

An Integrated Curriculum For The Washington Post Newspaper In Education Program

A New Era in Space



- Post Reprint: “Five Myths About Space”
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Most agree that NASA should remain a viable U.S. agency. In October 1958 when it was established it “was built on the National Advisory Committee for Aeronautics (NACA) and other government organizations as the locus of U.S. civil aerospace research and development.” Project Mercury, an effort to learn if humans could survive in space was its first major program.

Different Perspectives

What now?

Does NASA focus on the moon with a new Gateway or resumption of landings and lunar exploration? Does NASA continue to gather data on Mars and ready spacecraft for both unmanned and manned landings? Should it continue with space exploration like those accomplished by the Hubble telescope and New Horizons?

In what ways will mankind and the blue planet benefit from the space explorations? Read and ponder the points of view. Debate and discuss. Which for you is the most fascinating and acceptable of the different perspectives?

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5 Myths About Space

• Originally Published on Dec. 11, 2018

Space is literally all around us, and it's notoriously difficult to wrap our minds around it. Given the hundreds of billions of stars and planets that make up our galaxy alone, who can be blamed for a lack of cosmic perspective, even if NASA's InSight explorer just landed on Mars to send some back? As an astronomer at the Adler Planetarium in Chicago, I spend a lot of time talking with our visitors about their space questions, as well as debunking some persistent misconceptions. These five crop up again and again.

MYTH NO. 1

There's no gravity in space.

Maybe you've seen those videos of weightless astronauts on the International Space Station, gracefully

BY LUCIANNE WALKOWICZ

Lucianne Walkowicz is an astronomer at the Adler Planetarium, and the 5th Blumberg Chair in Astrobiology



RANDY BRESNIK

NASA Astronaut Randy Bresnik shared a video showing the International Space Station orbiting above the Sea of Japan on Nov. 29.

(or sometimes not so gracefully) flipping and floating around, hair aloft, like swimmers in a starry sea. This often leads people to conclude that there's no gravity up there. "Gravity is an important influence on root growth, but the scientists found that their space plants didn't need it to flourish," National Geographic wrote in 2012 of botanical research aboard the space station. A 2018 headline in the *Independent* similarly described a condition that affects astronauts during "zero-gravity missions."

In fact, if there were no gravity in space, it wouldn't be possible for astronauts (or anything) to orbit the Earth. As Newton explained it, gravity is the mutual attraction between any objects that have mass. Here on Earth, we experience gravity as our weight, which is to say the attraction between our own mass and the Earth. When

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WASHINGTON POST LIVE

The Washington Post hosted "Transformers: Space" on October 23, 2018. It featured Vice President Mike Pence, chairman of the National Space Council, who answered questions about a "Space Force." Also on the program were NASA Administrator Jim Bridenstine, Bill Nye and astronauts Chris Ferguson and Victor Glover who discussed the future of human spaceflight.

a rocket is in space, the vehicle and the astronauts carried by it still feel the pull of the planet's gravity. No matter where they are, they have some gravitational relationship with objects — from distant planets to faraway stars — however faint it might be. You, too, experience the tug of the entire universe, even if the tug that you notice is from Earth.

Back on the space station, astronauts (and the station itself) are slowly falling toward, or more technically around, the Earth. The astronauts look and feel weightless because they do not experience the Earth pushing back up on them as they would if they took a tumble on terra firma. If you've ever been in an elevator that descends quickly, dropping from under your feet, you've had a tiny taste of what they experience all the time.

MYTH NO. 2

Black holes suck.

News outlets tend to describe these gravity wells as if they were oversize cosmic vacuums. "Black Hole Sucks Down Star Stuff at 30 Percent Speed of Light," proclaimed a recent *Discover* magazine headline. The website Futurism offered a survival guide for those who somehow "get sucked into a black hole." And then there's Beavis and Butthead, who warned us that a black hole "sucks up the whole universe, and then it's like, it grinds it up and sends it all to hell or something."

In truth, black holes are a bunch of mass crunched together into a tiny volume, creating a huge gravitational field. Where their gravitational field is strongest, not even light, the fastest thing in the universe, can escape. As a result, black holes have long been

hard for astronomers to study, since most of our understanding of the universe relies on measuring light.

What we do know is that the huge masses of black holes (anywhere from tens to millions of times the mass of our sun) bend space-time in extreme ways, which is why illustrations often make them look like deep cosmic funnels. If you get close enough to one, you will certainly experience its powerful gravitational force, which is why astronomers see stars orbiting the supermassive black hole at the center of our Milky Way galaxy. But the gravitational tug is just like that of any other object — dependent on mass, and distance — and it's not special just because it's caused by a black hole. If I could magically replace our sun with a black hole that had exactly the same mass as our sun, our Earth would keep orbiting exactly where it is now, and similarly, those stars at the center of our galaxy will spend their entire lifetimes happily orbiting, with no danger of getting sucked in. In that sense, black holes are more like sinkholes than vacuums: One sinkhole in Florida isn't going to destroy the whole Earth, but best not to get too close.

MYTH NO. 3

The sun is yellow.

