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The Mars Decision

Robert Zubrin

There was a bittersweet quality to the recent celebrations of the fiftieth anniversary of the first lunar landing. It was an occasion of justifiable American pride—after all, sending men to the Moon in the late 1960s and early 1970s was not only a feat of human ingenuity and daring but a spectacular national accomplishment, one that, as Jules Verne had sagely predicted a century earlier, only Americans could pull off. But in the half-century since Apollo 11, NASA's human spaceflight program has stagnated. It has had very few memorable successes and certainly performed no comparably glorious feats.

Why not? At the time of the Moon landing, it was generally expected that the United States would quickly go on to Mars. Even several of the Apollo astronauts believed, as they described in their memoirs, that after going to the Moon they might help the United States reach the Red Planet. Apollo 11 astronaut Michael Collins recalled thinking "perhaps I could help them [NASA] plan" a Mars mission. Edgar Mitchell, the sixth man on the Moon, remembered feeling that "it wasn't unreasonable to hope" he'd be assigned to a Mars-bound crew. Gene Cernan, the twelfth and last man on the Moon, recounted with sadness the time that he "finally faced the facts: 'I'm not going to Mars.'"

Many explanations have been offered over the years for why American astronauts have not been sent on to Mars—or anywhere else of note—in the years since Apollo. Three explanations in particular stand out for being widely believed. Each of these explanations is intuitively plausible. Each has a kernel of truth. But these explanations are so incomplete as to be misleading. And taken together, they amount to a profound misunderstanding of how democratic peoples can do great things.

First: popular opinion. It is often argued that American progress in space stalled because of waning public interest. If only (or so the thinking goes) the American people had continued to care about and support NASA as heartily as they had during the 1960s, the space program's record of achievement would have continued unabated.

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While this claim does have an obvious basis in fact—of course politicians would be eager to send American astronauts to Mars if voters were clamoring for that, and of course a Mars program would suffer if overwhelmingly opposed by the public—there are two glaring problems with it. It overstates the degree of popular support for the space program in the 1960s; an analysis by historian Roger Launius found that Project Apollo in particular and lunar exploration in general almost never enjoyed majority support in contemporary polls. More importantly, the notion that strong popular support is a prerequisite for an ambitious space program is mistaken in the extreme. Yes, policymakers must take public opinion into account. But public opinion must also be informed and guided by policymakers willing to inspire with their vision, to offer concrete proposals, to make persuasive arguments, and to assemble necessary resources. That is the essence of political leadership in a democratic republic. We did not go to the Moon because of massive, preexisting public support for such an idea, and we haven't failed to reach Mars because of public uninterest.

The second overly simplistic explanation for why the American space program fizzled after Apollo 11 is money: If only (or so the thinking goes) funding for NASA were much higher, we would have been on Mars long ago.

Again, this explanation has a basis in fact. Even before we reached the Moon, NASA's budget was reduced, curtailing plans for Apollo and successor programs. And, as is often pointed out, at the peak of the Apollo program NASA consumed 4 percent of the federal budget, compared to about 0.5 percent today.

But underlying this explanation is the laughably false assumption that more funding results in more accomplishment, that level funding results in comparable accomplishment, and that reduced funding results in less accomplishment. Any student of history could name counterexamples—enterprises, both public and private, in which bigger budgets brought only waste and straitened budgets resulted in urgency and success.

More to the point, blaming low funding for NASA's stagnation is also misleading because, when adjusted for inflation, the agency's funding over the past twenty years has actually been *greater than* its funding was over its first twenty years. Expressed in constant 2018 dollars, NASA's total funding during the period from 1959 (the agency's first full year) through 1978 was $335 billion. The agency's total funding during the period from 1999 through 2018, again expressed in constant 2018 dollars, was $387 billion—an increase of 16 percent.

