Bruce Sterling

bruces@well.sf.ca.us

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OUTER CYBERSPACE

Dreaming of space-flight, and predicting its future, have always been favorite pastimes of science fiction. In my first science column for F&SF, I can't resist the urge to contribute a bit to this grand tradition.

A science-fiction writer in 1991 has a profound advantage over the genre's pioneers. Nowadays, space-exploration has a past as well as a future. "The conquest of space" can be judged today, not just by dreams, but by a real-life track record.

Some people sincerely believe that humanity's destiny lies in the stars, and that humankind evolved from the primordial slime in order to people the galaxy. These are interesting notions: mystical and powerful ideas with an almost religious appeal. They also smack a little of Marxist historical determinism, which is one reason why the Soviets found them particularly attractive.

Americans can appreciate mystical blue-sky rhetoric as well as anybody, but the philosophical glamor of "storming the cosmos" wasn't enough to motivate an American space program all by itself. Instead, the Space Race was a creation of the Cold War -- its course was firmly set in the late '50s and early '60s. Americans went into

space *because* the Soviets had gone into space, and because the Soviets were using Sputnik and Yuri Gagarin to make a case that their way of life was superior to capitalism.

The Space Race was a symbolic tournament for the newfangled intercontinental rockets whose primary purpose (up to that point) had been as instruments of war. The Space Race was the harmless, symbolic, touch-football version of World War III. For this reason alone: that it did no harm, and helped avert a worse clash -- in my opinion, the Space Race was worth every cent. But the fact that it was a political competition had certain strange implications.

Because of this political aspect, NASA's primary product was never actual "space exploration." Instead, NASA produced public-relations spectaculars. The Apollo project was the premiere example. The astonishing feat of landing men on the moon was a tremendous public-relations achievement, and it pretty much crushed the Soviet opposition, at least as far as "space-racing" went.

On the other hand, like most "spectaculars," Apollo delivered rather little in the way of permanent achievement. There was flag-waving, speeches, and plaque-laying; a lot of wonderful TV coverage; and then the works went into mothballs. We no longer have the capacity to fly human beings to the moon. No one else seems particularly interested in repeating this feat, either; even though the Europeans, Indians, Chinese and Japanese all have their own space programs today. (Even the Arabs, Canadians, Australians and Indonesians have their own satellites now.)

In 1991, NASA remains firmly in the grip of the "Apollo Paradigm." The assumption was (and is) that only large, spectacular missions with human crews aboard can secure political support for NASA, and deliver the necessary funding to support its eleven-billion-dollar-a-year bureaucracy. "No Buck Rogers, no bucks."

The march of science -- the urge to actually find things out about our solar system and our universe -- has never been the driving force for NASA. NASA has been a very political animal; the space-science community has fed on its scraps.

Unfortunately for NASA, a few historical home truths are catching up with the high-tech white-knights.

First and foremost, the Space Race is over. There is no more need for this particular tournament in 1992, because the Soviet opposition is in abject ruins. The Americans won the Cold War. In 1992, everyone in the world knows this. And yet NASA is still running space-race victory laps.

What's worse, the Space Shuttle, one of which blew up in 1986, is clearly a white elephant. The Shuttle is overly complex, over-designed, the creature of bureaucratic decision-making which tried to provide all things for all constituents, and ended-up with an unworkable monster. The Shuttle was grotesquely over-promoted, and it will never fulfill the outrageous promises made for it in the '70s. It's not and never will be a "space truck." It's rather more like a Ming vase.

Space Station Freedom has very similar difficulties. It costs far too much, and is destroying other and more useful possibilities for space activity. Since the Shuttle takes up half NASA's current budget, the Shuttle and the Space Station together will devour most *all* of NASA's budget for *years to come* -- barring unlikely large-scale increases in funding.

Even as a political stage-show, the Space Station is a bad bet, because the Space Station cannot capture the public imagination. Very few people are honestly excited about this prospect. The Soviets *already have* a space station. They've had a space station for years now. Nobody cares about it. It never gets headlines. It inspires not awe but tepid public indifference. Rumor has it that the Soviets (or rather, the *former* Soviets) are willing to sell their "Space Station Peace" to any bidder for eight hundred million dollars, about one fortieth of what "Space Station Freedom" will cost -- and nobody can be bothered to buy it!

