shelf space with another genre, it really should have been mystery fiction, as both prize picking up clues, deductive reasoning, and rational thought.

Anyway, Gernsback's definition—"fiction about science" served well enough for a couple of decades. Then Isaac Asimov, the great Russian-born American science-fiction writer, broadened Gernsback's definition to this: "science fiction is that branch of literature that deals with the responses of human beings to changes in science and technology." This revised definition put the science-fiction genre squarely in the foresight arena.

I have coined two definitions of the genre myself. One is simply that "science fiction is the literature of intriguing juxtapositions." That is, it is the field in which you can find quantum computing and paleoanthropology cheek-by-jowl, as in my own novel *Hominids,* or where

information theory, Chinese politics, primate communication, and the story of Helen Keller can all spark off each other, as in my novel *Wake.*

More germane to a discussion of foresight is my other definition: "science fiction is the mainstream literature of a plausible alternative reality"—"mainstream," in the sense that it's told as if to someone already familiar with the milieu of the story; if the story is set on Mars in the year 2087, the writer spins the tale as if the reader lives in 2087 and if he or she doesn't happen to be a denizen of Mars, it's no more exotic a locale to him or her than, say, Madagascar is to us.

Another of my criteria—an "alternative reality"—is designed to include not just the future but alternate presents and pasts: the field of counterfactual history, exploring scenarios such as the Axis triumphing in World War II, as exemplified by Philip K. Dick's 1962 masterpiece *The Man in the High Castle;* American author Harry Turtledove is the modern master of alternate history. Such stories are widely regarded as a subset of science fiction, and for good reason: the same extrapolative skill is required in writing them; the only difference is that the point being extrapolated forward from is in the past rather than the present.

In Gernsback's definition, in Asimov's, and in my own one about the mainstream literature of alternative realities, the constant, whether explicitly stated or merely implicit, is plausibility. *Science* is the empirical, the verifiable, the falsifiable; *science fiction* accepts the scientific method as the only legitimate way of knowing. You won't find a more skeptical bunch about mental powers, past lives, UFOs, or New Age nonsense than science-fiction writers.

A flat-out rejection of the supernatural or the implausible is only one of the fundamental building blocks for science fiction. The other foundational block is the core truth that SF espouses: mainstream fiction—also known as *mimetic* fiction, since it is imitative of real life—takes as a given that you *can't* change human nature; science fiction takes as a given that you

can. Yes, there are mainstream works that argue for attitudinal shifts—*Uncle Tom's Cabin* is a classic example—but such shifts are predicated upon appealing to existing, immutable human physiology and psychology. In Harriet Beecher Stowe's abolitionist novel, the appeal was to *existing* human compassion; it wasn't based on the assumption that a new capacity, namely one for empathy, could be developed in human beings when none had existed before. Charles Darwin understood that humanity is a work-in-progress; science-fiction writers have stood on Darwin's shoulders going all the way back to the days of H.G. Wells. The example from Wells's oeuvre of physical change that first springs to mind is from his 1895 novella *The Time Machine*, in which, 800,000 years from now, humanity has bifurcated into two species, the brutal, clever Morlocks and the feckless, feeble-minded Eloi. But much more interesting in this regard is my favourite Wells novel, *The Island of Dr. Moreau*, published the following year, in 1896, because in it change isn't something that *happened to* humanity; rather, change is something done with deliberation *by* humans. Dr. Moreau creates chimera beings, infusing animals with human traits—or perhaps vice-versa—producing creatures that think and feel fundamentally differently from us. And, of course, Aldous Huxley gave us one of our first tastes of genetic engineering, creating new kinds of humanity with his various castes grown in glass containers in his 1932 novel *Brave New World.* And, building on that, science fiction has long posited that fundamental human attitudes and mental capacities can and will change.

You can easily start an argument in any pub about which version of *Star Trek* is the best, but for me, it will always be the original series with Kirk, Spock, and McCoy. That said, it spectacularly fails with regards to science fiction taking a position that you can change human nature. Although set in the 23rd century, the crew of Kirk's *Enterprise* consisted of mid-20th century people, with 20th-century mindsets. Heck, at one point, in the episode "The Squire of

Gothos," Captain Kirk actually teases Spock by asking him if he'd ever "dipped little girls' curls in inkwells." Kirk and the rest were very much mired in their 1960s roots. Indeed, much of their behaviour doesn't even pass muster now. Certainly Kirk's womanizing would not be tolerated; you have to be at least a general to get away with that sort of thing today. And Dr. McCoy says things to Spock that we simply wouldn't countenance anyone saying in the workplace about a member of a different ethnic group: "You pointed-eared, green-blooded hobgoblin!" We also see lots of alcohol abuse, and despite some noble efforts, a lot of sexism, too, including the statement that women couldn't command starships.

To his credit, all of this started to grate on *Star Trek* creator Gene Roddenberry. When it came time for him to write the novelization of *Star Trek: The Motion Picture* in 1979, he proposed that much of the human race had evolved into more advanced "New Humans," and that Kirk and company were throwbacks, whose primitive impulses made them suited for gung-ho exploration.

Eight years later, when Roddenberry introduced us to Jean-Luc Picard and Commander Data in *Star Trek: The Next Generation*, he decided to directly address the issue of changing human nature. He decreed that come the 24th century, interpersonal conflict would be a thing of the past—as would the excesses of alcohol; his new crew drank "synthehol," the pleasing effects of which could be shrugged off with an effort of will, shocking the 23rd-century Scotty who shows up in one episode.