Now contrast what the agency accomplished during each period. In its first two decades, NASA not only did the Mercury, Gemini, Apollo, Skylab, Ranger, Mariner, Surveyor, Lunar Orbiter, Viking, Pioneer, and Voyager missions, it developed virtually all the technologies that have enabled space missions then and ever since, including hydrogen/oxygen rocket engines, multi-stage heavy-lift launch vehicles, space life-support systems, spacesuits, lunar rovers, radioisotope generators, space nuclear reactors, deep space navigation and communication technology, space-rendezvous technology, soft landing systems, reentry systems, and most systems that would be used for the space shuttle, and also built the Deep Space Network, the Cape Canaveral launch complex, and most of its centers and testing facilities.

Over the past two decades, however, NASA's accomplishments—with the notable exception of its superb robotic missions of planetary exploration and space astronomy—are not remotely comparable to those of its first two decades. Far from going beyond the Moon, NASA's astronauts have barely flown 0.1 percent of the distance to the Moon. The rate of development of new flight technologies has been near zero. In fact, it has arguably been less than zero in some areas, as exemplified by the failure of NASA's Space Launch System (SLS) program to be able to *redevelop* the J-2 engine that powered the upper stages of the old Saturn V from the Apollo days, leaving SLS, which has about the same takeoff thrust as the Saturn V, with only about half the ability of the Saturn V to throw payloads to the Moon.

The third culprit sometimes blamed for the stalling of the American space program is the fickleness of democratic government. Democracies (or so the thinking goes) are ill suited to the accomplishment of grand undertakings, except in the exigencies of war or war-like circumstances. Absent those conditions, it is held that great things can be accomplished only by private enterprise driven by the promise of profit or by unfree regimes that have a tyrant's constancy of aims.

This explanation, too, has a basis in fact. It is true that the space race against the Soviets—and the larger context of the Cold War—gave a sense of urgency to the Mercury, Gemini, and Apollo projects. It is true that, once the Soviets were beaten and the goal of reaching the Moon was achieved, the purpose of the American space program became less clear. It is also true that presidential administrations have tended to reject their predecessors' plans and timetables for sending humans into space, so that the overall direction of the space program has been erratic and rambling.

The belief that great public works are incompatible with peacetime democracy is also seemingly supported by other evidence from U.S. history outside the space program. There is a reason that the wartime

Manhattan Project is cited alongside Apollo as the very model of ambitious publicly funded R&D—as in the refrain "We need a Manhattan Project for X." And some of the biggest American engineering projects were made possible only by flouting democratic norms. "Pure democracy has neither the imagination, nor the energy, nor the disciplined mentality to create major improvements," asserted Raymond Moley in the foreword to a 1970 book by Robert Moses. Moses was the official who, across three decades, built a staggering number of bridges, tunnels, roads, parks, and housing projects in and around New York City. He accomplished all this by amassing quasi-dictatorial powers for himself, running roughshod over his critics, razing whole neighborhoods, and displacing hundreds of thousands of people in the service of his vision of progress. "You have from time to time remarked that I do not have to be elected to office," Moses told one opponent. "Perhaps that is why I am in a position to protect the really long-range public interest."

But this explanation for NASA's stagnation fails like the others. Many great things have been accomplished by democratic means during times of peace in the United States, including massive public works like the Erie Canal, the Hoover Dam, and the Interstate Highway System, and other awesome works that arose from public-private partnership, like the Transcontinental Railroad and much of our modern telecommunications system, including the Internet. Moreover, the undemocratic notion that elected officials cannot protect "the really long-range public interest" perniciously implies that power ought to be handed over to individuals who feel no obligation to answer to the people. And in the case of NASA, blaming the space agency's stagnation on the capriciousness of the American regime is also defeatist, since it implies that unless we give up democratic self-government we must give up all hope of doing great things in space.

Each of these three explanations for why NASA failed to get beyond the Moon—a lack of popular support, a lack of money, and a lack of stable goals in democracies—falls short. But having weighed each of them, we are now prepared to see more clearly the real structural reason for NASA's woes and to figure out, from sound principles of engineering, budgeting, and project management, how to build a human space program that can thrive under American democratic politics.

