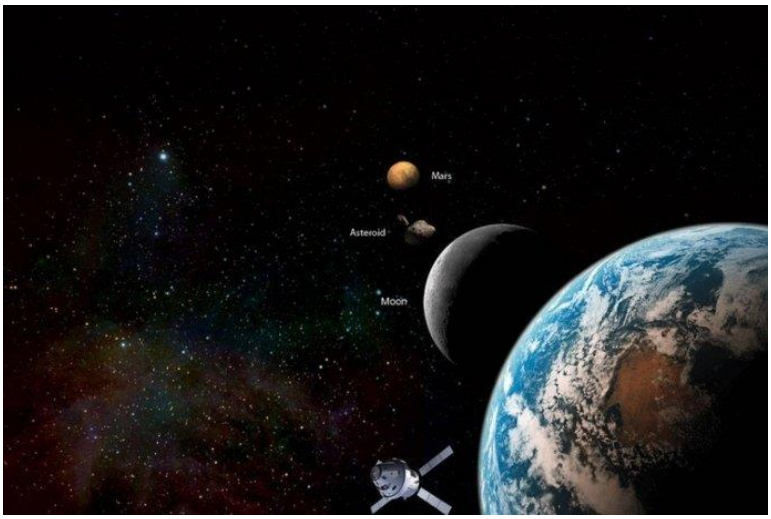


Settlement of Moon versus Mars?

Where in the solar system will humans go next? NASA and private industry are mulling whether astronauts should first go back to the moon—or instead voyage directly to Mars. A near-Earth asteroid could be a third possible destination for near-future human missions. *Credit: NASA*

"You can't be a Martian without being a lunatic," Clive Neal says. "If you want to do 'flags and footprints,' go to Mars now. But you'll never go back, because that's Apollo—a fantastic program, but it was not sustainable."
According to Neal, a lunar scientist at the University of Notre Dame, any moon-versus-Mars argument is a nonstarter. "It's not either-or," he says, because the moon can enable Mars by tapping lunar resources to support a sustainable human expansion deeper into the solar system. [1]

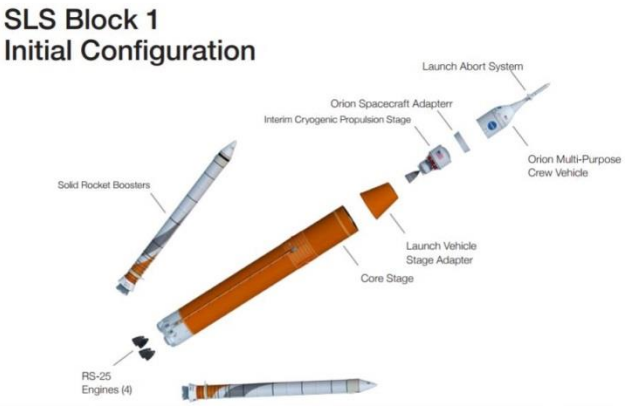
This pointedly summarized the conclusions of the debate about the next destination for astronauts to go during the 48th Lunar and Planetary Science Conference (LPSC) in The Woodlands, Texas on April 2nd 2017, in the light of the NASA bill President Trump signed on March 21st 2017, authorizing $ 19.5 billion in funding for NASA. [2]

"Planetary science will completely change once we get crew beyond low Earth orbit," says David Kring, a senior staff scientist at the Lunar and Planetary Institute. "The best way to explore the Moon is by the well-trained astronaut, hands down. Apollo demonstrated that wonderfully."
Speaking at a breakout session prior to the formal start of the LPSC gathering in April, *Apollo 17* moon walker and geologist Jack Schmitt reflected on the value of human exploration of the Moon. "A settlement on the Moon based on helium 3 export to Earth for fusion power provided, that is, that scientists back on Earth can first figure out how to make nuclear fusion an economically viable power source, makes a lot of sense to me. It starts not only to make us a two-planet species but enables, I think, Mars exploration in many different ways," he noted. [1]

Current Situation

The biggest winner in the spending bill is NASA's exploration program, which gets $4.32 billion, nearly $1 billion more than the original request but similar to what the House and Senate offered in their bills last year. That total includes $2.15 billion for the Space Launch System (SLS) and $1.35 billion for Orion.[2]
The report accompanying the spending bill allows NASA to use exploration funding to support technologies such as advanced proposal, asteroid deflection and grappling systems intended for use on the Asteroid Redirect Mission (ARM), provided they "not distract from the overarching goal of sending humans to Mars." The Trump administration's fiscal year 2018 budget blueprint, released March 16, announced plans to cancel ARM. [2]
Since June 14th 2017 NASA is in an "orderly closeout" phase of its Asteroid Redirect Mission (ARM) while keeping alive some of its key technologies for other applications. [3]

NASA's Space Launch System, or SLS, is a powerful, advanced launch vehicle for a new era of human exploration beyond Earth's orbit.



With its unprecedented power and capabilities, SLS will launch crews of up to four astronauts in the agency's Orion spacecraft on missions to explore multiple, deep-space destinations. To fit NASA's future needs for deep-space missions, SLS is designed to evolve into increasingly more powerful configurations. The first SLS vehicle, called Block 1, has a minimum 70-metric-ton (77-ton) lift capability. It will be powered by twin five-segment solid rocket boosters and four RS-25 liquid propellant engines, as well as a modified version of an existing upper stage.