The problem with having no interpersonal conflict was that, at least at the beginning, *Star Trek: The Next Generation* was boring—not to mention pretty much unwatchable. It was only after Roddenberry passed away that this constraint—something the show's writers had called "The Box"—was done away with. The more science fiction tries to portray the future of

humanity as a changed species, the harder it is for an untrained present-day audience to identify with it; as critic Samuel R. Delany has rightly pointed out, reading serious science fiction is hard work. And with science fiction currently predicting everything from profound body modification (people with gills or extra arms or bigger brains or sonar or what-have-you); to radical life extension providing practical immortality; the boosting of mental powers and the addition of new senses; scanning consciousness and uploading it into a virtual computer world or downloading it into durable android bodies; and even the fusing of individual consciousness into hive minds, the task of making modern science fiction accessible to the general reading public is daunting. For instance, here's an early paragraph from Scottish writer Charles Stross's 2006 novel *Glasshouse*, published to considerable acclaim by Orbit in the UK and Ace in the US:

> The Invisible Republic is one of the legacy polities that emerged from the splinters of the Republic of Is, in the wake of the series of censorship wars that raged five to ten gigaseconds ago. During the wars, the internetwork of longjump T-gates that wove the subnets of the hyperpower together was shattered, leaving behind sparsely connected nets, their borders filtered through firewalled assembler gates guarded by ferocious mercenaries. Incomers were subjected to forced disassembly and scanned for subversive attributes before being rebuilt and allowed across the frontiers. Battles raged across the airless cryogenic wastes that housed the longjump nodes carrying traffic between warring polities, while the redactive worms released by the Censor factions lurked in the firmware of

> every A-gate they could contaminate, their viral payload mercilessly deleting all knowledge of the underlying cause of the conflict from fleeing refugees as they passed through the gates.

Whew! My point is that the most elaborate extrapolations are, by their very nature, the least accessible texts. This is to be expected, of course. One of the most influential papers in modern philosophy is Thomas Nagel's 1974 "What is it Like to be a Bat?," in which he argued that it's impossible for beings like us, without sonar and without the ability to fly, to understand at all what those things would be like for beings that possess them. Another paper, "Helen Keller as Cognitive Scientist," published in 1996 by Justin Leiber, likewise argued that it is impossible for us, as sighted, linguistic beings to comprehend the thoughts of young Helen Keller in her blind, pre-linguistic state. That paper struck me as a challenge, and led directly to my WWW trilogy about the World Wide Web gaining consciousness.

Still, no matter how hard it is to portray, this notion that human beings—and their social structures—are not static but rather can and will change radically is central to science fiction.

Let me go off on what seems like a digression for a moment, but I promise it's germane. I'm a Canadian, and Canadians for the last decade and a half have been disproportionately represented on the ballots for science-fiction awards, often making up 40% or more of the shortlist for the major ones. Indeed, the field's top award, the best-novel Hugo, went to Canadians three times in the past decade, astonishing when you consider Canada's small population of 35 million. In that same time period, the award also three times went to Brits, but Brits are much more numerous than Canadians.

Still, that means the majority of recent best-novel Hugos have gone to writers from

countries with socialized health care, and I don't think that's a coincidence; rather, the ability to become a full-time writer early on, without needing a regular job to provide medical insurance for oneself and one's family, allows writers in all fields to hone their talents in their twenties, an age at which their American colleagues are hoping someday to find the time to write.

Damon Knight, the founder of the Science Fiction and Fantasy Writers of America, once observed that the most unrealistic thing about science fiction was the preponderance of Americans in its stories; practically no one, he observed, is an American—and he's right: well over 90% of characters in science-fiction books are Americans, whereas less than 4% of humans really are from the United States. And Canada has a population just a tenth that of the United States. Why are Canadians, in particular, doing so well on a *per capita* basis with science fiction?

I think one reason is that, as a nation, Canada does embrace that simple reality I spoke of earlier: you *can* change human nature, including fundamentally shifting attitudes or inculcating new capacities. Canadian essayist (and president of PEN International) John Ralston Saul has observed that one of the biggest differences between Canada and the US is in our approach to our foundational documents. Americans view their Constitution and Bill of Rights as holy writ, and expend an enormous amount of effort trying to make sure that 21st-century America lives up to—or down to—the ideals of a group of men mostly born in the early 1700s.

Canada, on the other hand, views its Constitution and Charter of Rights and Freedoms as works in progress: documents to be tweaked, changed, and, if ever the need should arise, completely rewritten, as humanity itself changes. That makes my compatriots particularly suited for the job of foresight through fiction—humanity *is* changing, and we Canadians acknowledge that. Canada's seventh prime minister, Sir Wilfrid Laurier, said in 1904, "The twentieth century belongs to Canada." I like to quip that he was off by a hundred years.

I also think it's no surprise that the best nonfiction book documenting the fundamental change in human attitudes over time was written by a Canadian. I speak of *The Better Angels of Our Nature: Why Violence Has Declined* by Stephen Pinker, published in 2011.

Interesting fact: the Pentagon has double the number of washrooms it actually needs. Why? Because it was built in the 1940s, when the United States required separate "Whites" and "Coloreds" washrooms in public facilities. When I was born, in 1960, the US was still a segregated country, with African-Americans a downtrodden underclass; before I'd turned fifty, a black man was sitting in the Oval Office. Although in academia, we often speak of the "retire or expire" factor—the notion that a new idea, such as continental drift, can't become mainstream until the old guard is replaced by a new generation—in the US, many of the same people who supported segregation came to recognize that it was wrong: *they* changed—as individuals—and so, collectively, society changed.