Purpose-Driven Missions

The main reason for NASA's stagnation—the best explanation for the difference between the rates of accomplishment in the agency's first two decades and the last two decades—is the change in its mode of operation. During the Apollo years, NASA's human spaceflight program was *purpose-driven.* Since then, it has largely been *vendor-driven.* A purpose-driven program spends money to do things. A vendor-driven program does things in order to spend money. In a purpose-driven program, spending is focused and directed toward a well-chosen goal. In a vendor-driven program, spending is unfocused and entropic.

The problem does not affect NASA as a whole. As noted above, the agency's programs for robotic planetary exploration and space astronomy have continued to produce impressive results. This is because they have remained purpose-driven. But without a clear, driving goal, NASA's biggest programs—its human spaceflight effort and associated launch-vehicle development programs—have dispersed hundreds of billions of dollars over the past half-century with very few results worthy of the costs and risks. (One could say virtually no worthwhile results, except for the five space shuttle missions to launch, repair, and upgrade the Hubble Space Telescope—an exception that proves the rule, for in those missions the shuttle was made to serve the purposeful science program.)

Part of the difficulty in moving from a vendor-driven approach to a purpose-driven approach lies outside NASA. The vendor-driven approach is reinforced by certain characteristics of our democratic politics, especially the tendency of members of Congress to prefer and push for projects that bring jobs to their districts. Moving to a purpose-driven approach will sometimes require NASA, with support from the president, to push back against that tendency and all the inefficiency it entails.

To be truly purpose-driven, a space program needs to meet the following conditions:

1. It must have a definite goal.
2. The goal must be assigned a proximate deadline, not a far-off one.
3. Projects must be selected and decisions about technology development must be made with the aim of achieving the goal by the deadline.
4. The projects selected must be pursued as rapidly and efficiently as possible.
5. The goal needs to be rationally chosen to accomplish the most we can.

These five conditions take into account the realities of big engineering projects, including the risks of bloat, sloth, and mission creep. And they take into account the pressures of electoral politics, public opinion, and budgeting. A space program that satisfies all five conditions, a purpose-driven program, is a worthwhile one that has a chance of success. A space program that fails on any of the five conditions is likely to result in waste and stasis and be vulnerable to being killed off by policymakers.

All five of these conditions were fulfilled by the Apollo program. The goal was to reach the Moon by the end of the 1960s. That satisfied conditions 1 and 2. The powerful focus on that goal meant that factions demanding peripheral projects, such as the construction of space stations, were pushed out of the way, thereby satisfying condition 3. Each component of the overall project was pursued expeditiously, in keeping with condition 4. Finally, the goal—by both achieving a major human milestone and winning a geostrategic victory—fully satisfied condition 5.

All this was laid out right from the start. As President Kennedy said in his famous speech before Congress on May 25, 1961, "First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

The Graveyard of Purposeless Programs

For most of the period since Apollo, NASA's human spaceflight program has had no goal at all. Some NASA leaders have even explicitly rejected the very idea of having a goal—as when Sean O'Keefe (NASA administrator, 2001–2005) repeatedly declared that the agency should not be "destination-driven."

Even when a nominal goal has been chosen, it has not been treated as authoritative. For example, in a speech on July 20, 1989, the twentieth anniversary of the Apollo 11 Moon landing, President George H. W. Bush announced that the United States would return to the Moon, this time to stay, and then go on to Mars. But that project, dubbed the Space Exploration Initiative, quickly collapsed. NASA at that time was pushing Space Station Freedom as its next major project and the president had unwisely described the space station as a "critical next step in all our space endeavors." So when, three months later, NASA laid out its plans allegedly to accomplish the president's goal, it proposed to send crews to the Moon using massive spaceships assembled on-orbit at a huge space station. The plans were so costly and complex that many veterans of the Apollo program who still filled NASA's ranks at that time could only scratch their heads and wonder, *If we could put a man on the Moon, why can't we put a man on the Moon?* And with the return to the Moon made impossible by the requirement to expand and then use the space station for on-orbit assembly, NASA's even more convoluted Mars mission design was utterly unfeasible. Bush's Space Exploration Initiative died quietly: It had no chance of getting through Congress, since it offered no prospects for attaining meaningful goals within a reasonable schedule and budget.