Manned space exploration itself has been oversold. Space-flight is simply not like other forms of "exploring." "Exploring" generally implies that you're going to venture out someplace, and tangle hand-to-hand with wonderful stuff you know nothing about. Manned space flight, on the other hand, is one of the most closely regimented of human activities. Most everything that is to happen on a manned space flight is already known far in advance. (Anything not predicted, not carefully calculated beforehand, is very likely to be a lethal catastrophe.)

Reading the personal accounts of astronauts does not reveal much in the way of "adventure" as that idea has been generally understood. On the contrary, the historical and personal record reveals that astronauts are highly trained technicians whose primary motivation is not to "boldly go where no one has gone before," but rather to do *exactly what is necessary* and above all *not to mess up the hardware.*

Astronauts are not like Lewis and Clark. Astronauts are the tiny peak of a vast human pyramid of earth-bound technicians and mission micro-managers. They are kept on a very tight (*necessarily* tight) electronic leash by Ground Control. And they are separated from the environments they explore by a thick chrysalis of space-suits and space vehicles. They don't tackle the challenges of alien environments, hand-to-hand -- instead, they mostly tackle the challenges of their own complex and expensive life-support machinery.

The years of manned space-flight have provided us with the interesting discovery that life in free-fall is not very good for people. People in free-fall lose calcium from their bones -- about half a percent of it per month. Having calcium leach out of one's bones is the same grim phenomenon that causes osteoporosis in the elderly -- "dowager's hump." It makes one's bones brittle. No one knows quite how bad this syndrome can get, since no one has been in orbit much longer than a year; but after a year, the loss of calcium shows no particular sign of slowing down. The human heart shrinks in free-fall, along with a general loss of muscle tone and muscle mass. This loss of muscle, over a period of months in orbit, causes astronauts and cosmonauts to feel generally run-down and feeble.

There are other syndromes as well. Lack of gravity causes blood to pool in the head and upper chest, producing the pumpkin-faced look familiar from Shuttle videos. Eventually, the body reacts to this congestion by reducing the volume of blood. The long-term effects of this are poorly understood. About this time, red blood cell production falls off in the bone marrow. Those red blood cells which are produced in free-fall tend to be interestingly malformed.

And then, of course, there's the radiation hazard. No one in space has been severely nuked yet, but if a solar flare caught a crew in deep space, the results could be lethal.

These are not insurmountable medical challenges, but they *are* real problems in real-life space experience. Actually, it's rather surprising that an organism that evolved for billions of years in gravity can survive *at all* in free-fall. It's a tribute to human strength and plasticity that we can survive and thrive for quite a while without any gravity. However, we now know what it would be like to settle in space for long periods. It's neither easy nor pleasant.

And yet, NASA is still committed to putting people in space. They're not quite sure why people should go there, nor what people will do in space once they're there, but they are bound and determined to do this despite all obstacles.

If there were big money to be made from settling people in space, that would be a different prospect. A commercial career in free-fall would probably be safer, happier, and more rewarding than, say, bomb-disposal, or test-pilot work, or maybe even coal-mining. But the only real moneymaker in space commerce (to date, at least) is the communications satellite industry. The comsat industry wants nothing to do with people in orbit.

Consider this: it costs $200 million to make one shuttle flight. For $200 million you can start your own communications satellite business, just like GE, AT&T, GTE and Hughes Aircraft. You can join the global Intelsat consortium and make a hefty 14% regulated profit in the telecommunications business, year after year. You can do quite well by "space commerce," thank you very much, and thousands of people thrive today by commercializing space. But the Space Shuttle, with humans aboard, costs $30 million a day! There's nothing you can make or do on the Shuttle that will remotely repay that investment. After years of Shuttle flights, there is still not one single serious commercial industry anywhere whose business it is to rent workspace or make products or services on the Shuttle.

The era of manned spectaculars is visibly dying by inches. It's interesting to note that a quarter of the top and middle management of NASA, the heroes of Apollo and its stalwarts of tradition, are currently eligible for retirement. By the turn of the century, more than three-quarters of the old guard will be gone.