The next planned evolution of the SLS, Block 1B, will use a new, more powerful Exploration Upper Stage (EUS) to enable more ambitious missions and deliver a 105-metric-ton (115-ton) lift capacity. A later evolution, Block 2, would replace the current five-segment boosters with a pair of advanced solid or liquid propellant boosters to provide a 130-metricton (143-ton) lift capacity. In each configuration, SLS will continue to use the same core stage design with four RS-25 engines. An evolvable design allows NASA to provide the nation with a rocket able to pioneer new human spaceflight missions and revolutionary scientific missions in the shortest time possible, while continuing to develop more powerful configurations. The next wave of human exploration will take explorers farther into the solar system — developing new technologies, inspiring future generations and expanding our knowledge about our place in the universe.[4]

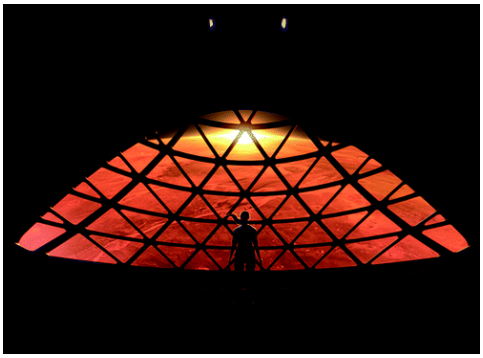
In February 2017, NASA began an effort looking at the feasibility of putting crew aboard the first integrated flight of the Space Launch System (SLS) rocket and Orion spacecraft - Exploration Mission-1, or EM-1 [around the Moon]. After weighing the data and assessing all implications, the agency will continue pursuing the original plan for the first launch, as a rigorous flight test of the integrated systems without crew. However, engineers will apply insights gained from the effort to the first flight test and the integrated systems to strengthen the long-term push to extend human presence deeper into the solar system.
"We are building both systems and supporting infrastructure to ensure a sustained cadence of missions beginning with EM-1 and continuing thereafter," said Lightfoot. "NASA will continue to work with the Administration and Congress as we move toward a crewed flight test on EM-2 and, right now, we are very focused on accomplishing the EM-1 flight test."[5]

The authorization bill mandates that NASA can't acquire space flight services from a foreign entity unless there are no NASA vehicles or U.S. commercial providers available. It also directs the space agency to look into ways to boost the private space industry. [6]
That means the next generation of American spacecraft and rockets that will launch astronauts to the International Space Station are nearing the final stages of development and evaluation. NASA's Commercial Crew Program will return human spaceflight launches to U.S. soil, providing reliable and cost-effective access to low-Earth orbit on systems that meet our safety and mission requirements. To meet NASA's requirements, the commercial providers must demonstrate that their systems are ready to begin regular flights to the space station. Two of those demonstrations are un-crewed flight tests, known as Orbital Flight Test for Boeing, and Demonstration Mission 1 for SpaceX. After the un-crewed flight tests, both companies will execute a flight test with crew prior to being certified by NASA for crew rotation mission. The following schedule reflects the most recent publicly-releasable targeted test flight dates for both providers [7]:
Boeing Orbital Flight Test: June 2018, Boeing Crew Flight Test: August 2018,SpaceX Demonstration Mission 1: February 2018, SpaceX Demonstration Mission 2 (crewed): June 2018. [8]

But it should also be mentioned that SpaceX CEO Elon Musk, after having successfully developed his own Falcon 9 Heavy launch vehicle (54 metric tons to LEO, first flight planned in Nov. 2017) is predicting that SpaceX could conceivably launch a robotic mission to Mars in 2020 followed by a crewed mission as soon as 2024, before a theoretical second Trump term expires. And that is much sooner than NASA's goal of sending humans to Mars by the 2030s.
Musk's ultimate vision is a Martian city of thousands if not millions of people — one that will require thousands of round-trips and 40 to 100 years to realize. But he's determined to make this vision a reality, first by sending a Dragon 2 capsule to Mars in 2020 — to test out landing procedures, scout locations for future landings and try out technologies needed to land larger, heavier equipment on the Martian surface — and then again every 27 months as SpaceX transports tons of equipment to the Martian surface. [9]

In February 2017 ESA's DG launched the European "Moon Village" vision and invited globally all spacefaring nations to participate without a strict project schedule but preliminary discussions have started already. [9]


ESA's Moon Village vision [10]


'Musk'-colonist looking out on Mars [12]

Conclusions

Having read the bestseller "The Terranauts" (T.C. Boyle) it seems very clear to me, that it is out of the question the "settlement" of Mars can't be implemented within the next 50 years [10].
The sensible approach would be to gradually send robots and astronauts to Mars the "conventional" way, i.e., for exploratory scientific reasons. If it comes to "settlement" and exploitation, ESA director's "Moon Village" approach should be followed. The advantage would be that the modular, "self-contained" development and expansion of an infrastructure on the Moon could be realized as "it flows" i.e., no stringent milestones would have to be met and the settling of the Moon could be joined by every nation as long as it is willing to follow the established international laws for outer space, standard rules and regulations. This would be a proving ground for gaining experience for the settlement of Mars: establishing an international "Moon" community respecting important human factors like:

- Less unknown long-term health and psychological hazards for humans living in space
- Quick return possibility to Earth as home base and permanent visibility avoiding the feeling to be "lost in space" with around the clock instant operational support.
- Growing transport and communications infrastructure.
- Return of Investment (ROI) possibility.
- Participation of private enterprises (astronomy, mapping imagery, tourism) and public-private partnerships for scientific and commercial projects.
- International funding by and global participation of space faring nations.
- Testing ground and staging area for Mars.

- ❖ Find out how the commitments for maintaining and operating a global infrastructure on the Moon over a long period of time would work.

… but maybe by the time we feel ready to settle on Mars we might be forced to start "terraforming" our Earth first.

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