Sometimes the goal selected for NASA has been made meaningless by not being proximate. This was the fate of the Obama administration's so-called "Journey to Mars" program, which accomplished nothing because it had no specific deadlines to accomplish anything. It thus died without anyone even taking the trouble to kill it, because it had never lived in the first place.

The plan currently on the table, placed there by the Trump administration, calls for returning astronauts to the Moon by 2024. This meets conditions 1 and 2. So far, so good. NASA, however, once again has its heart set on an expensive space station, this time the ironically named "Gateway," to be stationed in lunar orbit. While NASA claims that the Lunar Gateway is needed for missions to the Moon, it is in fact a holdover from an earlier NASA program for capturing asteroids; the plans for the station were laid down by Obama-era NASA administrator Charles Bolden, who openly declared that he had no interest in returning Americans to the Moon.

It gets worse. The problem is not just that NASA is proposing to delay real accomplishment by inserting diversionary programs into the critical path. It is also insisting on undertaking these programs in the slowest and most expensive way possible. NASA administrator Jim Bridenstine has stated that NASA will transport astronauts to the Moon using two technologies it has been developing for many years: the SLS rocket and the Orion crew capsule (along with an actual lunar lander, to be developed at some future date). But the Orion capsule is so heavy that even the long-overdue SLS heavy-lift booster cannot deliver it to low lunar orbit with enough propellant to fly home. So a halfway house is needed not only for the Orion to rendezvous with a lunar lander, but also to refuel—thus the Gateway.

The resulting mission plan requires not only the Gateway, but four launches per mission, involving five different flight elements and six rendezvous operations per mission. This plan is so complex that it would make lunar missions incredibly costly, infrequent, and ineffective, and all but guarantee mission failure.

If we were to build a lunar base on the actual Moon rather than in orbit, refueling could be accomplished using hydrogen/oxygen propellant manufactured from lunar ice. This is the logic behind the Moon Direct plan that I proposed in these pages last year (see "Moon Direct," Summer/Fall 2018). Not only is that plan much more cost-effective, it also puts our astronauts on the Moon for extended periods, allowing them the time for science and exploration.

In short, the Gateway project is making the technology, rather than the destination, the master—a point hammered home this summer, when, during a White House photo-op for the Moon landing anniversary, President Trump, prompted by Apollo 11 astronaut Mike Collins, asked a pointed question to the NASA administrator: "What about the concept of Mars Direct?" In response, Bridenstine claimed that we cannot go to Mars until we have a lunar orbit space station and a lunar base. As if that were not enough, Bridenstine has also said in an interview that "we're going to need a Gateway-type capability at Mars," implying that he intends to hamper human exploration of the Red Planet with an unnecessary orbiting space station there, too.

The Trump administration's current Moon plans satisfy conditions 1 and 2. But instead of enabling the goal of reaching the Moon by 2024, the Gateway project is disabling it—and likely also harming our chances of getting to Mars anytime soon. NASA is today saying the same thing it said to President George H. W. Bush three decades ago: "You can't do your program until you do my program." Conditions 3 and 4 have gone right out the window.

Wrong Goal, Right Goal

This brings us to condition 5, which holds that it is not enough to have a goal with a proximate deadline, but that the goal must be wisely chosen. Why has the Trump administration picked the goal of sending astronauts back to the Moon by 2024? It is true that by setting a deadline for NASA's human spaceflight program to accomplish its task, the administration has given the agency a very healthy shock, and rousing itself to meet the deadline would certainly restore some of NASA's can-do spirit. But is returning to the Moon the right goal?

In terms of glory and geostrategic influence, the United States is not going to inspire the world with what free people can do by repeating the accomplishments done for the first time a half-century ago by men who are now great-grandfathers. Moreover, while there may be some interesting science and exploration that astronauts could do on the Moon—we could perhaps add to our knowledge about the Moon's origins and about the past of the solar system—there is another obvious destination that holds much greater promise for science: Mars.