This grim and rather cynical recital may seem a dismal prospect for space enthusiasts, but the situation's not actually all that dismal at all. In the meantime, unmanned space development has quietly

continued apace. It's a little known fact that America's *military* space budget today is *twice the size* of NASA's entire budget! This is the poorly publicized, hush-hush, national security budget for militarily vital technologies like America's "national technical means of verification," i.e. spy satellites. And then there are military navigational aids like Navstar, a relatively obscure but very impressive national asset. The much-promoted Strategic Defence Initiative is a Cold War boondoggle, and SDI is almost surely not long for this world, in either budgets or rhetoric -- but both Navstar and spy satellites have very promising futures, in and/or out of the military. They promise and deliver solid and useful achievements, and are in no danger of being abandoned.

And communications satellites have come a very long way since Telstar; the Intelsat 6 model, for instance, can carry thirty thousand simultaneous phone calls plus three channels of cable television. There is enormous room for technical improvement in comsat technologies; they have a well-established market, much pent-up demand, and are likely to improve drastically in the future. (The satellite launch business is no longer a superpower monopoly; comsats are being launched by Chinese and Europeans. Newly independent Kazakhstan, home of the Soviet launching facilities at Baikonur, is anxious to enter the business.)

Weather satellites have proven vital to public safety and commercial prosperity. NASA or no NASA, money will be found to keep weather satellites in orbit and improve them technically -- not for reasons of national prestige or flag-waving status, but because it makes a lot of common sense and it really pays.

But a look at the budget decisions for 1992 shows that the Apollo Paradigm still rules at NASA. NASA is still utterly determined to put human beings in space, and actual space science gravely suffers for this decision. Planetary exploration, life science missions, and astronomical surveys (all unmanned) have been cancelled, or curtailed, or delayed in the1992 budget. All this, in the hope of continuing the big-ticket manned 50-billion-dollar Space Shuttle, and of building the manned 30-billion-dollar Space Station Freedom.

The dire list of NASA's sacrifices for 1992 includes an asteroid probe; an advanced x-ray astronomy facility; a space infrared telescope; and an orbital unmanned solar laboratory. We would have learned a very great deal from these projects (assuming that they

would have actually worked). The Shuttle and the Station, in stark contrast, will show us very little that we haven't already seen.

There is nothing inevitable about these decisions, about this strategy. With imagination, with a change of emphasis, the exploration of space could take a very different course.

In 1951, when writing his seminal non-fiction work THE EXPLORATION OF SPACE, Arthur C. Clarke created a fine imaginative scenario of unmanned spaceflight.

"Let us imagine that such a vehicle is circling Mars," Clarke speculated. "Under the guidance of a tiny yet extremely complex electronic brain, the missile is now surveying the planet at close quarters. A camera is photographing the landscape below, and the resulting pictures are being transmitted to the distant Earth along a narrow radio beam. It is unlikely that true television will be possible, with an apparatus as small as this, over such ranges. The best that could be expected is that still pictures could be transmitted at intervals of a few minutes, which would be quite adequate for most purposes."

This is probably as close as a science fiction writer can come to true prescience. It's astonishingly close to the true-life facts of the early Mars probes. Mr. Clarke well understood the principles and possibilities of interplanetary rocketry, but like the rest of mankind in 1951, he somewhat underestimated the long-term potentials of that "tiny but extremely complex electronic brain" -- as well as that of "true television." In the 1990s, the technologies of rocketry have effectively stalled; but the technologies of "electronic brains" and electronic media are exploding exponentially.

Advances in computers and communications now make it possible to speculate on the future of "space exploration" along entirely novel lines. Let us now imagine that Mars is under thorough exploration, sometime in the first quarter of the twenty-first century. However, there is no "Martian colony." There are no three-stage rockets, no pressure-domes, no tractor-trailers, no human settlers.

Instead, there are hundreds of insect-sized robots, every one of them equipped not merely with "true television," but something much more advanced. They are equipped for *telepresence.* A human operator can see what they see, hear what they hear, even guide them about at will (granted, of course, that there is a steep transmission

lag). These micro-rovers, crammed with cheap microchips and laser photo-optics, are so exquisitely monitored that one can actually *feel* the Martian grit beneath their little scuttling claws. Piloting one of these babies down the Valles Marineris, or perhaps some unknown cranny of the Moon -- now *that* really feels like "exploration." If they were cheap enough, you could dune-buggy them.

