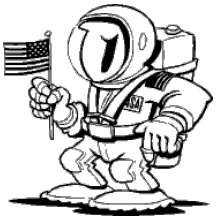
## OMNI Magazine, Space Age Misconceptions



Once upon a time, people didn't know much about spaceflight. The mysteries of the 'Space Race' were left to "rocket scientists" and TV commentators. Crazy ideas abounded: Some people thought the moon landing was faked; some thought rockets burned bales of thousand-dollar bills; some thought Soviet A-bombs circled overhead; some thought the space industry would cure cancer and produce perfect ball bearings for unmatchable engines.

A generation later, people know a great deal about spaceflight. But curiously, I've found no reduction in crazy common ideas. Visitors to the NASA center in Houston (where I work) want to know where the zero-G room and the launch pads are, and other people still think manned rockets take off from Cape Canaveral. People think there's no gravity in space, or that air friction causes the flames seen during atmospheric entry, or that human bodies exposed to a vacuum blow up and burst like balloons.

It turns out that while the public now does indeed know a lot more about space flight, much of what it knows is wrong. Before, there were vast reaches of innocent ignorance about space. But now, the field of public knowledge is cluttered with misconceptions, myths, and misinformation. From my vantage point as a space popularizer and a friend of many NASA tour guides, public opinion is molded -- and national space-policy decisions made -- by superficial impressions gained from oversimplified headlines, newscast sound bites, decades-old faulty analogies, and science-fiction script writers and producers.

As the old Appalachian Mountains proverb goes, "*it ain't what you don't know that makes you look like a fool; it's what you do know that ain't so*." Sadly, the out-of-this-world subject of spaceflight provides continuing proof of this warning's wisdom.

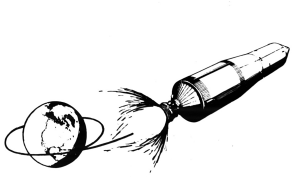
On national television a few years ago, I referred to this wise proverb to discreetly call a U.S. congressman a fool. He spouted nonsense about an endangered Soviet manned space mission that bore so little relation to the truth that it would have taken me several minute's to unravel it all. The Soviet capsule was crashing to Earth, he was certain. A retired general sitting next to him agreed: "They're dead men," he intoned gravely.

But there was no real cause for alarm, as any spaceflight expert could have told them. "They've got tricks they haven't yet had to try," I reassured the audience, explaining what had gone wrong and the cautious way the cosmonauts seemed to be working their way out of their predicament. "I'd bet the farm they'll be safely back on Earth in the next two hours." And they were.

Plenty of "obvious" spaceflight misperceptions can lead to more than humor -- they can lead to bad decisions. Two examples from the New York Times -- one, 73 years ago; the other, last year--show how little real progress has been made.

On January 13, 1920, an anonymous editorial-page writer mocked Robert Goddard for suggesting that a rocket could someday reach the moon. "That Professor Goddard, with his 'chair' in Clark College, and the countenancing of the Smithsonian Institution, does not know the relation of action to reaction and of the need to have something better than a vacuum against which to react -- to say that would be absurd. Of course, he only seems to lack the knowledge ladled out daily in high schools. The Times went on to cite "the same mistake" in Jules Verne's description of firing a rocket to adjust the course of a manned moonship: "The Frenchman, having got his travelers to the moon in a desperate fix of riding a satellite of a satellite, saved them from circling it forever by means of an explosion, rocket fashion, where it would not have had in the slightest degree the effect of releasing them from their dreadful slavery." Such ignorant criticisms of Goddard's work scared off many supporters for ten years until Charles Lindbergh courageously laid his own prestige on the line to boost Goddard's.

Almost 50 years later, after two manned lunar expeditions had already used a pure Vernesian rocket maneuver to escape from lunar orbit and return to Earth, the Apollo 11 moon-landing expedition was launched. In a special section of the newspaper, the Times printed a small box titled "A Correction." In it, the original Goddard criticism was quoted and retracted: "Further investigation and experimentation have



confirmed Isaac Newton in the seventeenth century and it is now definitely established that a rocket can function in a vacuum as well as in the atmosphere. The Times regrets the error."

We should avoid smug feelings of modern self-righteousness, however, while contemporary misconceptions about space physics continue to appear on the newspaper's editorial page (and, of course, elsewhere). In 1992, a commentary on the NASA plan for a permanent space station did allow that there might be one advantage, owing to the absence of gravity on a space station.

The myth that satellites remain in orbit because they have "escaped Earth's gravity" is perpetuated further (and falsely) by almost universal use of the zingy but physically nonsensical phrase "zero gravity" (and its techweenie cousin, "microgravity") to describe the free-falling conditions aboard orbiting space vehicles. Of course, this isn't true; gravity still exists in space. It keeps satellites from flying straight off into interstellar emptiness. What's missing is "weight," the resistance of gravitational attraction by an anchored structure or a counterforce. Satellites stay in space because of their tremendous horizontal speed, which allows them -- while being unavoidably pulled toward Earth by gravity -- to fall "over the horizon." The ground's curved withdrawal along the Earth's round surface offsets the satellites' fall toward the ground. Speed, not position or lack of gravity, keeps satellites up, and the failure to understand this fundamental concept means that many other things people "know" just ain't so.