Consider the biggest scientific question we could study on Mars: the question of the origins of life. This is one of the greatest mysteries of modern science. We know from fossil evidence dating back at least 3.5 billion years that life appeared on Earth virtually as soon as it could. This suggests that either life evolves quickly and spontaneously when the chemical conditions are suitable, or that life spreads in microbial form across interstellar space and readily takes hold as soon as it finds a habitable environment. If, as many scientists believe, early Mars was warm and wet and thickly enshrouded in carbon dioxide—if, in other words, it was similar to the early Earth—it might very well have hosted life. Methane emissions detected by the Curiosity rover lend support to the suspicion that Mars *still* carries life, protected underground in hydrothermal reservoirs. We need to go to Mars, drill, bring up samples of subsurface water, and see what is there.

And if there is some evidence of present-day or fossilized past life on Mars, the key question becomes *What is its nature?* At the biochemical level, all life on Earth is the same. Whether bacteria, mushrooms, grasshoppers, or people, all terrestrial life uses the same genetic alphabet of DNA and RNA. That is because we all share a common evolutionary ancestor. But what about Martian life? If terrestrial and Martian life both came from a common source, their genetic alphabets will resemble each other, as the English alphabet does that of French. But if each biosphere originated locally, they could be as different as English and Chinese.

The necessary program of drilling, sample-taking, culturing, biochemical analysis, and related observations is far beyond the ability of robotic rovers. Even our three best rovers, Spirit, Opportunity, and Curiosity—marvels of engineering kitted out with a variety of scientific instruments—have been able to discover, in a combined 27 functional years on Mars, just a small fraction of what a single well-equipped scientist could have discovered in a few days. Only human explorers can do the job right. And sending humans to Mars will be worth the cost and risk involved not only because of the potential for answering fundamental questions about the prevalence and diversity of life in the universe but because such a mission would once again astound the world with the daring creative genius of freedom.

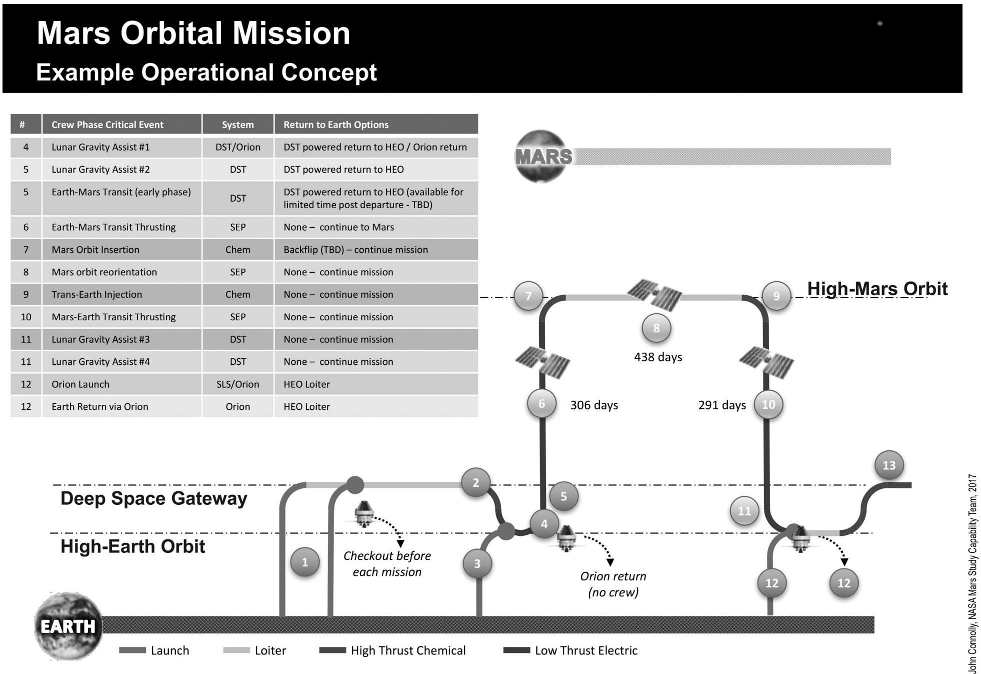
In short, unlike NASA's planned lunar venture, which frankly is being done just to have something to do, sending human explorers to Mars would really have a purpose. Therefore, that is what our goal should be.