No one lives in space stations, in this scenario. Instead, our entire solar system is saturated with cheap monitoring devices. There are no "rockets" any more. Most of these robot surrogates weigh less than a kilogram. They are fired into orbit by small rail-guns mounted on high-flying aircraft. Or perhaps they're launched by laser-ignition: ground-based heat-beams that focus on small reaction-chambers and provide their thrust. They might even be literally shot into orbit by Jules Vernian "space guns" that use the intriguing, dirt-cheap technology of Gerald Bull's Iraqi "super-cannon." This wacky but promising technique would be utterly impractical for launching human beings, since the acceleration g-load would shatter every bone in their bodies; but these little machines are *tough.*

And small robots have many other advantages. Unlike manned craft, robots can go into harm's way: into Jupiter's radiation belts, or into the shrapnel-heavy rings of Saturn, or onto the acid-bitten smoldering surface of Venus. They stay on their missions, operational, not for mere days or weeks, but for decades. They are extensions, not of human population, but of human senses.

And because they are small and numerous, they should be cheap. The entire point of this scenario is to create a new kind of space-probe that is cheap, small, disposable, and numerous: as cheap and disposable as their parent technologies, microchips and video, while taking advantage of new materials like carbon-fiber, fiber-optics, ceramic, and artificial diamond.

The core idea of this particular vision is "fast, cheap, and out of control." Instead of gigantic, costly, ultra-high-tech, one-shot efforts like NASA's Hubble Telescope (crippled by bad optics) or NASA's Galileo (currently crippled by a flaw in its communications antenna) these micro-rovers are cheap, and legion, and everywhere. They get crippled every day; but it doesn't matter much; there are hundreds more, and no one's life is at stake. People, even quite ordinary people, *rent time on them* in much the same way that you would pay for satellite cable-TV service. If you want to know what Neptune looks

like today, you just call up a data center and *have a look for yourself.*

This is a concept that would truly involve "the public" in space exploration, rather than the necessarily tiny elite of astronauts. This is a potential benefit that we might derive from abandoning the expensive practice of launching actual human bodies into space. We might find a useful analogy in the computer revolution: "mainframe" space exploration, run by a NASA elite in labcoats, is replaced by a "personal" space exploration run by grad students and even hobbyists.

In this scenario, "space exploration" becomes similar to other digitized, computer-assisted media environments: scientific visualization, computer graphics, virtual reality, telepresence. The solar system is saturated, not by people, but by *media coverage. Outer space becomes *outer cyberspace.*

Whether this scenario is "realistic" isn't clear as yet. It's just a science-fictional dream, a vision for the exploration of space: *circumsolar telepresence.* As always, much depends on circumstance, lucky accidents, and imponderables like political will. What does seem clear, however, is that NASA's own current plans are terribly far-fetched: they have outlived all contact with the political, economic, social and even technical realities of the 1990s. There is no longer any real point in shipping human beings into space in order to wave flags.

"Exploring space" is not an "unrealistic" idea. That much, at least, has already been proven. The struggle now is over why and how and to what end. True, "exploring space" is not as "important" as was the life-and-death Space Race struggle for Cold War pre-eminence. Space science cannot realistically expect to command the huge sums that NASA commanded in the service of American political prestige. That era is simply gone; it's history now.

However: astronomy does count. There is a very deep and genuine interest in these topics. An interest in the stars and planets is not a fluke, it's not freakish. Astronomy is the most ancient of human sciences. It's deeply rooted in the human psyche, has great historical continuity, and is spread all over the world. It has its own constituency, and if its plans were modest and workable, and played to visible strengths, they might well succeed brilliantly.

The world doesn't actually need NASA's billions to learn about our solar system. Real, honest-to-goodness "space exploration" never got more than a fraction of NASA's budget in the first place.

Projects of this sort would no longer be created by gigantic federal military-industrial bureaucracies. Micro-rover projects could be carried out by universities, astronomy departments, and small-scale research consortia. It would play from the impressive strengths of the thriving communications and computer tech of the nineties, rather than the dying, centralized, militarized, politicized rocket-tech of the sixties.

The task at hand is to create a change in the climate of opinion about the true potentials of "space exploration." Space exploration, like the rest of us, grew up in the Cold War; like the rest of us, it must now find a new way to live. And, as history has proven, science fiction has a very real and influential role in space exploration. History shows that true space exploration is not about budgets. It's about vision. At its heart it has always been about vision.

Let's create the vision.