Still, whether you're an American, a Brit, or a Canadian—the three nationalities that produce most of the world's science fiction, and not just counting the work in English—how does one, in fiction, extrapolate to what plausibly might happen?

The first thing you need, as I've stressed above, is the conviction that human nature *does* change, that our psyches and our societies are malleable. Indeed, it is this ability to change that may explain why we're here and all other forms of humanity have died out. Despite having bigger brains than us, Neanderthals were intellectually stagnant, making essentially the same stone tools—the Mousterian industry—for 200,000 years or so. Our kind of humanity, however, was constantly improving its technology—because our way of looking at the world was constantly changing. Linnaeus takes a lot of flak for hubristically naming our species *Homo sapiens*—people of wisdom—but if wisdom is the result of *cumulative* changing perceptions and

perspectives—then perhaps our nimble kind does deserve that name.

After accepting that human nature does change, the second thing you need to extrapolate the future is, perhaps ironically, a keen appreciation of history.

I had the pleasure of interviewing the American science-fiction writer Kim Stanley Robinson in 1989 for a documentary series I was writing for CBC Radio. He made the point then that the only way to extrapolate a trend is to look not just at the present, but the past, as well—the future is just the continuation of history. I agree with Robinson, and would add that it's the vector from past to present that gives directionality to our extrapolations. The plausible future is the one that *continues* past trends; implausible futures break off in new directions without sufficient cause. In fact, the standard story-generating template for science fiction is not, as many contend, simply asking "What if?"—that is, merely having a neat idea and working out its consequences—but rather wondering what will happen if this—whatever this happens to be—goes on, projecting a trend to a logical extreme or natural end point.

The third requirement for effective extrapolation is a recognition that the rate of change is no longer linear, but rather is exponential. This is a notion that's been widely popularized by inventor Ray Kurzweil, including in his massive tome *The Singularity is Near,* but the idea actually originated with a science-fiction writer, Vernor Vinge.

Like many other SF writers, Vinge was, at the time he wrote about this topic, also an academic; he has since retired from his position as Professor of Mathematics at San Diego State University—and he first put forward his ideas in an article rather than a story. As a well-regarded science-fiction writer, he was clearly using his SF chops when he published his seminal essay "The Coming Technological Singularity: How to Survive in the Post-Human Era," which came out in 1993, two years after Vinge took home the best-novel Hugo—the first of five Hugos he

would eventually win—for his novel *A Fire Upon the Deep.*

And, yes, I *do* think it's fair for science fiction to take credit for the singularity notion, even if it wasn't published *as* science fiction, since it was first formulated in depth by a science-fiction writer. Likewise, I think science fiction can also claim geostationary communication satellites. They were first proposed by science-fiction writer Arthur C. Clarke, even though he chose to unveil his calculation that anything in orbit 23,000 miles above the equator would stay stationary in the sky, and that three such satellites could cover the entire surface of the Earth, in 1945 in the journal *Wireless World* rather than in a science-fiction story. In later years, by the way, Sir Arthur had a T-shirt that said, "I invented the communications satellite and all I got was this lousy T-shirt."

Anyway, the notion of the singularity is wrapped up in the idea that the rate of technological progress is accelerating. The classic example, of course, is Moore's Law, coined in 1965 by Gordon Moore of Intel, and usually formulated these days to say that computing power doubles every eighteen months. That means the computers we had ten years ago were only 1/128th as powerful as the ones we have today—and the ones we'll have ten years from now will be 128 times as powerful as our current best machines.

Vernor Vinge told us the singularity—the moment when machine intelligence will exceed human intelligence—would arrive no sooner than 2005 and no later than 2030, a prediction, although twenty years old now, that still seems reasonable. And, at the moment it does arrive, a gigantic *woosh!* will occur, since thinking machines will be able to quickly engineer better thinking machines; very rapidly—perhaps in a matter of days or hours—humanity will be left far behind.

Or, at least, that's what the singularitarians would have us believe. Regardless of whether

they're right or not, the key point—that the rate of technological advancement is accelerating—is one that must be grasped by any futurist. The amount of progress this decade will be much greater than in the last decade; the progress made this century will far outstrip that of the last century.

And this *is* the century in which the human race will either go extinct or establish its stability for not just centuries but millennia to come.

AIDS and cancer are tractable scientific problems. We lament our slow progress in conquering them, but we've only known the structure of DNA for fifty years now, and we've only had a map of the human genome for ten.

Also, we finally have computers powerful enough to deal with complex things such as protein folding. In other words, we finally have the tools, after 40,000 years of civilization, to do real medicine; we just got them, but the progress will be rapid—I'll be astonished if, by the hundredth anniversary of Crick and Watson's discovery of the structure of DNA here at Cambridge, that any diseases continue to be a serious threat to humanity.

And it's not just technological devices that are changing at an accelerating rate; rather, it is humanity itself. The changes in the last fifty years—the collapse of the Soviet Union, the general decline in violence, the fact that a smaller percentage of the human race is in armed conflict than ever before, the acceptance in Europe and the growing acceptance in North America that atheists can have a role in public life, the legal recognition in many jurisdictions of same-sex marriages, the growth of women's rights, the recognition of the injustices that have been done to aboriginal peoples, the end of colonialism, the end of segregation in the US and South Africa, and the fact that the United Kingdom and Canada have had female prime ministers and that the United States and South Africa have had black presidents—all attest to the rapidity of societal

change. And even more change will come in the next fifty years than what we experienced in the previous half-century.