Mars the Hard Way

Unfortunately, NASA's current thinking about putting astronauts on Mars satisfies none of the five conditions for a purpose-driven program that could succeed. The agency's leaders seem interested in paying only lip service to the goal of humans-to-Mars. They are assigning no deadline for such a mission. And instead of working directly to send people to land on Mars, they are dreaming up a complicated infrastructure whose transparent purpose is to provide a rationale for the Gateway. These are vendor-driven plans.

NASA's putative design for a human mission to Mars would use the Lunar Gateway to support the operations of an interplanetary spaceship called the Deep Space Transport (DST). The DST relies on a slow, unproven electric propulsion ion drive to travel from the Gateway to Mars and back, with one-way trip times of about 300 days. This contrasts poorly with what chemical rockets can already do, as demonstrated by the robotic missions (Pathfinder, Spirit, Opportunity, and InSight) that have reached Mars in about 200 days after starting from low Earth orbit. If it were starting from low Earth orbit, the DST would take some *600 days* to reach Mars. In other words, the purpose of the Lunar Gateway is to provide a crutch for the feeble DST, allowing a catastrophic choice of propulsion technology to become a merely horrible one.

Furthermore, the xenon intended to be used as a propellant for the DST's ion drive is not available from the Moon, negating all of NASA's claims that the planned outpost on the lunar surface could productively support Mars missions. And using the orbiting Lunar Gateway as a base for the DST will impose massive technical requirements on both systems, since the Gateway will need to include maintenance and propellant-storage facilities, and the DST will need to be made maintainable by astronauts on spacewalks and refuelable on orbit, and all this will need to be backed up by a logistics train transporting propellant and replacement parts from Earth to the Gateway. The requirement for refueling will add to the mission plan numerous critical orbital rendezvous operations that will impose severe timing and coordination constraints, and with them repeated risk of the loss of the mission, vehicle, or crew should any one of them fail to be executed on time.



#	Crew Phase Critical Event	System	Return to Earth Options
4	Lunar Gravity Assist #1	DST/Orion	DST powered return to HEO / Orion return
5	Lunar Gravity Assist #2	DST	DST powered return to HEO
5	Earth-Mars Transit (early phase)	DST	DST powered return to HEO (available for limited time post departure - TBD)
6	Earth-Mars Transit Thrusting	SEP	None – continue to Mars
7	Mars Orbit Insertion	Chem	Backflip (TBD) – continue mission
8	Mars orbit reorientation	SEP	None – continue mission
9	Trans-Earth Injection	Chem	None – continue mission
10	Mars-Earth Transit Thrusting	SEP	None – continue mission
11	Lunar Gravity Assist #3	DST	None – continue mission
11	Lunar Gravity Assist #4	DST	None – continue mission
12	Orion Launch	SLS/Orion	HEO Loiter
12	Earth Return via Orion	Orion	HEO Loiter

An example of a convoluted architecture designed by NASA for Deep Space Transport (DST) missions to Mars orbit in the 2030s. No useful exploration is accomplished.

And all this is needed for what, exactly? The DST does not solve any of the problems that NASA has cited as key obstacles for human Mars exploration, such as cosmic-radiation dosage or health deterioration due to prolonged exposure to zero gravity. On the contrary, it makes these problems significantly worse by greatly increasing the interplanetary transit time over what is otherwise feasible, and requiring a configuration that is inimical to the use of artificial gravity.

