How Much Is an Astronaut's Life Worth?

Robert Zubrin | Jan. 26, 2012 10:30 am

If we could put a man on the Moon, why can't we put a man on the Moon?

Starting with near zero space capability in 1961, the National Aeronautics and Space Administration (NASA) put men on our companion world in eight years. Yet despite vastly superior technology and hundreds of billions of dollars in subsequent spending, the agency has been unable to send anyone else farther than low Earth orbit ever since.

Why? Because we insist that our astronauts be as safe as possible.

Keeping astronauts safe merits significant expenditure. But how much? There is a potentially unlimited set of testing procedures, precursor missions, technological improvements, and other protective measures that could be implemented before allowing human beings to once again try flying to other worlds. Were we to adopt all of them, we would wind up with a human spaceflight program of infinite cost and zero accomplishment. In recent years, the trend has moved in precisely that direction, with NASA's manned spaceflight effort spending more and more to accomplish less and less. If we are to achieve anything going forward, we have to find some way to strike a balance between human life and mission accomplishment.

What we need is a quantitative criterion to assess what constitutes a rational expenditure to avert astronaut risk. In plain English, we need to answer a basic question: How much is an astronaut's life worth?

The Worth of an Astronaut

The life of an astronaut is intrinsically precious, but no more so than that of anyone else. Let's

therefore consider how much other government programs spend to save people's lives. Based on data from hundreds of programs, policy analyst John D. Graham and his colleagues at the Harvard Center for Risk Analysis found in 1997 that the median cost for lifesaving expenditures and regulations by the U.S. government in the health care, residential, transportation, and occupational areas ranges from about $1 million to $3 million spent per life saved in today's dollars. The only marked exception to this pattern occurs in the area of environmental health protection (such as the Superfund program) which costs about $200 million per life saved.

Graham and his colleagues call the latter kind of inefficiency "statistical murder," since thousands of additional lives could be saved each year if the money were used more cost-effectively. To avoid such deadly waste, the Department of Transportation has a policy of rejecting any proposed safety expenditure that costs more than $3 million per life saved. That ceiling therefore may be taken as a high-end estimate for the value of an American's life as defined by the U.S. government.

But astronauts are not just anyone. They are highly trained personnel in whom the government has invested tens of millions of dollars (the exact figure varies from astronaut to astronaut). Some, such as former fighter pilots, have received much more training than others. Let us therefore err on the high side and assign a value of $50 million per astronaut, including intrinsic worth and training.

Looking at the matter this way can provide some useful guidance for weighing risk against expenditure in the human spaceflight program. The issue is well illustrated by the case of the Hubble Space Telescope.

The Hubble Deserters

In January 2004, Sean O'Keefe, then NASA's administrator, announced that he was canceling the agency's planned space shuttle mission to save, repair, and upgrade the Hubble Space Telescope, thereby sentencing the Hubble to death by equipment failure and eventual total destruction upon re-entry into the Earth's atmosphere due to orbital decay. According to O'Keefe, the February 2003 explosion of the space shuttle *Columbia* showed how risky such telescope-maintenance flights were. As a responsible government official, he said, he could not authorize such a perilous venture.

The Hubble Space Telescope is a unique astronomical observatory that has made world-historic

contributions to science, discovering, among other things, that the universe's expansion is accelerating, indicating the existence of a previously unsuspected fundamental physical force. It also represents a cash investment of about $5 billion by American taxpayers.

To be conservative, let us assume that all the safety improvements undertaken after the *Columbia* accident accomplished absolutely nothing, so that the space shuttle's reliability rate was still just the 98 percent demonstrated up until that time (123 successful flights out of 125). Based on the $50-million-per-astronaut value we arrived at above, the seven-person crew of the shuttle can be assigned a value of $350 million, to which we'll add the replacement cost of the shuttle orbiter itself, around $3 billion. Proceeding with the mission—which would have extended Hubble's life for another decade, yielding incalculable scientific knowledge—therefore would have posed a 2 percent risk of losing $3.35 billion, which implies a probabilistic loss of $67 million. Comparing that $67 million risk or insurance cost to Hubble's $5 billion value, we can see that O'Keefe's argument for abandoning Hubble was completely irrational.

Imagine that the captain of a $5 billion aircraft carrier let his ship sink rather than allow seven volunteers to attempt a repair, on the grounds that the odds favoring their survival were only 50 to 1. Such an officer would be court-martialed and regarded with universal contempt both by his brother officers and by society at large.

The attempted Hubble desertion demonstrates how a refusal to accept human risk has led to irresponsible conduct on the part of NASA's leadership. The affair was such a wild dereliction of duty, in fact, that O'Keefe was eventually forced out and the shuttle mission completed by his replacement. But in its broad approach to human space exploration, NASA has been generally—if not so obviously—feckless.

Put simply, when the agency takes some $4 billion in taxpayer money per year to fly humans into space, it really has to fly them there and put them to good use. That amount of money, if spent on ground-based life-saving efforts such as childhood vaccinations, swimming lessons, fire escape inspections, highway repairs, body armor for the troops, save (at the government average of $2 million per life) roughly 2,000 lives. This is the sacrifice that the nation makes so NASA can run a human spaceflight program. In the face of such sacrifice, real results are required.

The Long Way to Mars

Mars is key to humanity's future in space. It is the closest planet that has the resources needed to

support life and technological civilization. Its complexity uniquely demands the skills of human explorers, who will pave the way for human settlers. It is therefore the proper destination for NASA's human spaceflight program, and the agency has publicly embraced it as such. But according to NASA, before the agency attempts such a mission, it must minimize the risk by conducting a variety of preparatory programs, including the now-ended shuttle program, the continuing space station program, a variety of robotic probes, a set of near-Earth asteroid expeditions, the construction of a lunar base, missions to the Martian moons, and an assortment of allegedly valuable orbital infrastructure projects and advanced propulsion systems.