To see some failings in this area, let's turn to the poor stepchild of written science fiction: SF film and television, what we in the business call "media sci-fi" Such fare represents a different realm, with different roots, and most of the good things that can be said about science fiction as an extrapolative genre apply *only* to written SF.

One of my favourite examples of the failing of science-fiction films to recognize the increasing rate of technological and societal change is at the beginning of what is otherwise regarded as one of the best SF films of the 20th century, *Forbidden Planet,* which starred Canadian actors Leslie Nielsen and Walter Pidgeon.

Forbidden Planet was released in 1956, one year before the launch of the first Sputnik, five years before Yuri Gagarin became the first man to orbit the Earth, and just thirteen years before we landed on the moon. But it begins with this notice: "In the final decade of the 21st Century, men and women in rocket-ships landed on the Moon." Sitting in the mid-1950s, and looking at how long it had taken us to get from steam engines to a car in every driveway—a hundred and fifty years—it seemed likely that the moon was that far in our future, if you assumed a steady rate of technological change.

Our first three requirements for extrapolating were (1) a recognition that human nature, and human societies, do change; (2) an appreciation of history—of what has gone before; and (3) an understanding that the rate of change is accelerating.

The fourth thing a good extrapolator must remember is the dictum from the greatest American science-fiction editor, John W. Campbell, Jr.: the future doesn't happen one at a time.

A case-in-point is what I consider to be the finest science-fiction film of all time: *2001: A*

Space Odyssey, made in the UK, and released in 1968. Its screenplay was written by Arthur C. Clarke and Stanley Kubrick, who also directed the film. Now, I'm the first to admit that *2001* made a few enormous blunders in its attempts to extrapolate technology three and a half decades ahead, and I'll come to the reason for that failing later. But its greatest failing was perhaps in the area of societal extrapolation; that is, Clarke and Kubrick, thought *only* technology would change, and so *2001* depicted an all-white future; not a single person of colour appears in the movie. Indeed, so little thought was given to the international nature of the future that one of the first things you see after the first line of dialogue is spoken, 37 minutes into the film, is a futuristic immigration computer that asks you to choose your native language from a list presented *in English*—offering English, German, French, Spanish, and so on, instead of English, Deutsch, Français, or Español.

The second major mistake was failing to acknowledge the increasing prominence of women: by the time the film was made, there had already been a woman in space, the cosmonaut Valentina Tereshkova. Not only that, but when *2001: A Space Odyssey* came out in 1968, *Star Trek,* with its multiracial crew including Lt. Uhura and many other females, had been on the air for two years.

The third major mistake in *2001* was thinking the Cold War would endure into the twenty-first century.

And the fourth major mistake—and this was one that no science-fiction writer got right—was the belief that humanity would continue its ever-outward expansion into space. By the time of *2001,* we were to have giant wheeled orbiting space stations, a city on the moon, and crewed interplanetary missions. Instead, just three and half years after the first person walked on the moon the *last* person to do so did. In the year-end summations that just came out for 2012, every

newspaper and newsmagazine noted the passing of that first man, Neil Armstrong, but none remarked on the fact that the thirtieth anniversary of the last man on the moon also passed last year. One can almost—almost—have sympathy with moon-landing deniers, who marvel at the notion that we could have done in the 1960s something we can't do in the twenty-teens.

I was lucky enough to have dinner with Buzz Aldrin, the second man on the moon, a couple of years ago. He'd been lobbying for commercial airlines to let astronauts into their airport lounges for free. He'd been getting some pushback: the airlines were saying there were just too many astronauts these days. Buzz countered that the perk should then be limited to "real" astronauts, the ones who had undergone TLI—trans-lunar injection: leaving Earth orbit to voyage to another world—of which there were precisely twenty-seven, the crews of *Apollos* 8 and 10 through 17. No one has undergone trans-lunar injection—indeed, no one has gone more than 500 kilometres from Earth—since 1972, just four years after *2001: A Space Odyssey* debuted. The mistake Arthur C. Clarke and Stanley Kubrick had made was the mistake every science-fiction writer had made: they'd assumed the whole human race shared their agenda, an agenda that basically said price was no object.

But, of course, price was, and is. Despite my earlier comments about the prevalence of Canadians on the science-fiction award ballots, I contend that a thousand years from now, if you look up "science fiction" in the *Encyclopedia Galactica*, the entry will begin, "A 20th-century American literary genre ..." No one in the 19th century dreamed of such profligate spending as depicted in the movie *2001,* nor can anyone in the 21st century. Indeed, although Thomas Carlyle dubbed economics "the dismal science" in 1849, it was one area of extrapolation mostly ignored by science-fiction writers for a very long time. (Today, though, I'm pleased to announce that it's at the core of many fine works of extrapolation, including the *Unincorporated* series by brothers

Dani and Eytan Kollin.)

Of course, it's possible to take extrapolation too far. As it happens, my father is professor emeritus of economics at the University of Toronto. And although it was he who took me to see *2001: A Space Odyssey* at a theatre during its first run in 1968, he had never read any science fiction. And yet as a bright gadget-loving scientifically and mathematically literate person, he perfectly fit the core demographic. And so I set about to introduce him to the joys of the genre. My first couple of suggestions failed to strike his fancy, and then it hit me: the perfect choice. My father's specialty was economic forecasting; in fact, he had headed the University of Toronto's Institute for the Quantitative Analysis of Social and Economic Policy, which tried to gauge the effects government programs would have on the economy, and he had pioneered many techniques of econometric modeling, including, I vividly remember from my childhood, one that involved elaborate structures made out of Tinker Toys.