No-gravity myth #1: One terrifying but dying myth is that satellites with nuclear weapons or spy cameras can hover over particular ground targets such as Washington, DC. That's easy if there's no gravity in space, but it's impossible in the real world except at a precise distance over the equator (the so-called geostationary orbits).

No-gravity myth #2: For those fascinated by the possibilities of "war in space, Earthside analogies have been stretched beyond the breaking point. The oft-repeated idea of "shooting down a satellite" falls into that category because a satellite struck by a weapon would retain its speed and hence would stay in orbit, dead or alive, whole or in pieces.

No-gravity myth #3: If the notorious clouds of "space junk" stay up there because the fragments float around aimlessly, why can't we send up a shuttle or two and pick up all the trash as it goes by? But when you realize that each piece of junk flies through space at tremendous speeds in different locations and directions, the "obvious solution" evaporates.

No-gravity myth #4: Another tipoff that someone possesses an inadequate understanding of space physics is if they ever use the phrase "falling into the sun." For example, some people seem to believe that if nuclear waste can be thrown across the nonexistent "gravity boundary" between the earth and outer space, it will fall harmlessly into the sun. While disposing of dangerous wastes in space is not entirely a hare brained scheme, serious analysts realize that all probes launched away from Earth enter orbit around the sun with the earth's own forward speed, which is more than adequate to prevent them from falling into the sun. It's far easier to push the junk outward to interstellar space 3.7 billion miles away (if you're patient) than to push it into the sun 93 million miles away.

**Out to Launch**

Ask anyone today where Columbus or the Mayflower sailed from, and the likely answer is that they don't know and it's not important anyway, because their destination held greater significance. But ask anyone where the Apollo expeditions took off or from where the current space shuttle missions are launched, and the answer with equal consistency will be Cape Canaveral. People should stick to the sailing-ships answer, because for manned spaceships, Cape Canaveral is wrong.

"Maybe people are fooled because the pads are so near the beach," suggests a NASA press official. "But the shuttle pads are on an island mostly separated from Cape Canaveral by the Banana River." As clearly shown on all official NASA documents and standard topographic charts, the pads lie inside the Kennedy Space Center on Merritt Island, located to the north and west of a long, sandy island that for more

than 400 years (except 1963 to 1973, when it was "Cape Kennedy") has been called "Cape Canaveral. "The first space shots really were from the Cape, explains an old-time newsman who has retired to nearby Cocoa Beach, "so people just got into the habit." But since the last manned spaceflight from Cape Canaveral was 30 years ago, more than mere force of habit must be at work. To say "the Cape" conjures up far more idyllic visions of space adventure than does the sterile acronym "KSC" or "Merritt Island. Right or wrong, it sounds good, and there seems to be no harm in "knowing" what, in this case, "ain't so.

At least there's no intentional fraud here. The Soviets deliberately created their own geographic confusion, trying to conceal the location of their manned space center. By 1957, CIA spy planes had spotted the pad near the Central Asian railway station of Tyura-Tam, which CIA analysts proceeded to misspell forever after as "Tyuratam." In 1961, the Soviets, in a vain attempt at ex post facto geographic disinformation, named their launch site "Baikonur," which was itself a clumsy transliteration of Baikonyr, a small mining village hundreds of miles from the space base. When Kazakhstan became autonomous in 1991 and took nominal sovereignty over the spaceport, its leaders began referring to it as "Baikonyr." Perhaps someday the Russians can drop the now- admitted fraud once and for all and name the space base for the man who founded it, Sergei Korolev; then all the world's maps could carry a single -- and honorable -- designation.


**Blow Up**

Special-effects wizards love space vacuum scenes. In Total Recall (set on Mars) and a dozen other Hollywood space westerns, movie makers take the standard gory approach of painfully puffing torsos and grapelike bursting eyeballs to show what happens to a human thrown out into open space. Such an imaginary fate is enough, wrote veteran spacewalker Michael Collins in his lyrical autobiography Carrying the Fire, to make a spaceman think long, encouraging thoughts about "the little old ladies and their gluepots" who assemble each NASA spacesuit by hand.

But one Hollywood director, Stanley Kubrick, was much more accurate about this (and so much else) in his 1968 cult classic, 2001: A Space Odyssey. Deep-space voyager Bowman outwits the psychotic autopilot HAL by jumping into an open airlock without his helmet and then boarding the ship to lobotomize the mutinous microchip. Actually, author Arthur C. Clarke got it right first, back in the 1950s: He knew that the physical toughness of the human body allows it to resist deformation even in a full vacuum. A human will suffocate and double over in pain from the bends -- and lapse into unconsciousness in just seven seconds -- but at least the eyeballs won't pop out. "What you should expect is to fart a lot," notes a space-medicine expert at Cape Canaveral.