Discounting the probes, which don't cost much and actually are quite useful, the rest of this agenda comes with a price tag on the order of $500 billion and a delay in mission accomplishment by half a century. NASA's Apollo-era leadership wanted to send men to Mars by 1981. Their plan was canned in favor of the space shuttle, the space station, and an extended program of learning how to live and work in low Earth orbit before we venture further.

It would have been unquestionably risky to attempt a Mars mission in the 1980s, just as it was to reach for the Moon in the 1960s. But even if we ignore the fact that the multi-decade preparatory exercise adopted as an alternative to real space exploration has already cost the lives of 14 astronauts, and will almost certainly cost more as it drags on, the question must be asked: How rational is it to spend such huge sums to marginally reduce risk to the crew of the perpetually deferred *Mars I*?

Let's do the math. It's true that nearly anything we do in space will provide experience that will reduce risk to subsequent missions, but by how much? Suppose that by doing one of the aforementioned intermediate activities—say, running the space station program for another 10 years—we can increase the probability that the first expedition to Mars will succeed from 90 percent to 95 percent. Assume that the extended space station program costs $50 billion, that we disregard its own risk, and that the crew of the first Mars mission consists of five people. Cutting the risk to five people by 5 percent each is equivalent to saving 25 percent of one human life. At a cost of $50 billion, that would work out to $200 billion per life saved, a humanitarian effort 100,000 times less efficient than the average achieved by the Department of Transportation. Meanwhile, the space station program would entail considerable risk of its own, while tacking on an additional decade of delay in achievement of the primary mission. Such an approach makes no sense.

The Mission Comes First

The contrast between NASA's current attitude toward risk and that of earlier explorers is stark. Neither Columbus nor Lewis and Clark would have imagined demanding 99.999 percent safety assurances as a precondition for their expeditions. Under such a standard, no human voyages of exploration would ever have been attempted. For those courageous souls who sought and found the paths that took our species from its ancestral home in the Kenyan Rift Valley to every continent and clime of the globe, it was enough that the game was worth the candle and that they had a fighting chance to win.

During its Apollo days, NASA had a similar attitude because *Apollo was mission driven*. It was called into being by John F. Kennedy, a former torpedo boat commander, and the men who flew it—the younger brothers of those who had stormed beaches and machine gun nests to liberate Europe and Asia—were quite prepared to put their necks on the line to further the cause and expand the frontiers of freedom. It's when the space program lacks a mission that it cannot bear risk. Instead, it (and we) can only recoil in horror at the spectacle of the *Columbia* crew—which included Israeli Col. Ilan Ramon, the pilot who led the daring raid that destroyed Saddam Hussein's Osirak nuclear bomb factory—dying on a flight devoted to ant farms, recycled-urine-based finger paints, and other science fair experiments.

Should a true private entrepreneurial space sector emerge, its captains may take the same heroic stance as the great explorers did during the Age of Discovery, whose bold quests for gold, glory, and God gave so much to a sometimes ungrateful posterity. But speaking realistically, while SpaceX and its competitors may substantially reduce the costs of NASA's exploration program, they remain vendors to that program. NASA supplies the funds and therefore calls the shots. This situation makes the question of risk a matter of public policy.

So, am I saying that we should just bull ahead, regardless of the risk? No. What I am saying is that in space exploration, the top priority must not be human safety, but mission success. These sound like the same thing, but they are not. Let me explain the difference by means of an example.

Imagine you are the manager of a Mars robotic-rover program. You have a fixed budget and two options for how to spend it. The first option is to spend half the money on development and testing, the rest on manufacturing and flight operations. If you take this choice, you get two rovers, each with a 90 percent chance of success. The other option is to spend three-quarters of the budget on development and testing, leaving a quarter for the actual mission. If you do it this way, you get just one rover, but it has a success probability of 95 percent. Which option should

you choose?

The right answer is to go for two rovers, because if you do it that way, you will have a 99 percent probability of succeeding with at least one of the vehicles and an 81 percent probability of getting two successful rovers—an outcome that is not even possible with the other approach. This being a robotic mission, with no lives at stake, that's all clear enough. But if we were talking about a human mission, what would the right choice be? The correct answer would be the same, because with tens of billions of dollars that could be used instead to meet all kinds of other pressing human needs, the first obligation must be to get the job done.

Of course, if the choice were between two missions that each had just a 10 percent success probability and one with a 90 percent chance, the correct answer would be different. The point is that there is a methodology, well established in other fields, that can help assess the rationality of risk reduction expenditures in the human spaceflight program. If NASA disagrees with the suggested assignment of $50 million for the life of an astronaut, it should come up with its own figure, substantiate it, and then subject its proposed plan of action to a quantitative cost-benefit analysis based on that assessment. But it needs to be a finite number, ~~for~~ to set an infinite value on the life of an astronaut is to set both the goals of the space exploration effort and the needs of the rest of humanity at naught.

This may seem like a harsh approach. But the many billions being spent on the human spaceflight program are not being spent for the safety of the astronauts; they could stay safe if they stayed home. The money is being spent to open the space frontier. Human spaceflight vehicles are not amusement park rides. They are daring ships of exploration that need to sail in harm's way if they are to accomplish a mission critical to the human future. That mission needs to come first.

Robert Zubrin is president of Pioneer Astronautics and of the Mars Society. An updated edition of his book The Case for Mars: The Plan to Settle the Red Planet and Why We Must has just been published by The Free Press.