And so I gave my father Isaac Asimov's magnum opus, *The Foundation Trilogy*—the series that has confounded countless readers and librarians because the title of the third book in the series is *Second Foundation. The Foundation Trilogy* tells of Hari Seldon, a social scientist and mathematician, who has developed a field he calls "psychohistory," which predicts social trends over not just months or years, but millennia. Asimov's position was that when the human population gets big enough, no one person can have a significant impact, and so the laws of mass action will apply, letting the broad strokes be mapped out; by the time of his story there are quadrillions of human beings scattered over thousands of worlds. Unfortunately, Hari Seldon's psychohistorical analysis predicts that the vast galactic empire is about to fall, and a dark age of 30,000 years' duration will ensue. He sets out—more or less negating Asimov's premise that one person can't make a difference—to ensure that a new prosperous civilization with arise after the

interregnum.

The problem, of course, is that Asimov started writing *Foundation* around 1940, decades before the notion of chaos theory, and sensitive dependence on initial conditions, had been developed. We know now that even a slight change has gigantic effects; rather than being damped out, it can alter everything.

This is one case in which media science fiction actually got it more correct. The final episode of *Star Trek: The Next Generation* is called "All Good Things ...," and in it, the omnipotent Q takes Captain Picard back four billion years to observe the primordial ooze on the young Earth. As he says, if he were to merely stir that ooze with his finger, humanity will never be born.

I took *2001: A Space Odyssey* to task earlier for some of its extrapolative failings—but, of course, it also had many resounding successes. Something very similar to the tablet computers we all use now was shown in this film made in 1968: a flatscreen device that could display any content. The name was even close to what the real product ended up being called: "NewsPad" instead of "iPad." The only thing they got wrong is that in the film, you can clearly see that the manufacturer of this wonderful device was IBM. Apparently, Big Blue didn't have the foresight to actually try to make the devices portrayed in the movie, ceding one of the biggest technology booms of recent years to a rival.

The most significant creation in *2001: A Space Odyssey*, though, was the Hal 9000 computer, voiced by the wonderful Canadian actor Douglas Rain.

There's a category of book I call shop-floor sweepings: you look around for what's lying about, sweep it up, and collect it into a single volume. William Gibson's recent *Distrust That Particular Flavour* was one such, as was my own *Relativity: Essays and Stories*. Yet another was

Arthur C. Clarke's *The Lost Worlds of 2001,* which collected fragments of earlier drafts of the novel written simultaneously with the screenplay. In this book, we learn that originally the spaceship crew was to be aided by an ambulatory robot named Athena; it was only quite late in the development process that the notion of a central computer came to the fore.

The name Hal was said to be a contraction of Heuristically programmed ALgorithmic computer. However, it's also true that H-A-L is one step alphabetically ahead of I-B-M. Arthur C. Clarke denied that that was deliberate. I never used to believe him; the odds are hugely against it coming up by accident. But my own first novel, *Golden Fleece,* published in 1990, is very much a homage to *2001,* and it features a central computer named JASON, which someone pointed out to me could be rendered not only as J-A-S-O-N but also as J-C-N, and the letters J-C-N come one letter alphabetically after I-B-M.

In the movie *2001,* Hal says his birthday was the 12th of January 1992. Now, it's not actually clear what part of the movie takes place in the year 2001. After we leave the apemen and go to the future, there's the portion of the film that takes place on the wheel-shaped space station and on the moonbase, and then there's the Jupiter mission that's identified as occurring eighteen months later. If we assume the Jupiter mission is the part set in 2001, then we're supposed to believe that a cutting-edge spaceship had an eleven-year old central computer—and if it's the moonbase stuff that's set in 2001, then Hal would be thirteen by the time the mission took place.

Too late for the movie, Arthur C. Clarke realized this was a mistake; Moore's Law was coined in 1965, about when Clarke and Kubrick started collaborating on their screenplay, but Clarke apparently hadn't gotten the memo yet.

Still, for the novel, which was published after the movie was in theatres, he changed the date to the 12th of January 1997—five years later—meaning Hal was between four and six years

old when we meet him. To commemorate that date—January 12, 1997—in real life, MIT Press published a lovely volume entitled *Hal's Legacy: 2001's Computer as Dream and Reality.* The book has contributions from or interviews with such seminal computing figures as Marvin Minsky, Ray Kurzweil, and Douglas Lenat, as well as cognitive scientist Daniel C. Dennett. The papers in the book make the case that the whole agenda of the computer-science and artificial-intelligence communities was set from 1968 for the next thirty years by the vision people saw in the movie *2001*.

And, indeed, it was: In *2001,* Hal beats a human at chess, exhibits speech recognition, exhibits natural language processing, and has very sophisticated vision—including the ability to read lips. He also shows a remarkable talent for facial recognition, not only recognizing real people, but recognizing others in sketches done by an amateur artist, and he even seems to exhibit common sense and moral reasoning.