In a spaceflight tragedy in 1971, three Soviet cosmonauts went to vacuum in shirt sleeves during an accidental depressurization during their return to Earth. Recently released top-secret Soviet space films show them receiving emergency resuscitation after landing. They had gone without air too long -- about 30 minutes -- to be revived, but their bodies were not physically deformed by the exposure to vacuum.

**Running Out of Oxygen**

Being trapped in space is a science-fiction nightmare, and on a few occasions, it has been a real-life spaceflight threat. In 1988, a Soviet crew had to remain in space for an extra day when control problems confused its onboard computer. (This, by the way, was the occasion of my confrontation with the misinformed congressman mentioned earlier -- he's now Senator Torricelli) And, in 1990, two Soviet spacewalkers found their main airlock hatch too damaged to close properly; they later used a backup hatch. To enhance the drama of their 30-second narratives, the news media usually breathlessly describes the impending death of the crew members when "their oxygen runs out." But in reality, nobody trapped in space will die from lack of oxygen. They may die, but there will be plenty of oxygen left in their cabins or spacesuits when they do.

What can kill a person in a spacecraft (or a locked room on Earth) is not the oxygen running out but the exhaled carbon dioxide building up. After a while, the body can't expel any more waste gas into the air

through the lungs, because the air breathed into the lungs from outside contains too much carbon dioxide already. Ultimately, the waste-saturated blood becomes poisonous to the body and kills it. But while this occurs, there will be plenty of breathable oxygen left in the room, although it will be poisoned by high levels of carbon dioxide.

**Burn, Spaceship, Burn!**

How many times have we heard about how spacecraft turn into blazing fireballs when they reenter the atmosphere due to "the heat of friction."? True, spaceships hit the upper atmosphere at Mach 25, and there are flames. But if the friction of air rushing across the spacecraft's skin really causes those flames, then how could the space shuttle's fragile protective tiles, which even a fingernail or a raindrop can damage and which come off with small hand tools, survive such a hypersonic blast without wearing or tearing away?

It turns out that the friction of air rubbing against spaceship skin (the boundary layer) has little to do with the fireball. Rather, compression mostly creates the heat as the thin air is squeezed in the shock layer ahead of the onrushing spacecraft. The air can't get out of the way fast enough, like snow in front of a plow, so it piles up.

Heating from air compression is familiar to anyone who's ever blown up an air mattress or a tire and felt the warmth with their hand, but it occurs on a much greater scale with spaceflight. The compressed, lower-speed, superheated air forms a mass of glowing plasma a meter or so in front of the descending spacecraft, and the air then moves through the shock layer to the boundary layer, transmitting heat to the spacecraft's surface by direct physical conduction. That's why the glass-fiber insulation of the tiles works so well: It transports heat very slowly along the fibers, and it radiates much of it back out into space. Meanwhile, the air that's in contact with the tiles moves across them much more slowly than the speed at which the spacecraft itself rushes through the atmosphere.

Where did this misconception come from? It's an old concept handed down by newsmen and writers from generation to generation. Frictional heating actually did cause great concern back in the 1950s when streamlined supersonic rocket planes pushed to the Mach 3, 4, or 5 speeds. The planes' designers did all they could to minimize drag so a rocket plane's engine could accelerate it to higher speeds despite the air holding it back. The passing air did indeed rush across the skin's surface, forming a physical phenomenon called the boundary layer, in which air friction caused dangerous heating of the plane's skin. The aircraft needed special protection to keep the skin from burning off, and the same still applies for rocket-plane designs today.

But as soon as flights to space and back started, the object of aerodynamic design changed, and so did spacecraft shapes. The designers no longer had to figure out how to speed up the craft more efficiently during thrusting, but instead, how to slow down with the least heating of the surface. Engineers worked to minimize the heating of falling space vehicles through the use of blunt shapes. This, in turn, created the shock layer, the compressional heating, and the famous flames.

**The Impact of Space Myth-takes**

For visitors coming to NASA's Houston center in search of the fabled "zero- gravity room" used for training astronauts, the shock of reality can be harsh. When they're told that it doesn't exist, they sometimes argue with the guides. "We've seen it on television, some insist, confusing half-remembered images of the Boeing 707 zero-G airplane (nicknamed the "Vomit Comet" for what its midair gymnastics do to passengers' stomachs) and the pool where astronauts get accustomed to moving around in their spacesuits. Most accept the guides' explanations grudgingly, but others refuse to disbelieve the myths. One U.S. UFO lecturer even tours the country describing his visit to the zero-G chamber, now classified, he says, "above top secret."

These kinds of misconceptions are amusing and mostly harmless because they don't have far-reaching impacts. Much more serious is the profusion of mythical knowledge among politicians and government officials. These people often attempt to base plans for the third millennium on eighteenth-century stereotypes, analogies, and paradigms. The resulting decisions don't work because they don't recognize the realities of spaceflight.

To comprehend the nation's options for the doctrines, strategies, and tactics for the future, this sadly astronomical gap between what people "know" and what is must be narrowed. Otherwise, the people who look foolish in the eyes of future generations won't be just the mistaken ones; they'll be all of us.