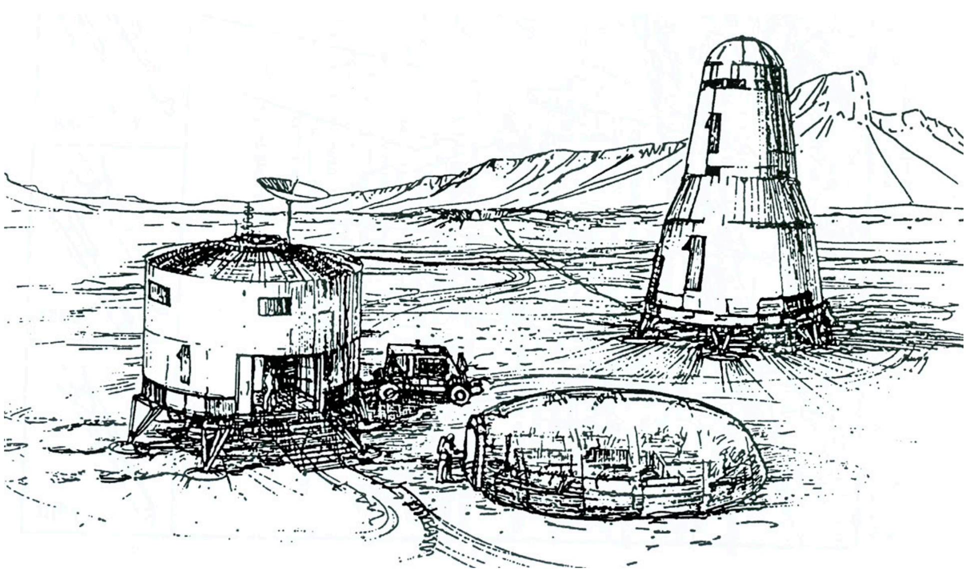
But the worst part is that the DST doesn't actually do anything useful. The value of sending human beings to Mars is not in sailing them about in interplanetary space. It is in intensively exploring the surface and searching for evidence of past and present life. The DST does not address those requirements at all. Rather than being derived from a plan to explore Mars, it is a thing in itself, an attempt to realize some science-fiction vision of the interplanetary spaceship.

In a purpose-driven space program, the mission comes first. From the mission comes the plan, from the plan come the vehicle designs, from the vehicle designs come the required technologies. That's how we did Apollo, and how every successful unmanned robotic planetary mission has been done. But the DST effort reverses this logic. NASA wants to employ electric propulsion, so it creates the DST—then insists on imposing the DST on the Mars mission. Instead of the Mars mission being the *reason* for the DST, it must suffer the role of serving as the *rationale* for the DST. The mission is nothing, the vendor contracts are everything.

So: NASA needs the DST to justify the Lunar Gateway, because the Gateway is necessary to prevent the DST from being even worse than it is. It may be nuts, but that's their story and they're sticking to it.

If You Want to Go to Mars, Go to Mars

There is a clear alternative to NASA's series of boondoggles: the Mars Direct plan, which I first proposed in 1990 with my colleague David Baker, and which I have continued to develop and advocate. Under this plan, or others resembling it, necessary payloads are sent on direct trajectories to Mars using the upper stage of a heavy-lift rocket (such as the SLS or the SpaceX Starship system, both now under development, or the currently operational Falcon Heavy). Methane and oxygen propellant can then be produced using Martian water and carbon dioxide even before the crew arrives. For example, in the original Mars Direct plan, an uncrewed Earth Return Vehicle (ERV) is landed on Mars, along with a 100-kilowatt nuclear reactor and a propellant-synthesis unit built into its landing stage. The



Martin Marietta / NASA

An early 1990s NASA sketch of a Mars Direct surface mission. The habitat module is at left, the Earth Return Vehicle at right.

ERV makes its return propellant by reacting atmospheric carbon dioxide with a small amount of liquid hydrogen it brings with it. So no humans need even launch from the Earth until we know that a vehicle capable of carrying them back to Earth is already awaiting them, fully fueled, on the Martian surface. The crew then launches and is delivered to Mars in a habitation module, which will also serve as their house and laboratory on the Martian surface during their stay of about a year and a half. At the end of their time on Mars, they ride the ERV home, leaving behind their hab module, so that as missions proceed every two years, either a string of small bases or a combined large base is developed.

In the more recent modified Mars Direct plan put forward by SpaceX, a reusable launch vehicle (Starship) lands on Mars and makes its return propellant out of atmospheric carbon dioxide and water ice, so that the same system can serve as both hab module and ERV.