Arthur C. Clarke's famous peer was Isaac Asimov, whose name is indelibly associated with robots, thanks to his fictional Three Laws of Robotics. Those laws, as Asimov himself told me in a 1985 CBC interview, were actually coined by the great editor of *Astounding Stories* I mentioned previously, John W. Campbell, Jr. So it's no surprise to find that Asimov himself didn't really understand computers. Back in 1952, his attention was caught by UNIVAC, the computer that correctly predicted that Dwight Eisenhower would beat Adlai Stevenson in the race for the White House, when all the traditional pollsters predicted Stevenson would win. The name UNIVAC is a contraction of "UNIVersal Automatic Computer," but Asimov figured it was a computer with one vacuum tube, and so decided that his futuristic fictional computer in his 1956 story "the Last Question" would out-do it by having lots of vacuum tubes—leading him to dub his thinking machine Multivac. Multivac was never networked; it was a single giant physical

entity, tended by hundreds of technicians, and if you wanted to ask it a question, you had to go to it.

And, speaking of networks, it's a silly canard that Al Gore claimed to have invented the Internet. Of course, he never said that. It's an equally silly claim—although one often heard—that science fiction *failed* to predict the Internet. In fact, it did so repeatedly. The oldest reference to something like the Internet was probably Mark Twain's "telectroscope," which he proposed in a 1898 short story:

> The improved "limitless-distance" telephone was presently introduced, and the daily doings of the globe made visible to everybody, and audibly discussable too, by witnesses separated by any number of leagues.

Something even closer to our modern Internet—and the World Wide Web that supervenes upon it—was put forth in Murray Leinster's short story "A Logic Named Joe," first published in 1946.

When Murray Leinster published his story, the word "computer" referred to a person who worked with a calculating machine; it was the name of the operator, rather than the device. And so he needed a term for the actual machines, and he came up with Logics, which is pretty good. As for calling this particular one "Joe," well, really, is that any sillier a name than "Google"? In any event, Leinster predicts massively interlinked computers providing answers to questions on any subject at any time from anywhere. His narrator, an aw-shucks repairman, describes technology eerily reminiscent of what we now rely on two-thirds of a century later:

> You know the logics setup. You got a logic in your house. It looks like a vision receiver used to, only it's got keys instead of dials and you punch the keys for what you wanna get ... Say you punch "Station SNAFU" on your logic. Relays in the tank take over an' whatever vision-program SNAFU is telecastin' comes on your logic's screen. Or you punch *"Sally Hancock's Phone"* an' the screen blinks an' sputters an' you're hooked up with the logic in her house an' if somebody answers you got a vision-phone connection. But besides that, if you punch for the weather forecast or who won today's race at Hialeah or who was mistress of the White House durin' Garfield's administration or what is PDQ and R sellin' for today, that comes on the screen too ... everything you wanna know or see or hear, you punch for it an' you get it.

And let us go back to Arthur C. Clarke's novel version of *2001: A Space Odyssey.* In that book, he has one of his characters using the NewsPad I described earlier thus:

> When he tired of official reports and memoranda and minutes, he would plug in his foolscap-size newspad into the ship's information circuit and scan the latest reports from Earth. In a few milliseconds he could see the headlines of any newspaper he pleased ... one could spend an entire lifetime doing nothing but

absorbing the ever-changing flow of information.

In other words, science fiction even predicted that surfing the web could become an enormous time sink!

Now, remember what I said about the *Foundation* trilogy earlier: Isaac Asimov had failed to take into account—because it hadn't been invented yet—the notion of chaos theory, which meant any prediction might go awry, thanks to ignored seemingly small effects. Although the most famous science-fictional prose treatment of computing is William Gibson's 1984 novel *Neuromancer,* is it any wonder that it doesn't accord with how reality turned out, given that Gibson wrote it on a manual typewriter?

I've sometimes said in interviews that my recent novel *Wake* (and its sequels *Watch* and *Wonder*) are in dialog with *Neuromancer,* but where Gibson's view is pessimistic and closed (a hacker underground and/or big corporations controlling everything), mine is optimistic and open (power devolves to all individuals everywhere).

Gibson's take, fascinating when he first put it forth, has been superseded by reality; the whole cyberpunk fork of science fiction is now a kind of alternate history unrelated to how computing really evolved: instead of cyberpunks, we got the communal Wikipedia, and *Time* magazine naming "You"—us, the average joe who freely and altruistically creates online content—its 2006 Person of the Year.

The difference between Gibson's approach and mine is driven home most directly in *Wake,* where I paraphrase the opening line of *Neuromancer,* then add a final clause that turns its meaning around. Neuromancer begins, "The sky above the port was the colour of television, tuned to a dead channel." When Gibson wrote "the colour of television, tuned to a dead channel,"

he meant to imply a gray foreboding firmament—but technology changed in ways he didn't anticipate. In my novel, I write, "The sky above the island was the colour of television, tuned to a dead channel—which is to say it was a bright, cheery blue." *Neuromancer* is, of course, a remarkable achievement, but *Wake* came out twenty-five years later, and starts extrapolating forward from a reality in which the World Wide Web actually exists.

Still, Gibson and I are in accord on some things. As I argued in a 1999 speech at the Library of Congress, the central message of science fiction is this: "Look with a skeptical eye at new technologies." Or, as Gibson has put it, "the job of the science-fiction writer is to be profoundly ambivalent about changes in technology."

Now, certainly, there are science-fiction writers who use the genre for pure scientific boosterism: science can do no wrong; only the weak quail in the face of new knowledge. Jerry Pournelle, for instance, has rarely, if ever, looked at the downsides of progress. But most of us, I firmly believe, do take the Gibsonian view: we are not techie cheerleaders, we aren't flacks for big business or entrepreneurism, we don't trade in utopias.

Neither, of course, are we Luddites. The late Michael Crichton used to write of the future, too, but he wasn't really a science-fiction writer; if anything, he was an anti-science writer. Indeed, both Gregory Benford and I discussed with our shared agent, Ralph Vicinanza, why it was that Crichton outsells us. Ralph explained that he could get deals at least approaching those Crichton gets if—and this was an unacceptable "if" to both me and Greg—we were willing to promulgate the same fundamental message Crichton does, namely, that science always goes wrong.

Think about it: when Michael Crichton made robots, as he did in *Westworld,* they run amuck, and people die. When he cloned dinosaurs, as he did in *Jurassic Park,* they run amuck

and people die. When he found extraterrestrial life, as he did in *The Andromeda Strain,* it runs amuck and people die. When he delved into nanotechnology, as he did in *Prey,* it runs amuck and people die. Crichton wasn't a prophet; rather, he pandered to the fear of technology so rampant in our society—a society, of course, which ironically would not exist without technology. His mantra was clearly the old B-movie one that "there are some things man was not meant to know."

The writers of real SF refuse to sink to fear-mongering, and, indeed, we have an essential societal role, one being fulfilled by no one else. Actual scientists are constrained in what they can say. Even those scientists lucky enough to have tenure, which supposedly ensures the right to pursue any line of inquiry, are in fact muzzled at the most fundamental economic level. They cannot speculate openly about the potential downsides of their work, because they rely on government grants or private-sector consulting contracts.

The government is answerable to an often irrational public. If a scientist is dependent on government grants, those grants can easily disappear. And if he or she is employed in the private sector, well, then certainly Samsung doesn't want you to say cellular phones might cause brain cancer; Dow Chemical didn't want anyone to say that silicone implants might cause autoimmune problems; British American Tobacco didn't want anyone to say that nicotine might be addictive.

Granted, not all of these potential dangers turned out to be real, but even considering them, putting them on the table for discussion, was not part of the corporate game plan; indeed, suppressing possible negatives is key to how all businesses, including those built on science and technology, work.

There are moments—increasingly frequent moments—during which the media reports that "science fiction has become science fact." Certainly one of the most dramatic recent ones

was made public in February 1997. Ian Wilmut at Roslin Institute in Edinburgh had succeeded in taking an adult mammalian cell and producing an exact genetic duplicate: the cloning of the sheep named Dolly.

Dr. Wilmut was interviewed all over the world, and, of course, every reporter asked him about the significance of his work, the ramifications, the effects it would have on family life. And his response was doggedly the same, time and again: cloning, he said, had narrow applications in the field of animal husbandry.

That was all he *could* say. He couldn't answer the question directly. He couldn't tell reporters that it was now technically possible for a man who was thirty-five years old, who had been drinking too much, and smoking, and never exercising, a man who had been warned by his doctor that his heart and lungs and liver would all give out by the time he was in his early fifties, to now order up an exact genetic duplicate of himself, a duplicate that by the time he needed all those replacement parts would be sixteen or seventeen years old, with pristine, youthful versions of the very organs that needed replacing, replacements that could be transplanted with zero chance of tissue rejection.

Why, the man who needed these organs wouldn't even have to go to any particular expense—just have the clone of himself created, put the clone up for adoption—possibly even an illegal adoption, in which the adopting parents pay money for the child, a common enough if unsavory practice, letting the man recover the costs of the cloning procedure. Then, let the adoptive parents raise the child with their money, and when it is time to harvest the organs, just track down the teenager, and kidnap him, and—well, you get the picture. Just another newspaper report of a missing kid.

Far-fetched? Not that I can see; indeed, there may be adopted children out there right now

who, unbeknownst to them or their guardians, are clones of the wunderkinds of Silicon Valley or the lions of Wall Street. Still, the man who cloned Dolly couldn't speculate on this possibility, or any of the dozens of other scenarios that immediately come to mind. He couldn't speculate because if he did, he'd be putting his future funding at risk. His continued ability to do research depended directly on him keeping his mouth shut.

The same mindset was driven home for me when I was co-hosting a two-hour documentary called *Inventing the Future: 2000 Years of Discovery* for the Canadian version of The Discovery Channel. I went to Princeton University to interview Joe Tsien, who created the "Doogie Mice"—mice that were born more intelligent than normal mice, and retained their smarts longer.

While my producer and the camera operator fussed setting up the lighting, Dr. Tsien and I chatted animatedly about the ramifications of his research, and there was no doubt that he and his colleagues understood how far-reaching they would be. Indeed, by the door to Dr. Tsien's lab, not normally seen by the public, was a cartoon of a giant rodent labeled "Doogie" sitting in front of a computer. In Doogie's right hand is his computer's pointing device—a little human figure labeled "Joe": the super-smart mouse using its human creator as a computer mouse.

Finally, the camera operator was ready, and we started taping. "So, Dr. Tsien," I said, beginning the interview, "how did you come to create these super-intelligent mice?"

And Tsien made a "cut" motion with his hand, and stepped forward, telling the camera operator to stop. "I don't want to use the word 'intelligent,'" he said. "We can talk about the mice having better memories, but not about them being smarter. The public will be all over me if they think we're making animals more intelligent."

"But you *are* making them more intelligent," said my producer. Indeed, Tsien had used

the word "intelligent" repeatedly while we'd been chatting.

"Yes, yes," he said. "But I can't say that for public consumption."