Which approach—some variant of the Mars Direct plan or NASA's Lunar Gateway/DST—is better suited for a Mars program? That depends on the goal of the program. Is the goal to fly around in space, to go further than we have ever gone, perhaps to set a new record for the almanacs? Or is it to bring human explorers to the Red Planet's surface to search for life and develop the technologies required to open the Martian frontier? In a purpose-driven program it clearly must be the latter. The DST concept does nothing toward achieving that objective. Quite the contrary, it inserts the development and support of an entire parallel universe of in-space infrastructure, technologies, and operational capabilities into the Mars mission critical path. As explained above, these new systems do not represent additional Mars mission capabilities. Rather, they are liabilities. Their creation and support imposes additional costs on the Mars program, and if any of them should fail, the Mars mission is off. All this looks very attractive to the vendors, because more complicated components means more contracts, more money, more jobs. But because these components will subtract funds from actual Mars exploration systems and operations, they severely reduce the overall effectiveness of the program.

Put bluntly, the DST is a vehicle for flying around in space. But the purpose of interplanetary travel is not to fly around in space. It is to transit across space to reach, explore, and develop the worlds on the other side of space. This should be done in the simplest way possible. The Mars Direct systems are components of a plan for exploring Mars. Mars Direct would deliver all its payloads to the Martian surface because the surface is where the mission is. For the DST plan any surface activity is at best an afterthought.

It is possible to imagine giving a DST mission some exploration capability by adding to the flight plan the delivery to the Martian surface of a habitation module and descent/ascent vehicle. But in this case the number of mission-critical systems and rendezvous operations would be multiplied, with corresponding added cost and risk. Consider: In the Mars Direct mission, the crew is sent on its way to Mars with a twenty-minute burn of a rocket engine of a type that has been tested and flown hundreds of times before. Once that is done, the crew is on a six-month transit to Mars, and nothing will stop them from reaching their destination unless they choose to abort onto a free-return trajectory that will infallibly take them back to Earth exactly two years after their departure. By contrast, after leaving the Lunar Gateway, the novel DST engines must fire continuously for 300 days for the crew to make it to Mars. If the thrusters, power conditioners, or power system should fail at any point along the way, the crew will be stranded in interplanetary space.

This is not a purpose-driven plan for sending people to Mars. By requiring the development of a wildly complex set of systems, NASA's DST–Gateway planners are cooking up a vendor-driven plan that will accomplish nothing before it is eventually killed off by political realities.

If we want to send human beings to Mars, we don't need a complicated plan involving a lunar space station, a slow-moving spaceship, and many extraneous potential failure points. What we need is a big rocket—a heavy lifter with a payload capacity to the Martian surface of ten tons or more. SpaceX's planned Starship and NASA's planned SLS (with a proper upper stage) could deliver a twenty-ton lander to Mars. (The already-operational Falcon Heavy could send a ten-ton lander.) Even before sending human beings to Mars, we could use such a system to deliver platoons of rovers armed with diverse instruments and tools to reconnoiter regions of interest, demonstrate the systems needed to use Martian resources (including to make propellant), and ultimately prepare a base. Such rover missions would be of scientific value in themselves, and would set the stage, at last, for a human presence on Mars.

Getting Started

At the Oval Office meeting this past summer with the Apollo 11 astronauts, President Trump seemed to sense that he was being given the runaround. But will he take decisive action to address the situation? Will NASA have a purpose-driven plan or a vendor-driven plan? Will we spend money to do great things, or do things in order to spend a great deal of money?

If we allow NASA's human spaceflight program to remain vendor-driven, not only will we not reach Mars by the 2030s, we may not even return to the Moon in any valuable way by then. But if we insist that our space program be purpose-driven, we can reach the Moon by 2024 and Mars before 2030.

This is the choice we face. The stakes are huge: We can prove that democracies in peacetime can still do great things. We can push the United States far to the forefront of technical achievement for a generation or more. We can investigate the very origins of life. We can explore—and even prepare to settle—a new world.

The Moon landing was a grand deed, but a half-century later it is tragic that it remains the peak of our achievement in space. We would be doing far better—and honoring the heroes of Apollo far more appropriately—if this year we were hailing the eighteenth birthday of the first child born on Mars. Let us resolve that by the Moon landing's one hundredth anniversary, Americans will have much more recent epics to acclaim.