The muzzle was clearly on. We soldiered ahead with the interview, but never really got what we wanted. I'm not sure if Tsien was a science-fiction fan, and he had no idea that I was also a science-fiction writer, but many SF fans have wondered why Tsien didn't name his super-smart mice "Algernons," after the experimental rodent in Daniel Keyes's story "Flowers for Algernon," made into the movie *Charly,* starring Cliff Robertson. Tsien might have been aware of the reference, but chose the much more palatable "Doogie"—a tip of the hat to the old TV show *Doogie Howser, M.D.,* about a boy-genius who becomes a medical doctor while still a teenager—because, of course, in the story "Flowers for Algernon," the leap is made directly from the work on mice to the mind-expanding possibilities for humans, and Tsien was clearly trying to restrain, not encourage, such extrapolative leaps.

We science-fiction writers also aren't bound by nondisclosure agreements, the way so many commercial and government scientists are. Because of that, we were the first to weigh in on the dangers of nuclear power (as in Lester del Rey's 1942 story "Nerves"). And we began the public discourse about the actual effects of nuclear weapons (as in Judith Merril's 1948 story "That Only a Mother," which deals with gene damage caused by radiation). Science fiction is the WikiLeaks of science, getting word to the public about what cutting-edge research really means.

And we come with the credentials to do this work. Many science-fiction writers, such as Gregory Benford, are working scientists; many others, such as Joe Haldeman, have advanced degrees in science; others still, such as myself, have backgrounds in science and technology journalism. Our recent works have tackled such issues as the management of global climate change (as in Kim Stanley Robinson's *Forty Signs of Rain* and its sequels), biological terrorism

(as in Paolo Bacigalupi's *The Windup Girl*), and the privacy of online information and China's attempts to control its citizens' access to the World Wide Web (as in my own *Wake* and its sequels). And although one can't imagine George Lucas being asked to advise the space program, print science-fiction writers often do consulting for government bodies. A group of SF writers called SIGMA frequently advises the US Department of Homeland Security about technology issues, and Stephen Baxter, Allen Steele, and I were recently consulted by DARPA, the US Defense Advanced Research Projects Agency, about future spaceship designs.

Why do they come to us? Because someone needs to openly do the speculation, to weigh the consequences, to consider the ramifications—someone who is immune to economic pressures. And that someone is the science-fiction writer.

Although, as I mentioned, Isaac Asimov is most famous for the Three Laws of Robotics, in 1974 he coined his Three Laws of Futurics, and they define well the science-fiction approach to extrapolation. The Laws of Futurics are:

1. What is happening will continue to happen.
2. Consider the obvious seriously, for few people will see it.
3. Consider the consequences.

However, we science-fiction writers don't just consider the obvious consequences: our job is not to see just the first-order effects, but the second- and third-order effects, as well. Anyone could have predicted the automobile, but only a science-fiction writer would have predicted the traffic jam. Anyone could have predicted the airplane, but only a science-fiction writer would have predicted hijacking, frequent-flyer miles, and airport lounges.

This sort of extrapolation to second- and third-order effects goes right back to the very beginning of the genre. Brian Aldiss, and many other critics, contend that the first science-fiction work was Mary Shelley's 1818 novel *Frankenstein, or the Modern Prometheus.* It explores, in scientific terms, the notion of synthetic life: Dr. Victor Frankenstein studies the chemical breakdown and putrefaction that occurs after death so he can reverse it to animate nonliving matter. Take out his scientific training, and his scientific research, and his scientific theory, and, for the first time in the history of fiction, there's no story left. Like so many other works of SF that followed, Shelley's story is a cautionary tale: it raises profound questions about who should have the right to create living things, and what responsibility the creators should have to their creations and to society.

Think about that: Mary Shelley put these questions on the table almost two centuries ago—41 years before Darwin published *The Origin of Species* and 135 years before Crick and Watson figured out the structure of DNA. Is it any wonder that Alvin Toffler, one of the first futurists, called reading science fiction the only preventive medicine for future shock? (Note *Frankenstein*'s publication date, by the way: 1818. The science-fiction bicentennial is just five years away. I, for one, am going to have a party.)

When people talk about all the things science fiction correctly predicted, they often cite moon landings and submarines (suggested by Jules Verne) or surveillance technology (made famous by George Orwell) or the cell phone (inspired by *Star Trek*'s handheld communicator) or robots (the very name of which comes from a work of science fiction, Karel Capek's 1920 play, *R.U.R.*).

That said, science fiction's job is not to predict *the* future. Rather, it's to propose and explore a smorgasbord of possible futures—so that society can make informed decisions about

where we want to go. George Orwell's science-fiction classic *Nineteen Eighty-Four* wasn't a failure because the future it predicted didn't turn out to be anything like the real year 1984; rather, it was a resounding success because it helped us avoid that fate. As Ray Bradbury famously said, "My job isn't predicting the future; it's *preventing* the future."

Still of all the things science fiction has foretold, I think the most important one is the simple fact that there will *be* a future. From the advent of nuclear weapons (the exact mechanism the secret Manhattan Project had in mind was predicted in such exquisite detail in the science-fiction magazine *Astounding Stories* that the FBI demanded a recall of one of its issues), through the Cold War and the war on terror, to the present day as we stand on the brink of catastrophic climate change, science fiction has always said—and continues to insist—that humankind *does* have a future, a future that stretches far ahead for hundreds, thousands, and even millions of years. This deeply held conviction that the human journey has only just begun is the most important, and the most wondrous, prediction of all.

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