Every child has reached for the yellow crayon or marker when it's time to draw the sun. This common perception leads to articles like one in *Sciworthy* that begins, "The yellow sun in our sky provides the light and energy needed to sustain our planet." Pretty forgivable, given

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In this image taken from NASA Television, the SpaceX Dragon cargo spacecraft approaches the robotic arm for docking to the International Space Station, Saturday, Dec. 8, 2018. ^{AP}

that even astronomers refer to the sun as a “yellow dwarf.” And Superman famously gets his powers from his proximity to “yellow stars.”

Yet to understand the true color of the sun, you have to know a little bit about light itself. Visible light, the kind that human eyes can see, is just a tiny fraction of the energies of light in the universe. Mixed together, all this light appears white — but the colors of the rainbow, from red to violet, are different energies of light that your eyes can see (red is at the lower energy end of the visible spectrum, violet is towards the high energy end). By the time light from the sun hits your eyes (hopefully not directly: please don’t look straight at it!), it has traveled across the solar system and through Earth’s atmosphere which bends, filters

and scatters solar radiation before it makes it to our eyes. Because the higher-energy, bluer light gets scattered more, the light from the sun that reaches our eyes on Earth appears more yellow. But in space, the sun would appear white to us.

MYTH NO. 4

The sun is on fire.

As it turns out, when you take the incredibly dynamic surface of the sun, and colorize it in yellows and oranges, it looks a whole lot like fire. Perhaps that’s why we often embrace a fiery vocabulary to describe it, as the band They Might Be Giants did when they referred to the sun as a “nuclear furnace.” Astronomers also speak of the sun “burning” hydrogen, and *Popular Science* writes that we’re lucky “it didn’t

burn out before we showed up a few hundred thousand years ago.”

In the case of our sun, however, “burning” is a total misnomer. There is no combustion, fed by oxygen, to release the energy stored in the fuel. Stars generate energy through fusion, smashing together atoms deep in their cores like gigantic particle colliders. These fusion reactions take lighter elements, such as hydrogen, and smash them together to build heavier elements (like helium). When hydrogen atoms fuse together, they release energy, which eventually makes it out of the heart of the star to shine into the universe.

MYTH NO. 5

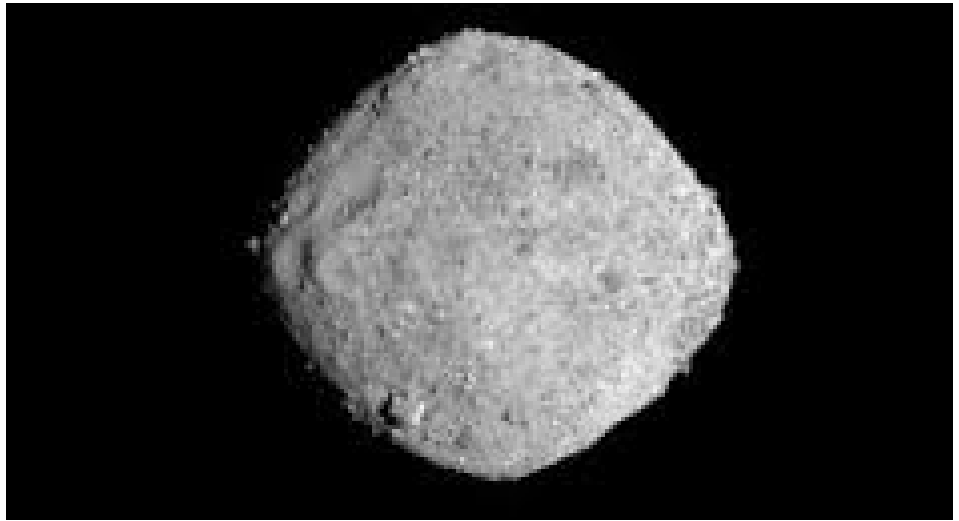
It would be hard to fly through the asteroid belt.

To get past Mars, onward to Jupiter and beyond, one must pass through the asteroid belt, a region of space that harbors an especially large number of rocks. That sounds dangerous, at least to some science fans who write into sites like “Ask an Astronomer.” Usually, people’s ideas about the asteroid belt come from scenes in sci-fi movies like *The Empire Strikes Back*, where Han Solo nimbly navigates the Millennium Falcon through a dangerous field strewn with jagged, flying boulders.

In reality, we’ve successfully sent numerous NASA missions to study the outer solar system, no bobbing or weaving required. At the extreme speeds they travel — tens of thousands of miles per hour — spacecraft don’t need to hit a boulder to be

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annihilated. (Just over two years ago, a window on the International Space Station was seriously damaged by a mere paint chip.) Navigating the asteroid belt in our solar system, however, is a piece of cake: While it does have a lot of rocks flying around in it compared with other regions of space, those rocks are still incredibly far apart — hundreds of thousands of miles, on average. So, if you're ever on a road trip with C-3PO, and he claims that “the possibility of successfully navigating an asteroid field is approximately 3,720 to 1,” you can tell him to chill out and enjoy the view.



AGENCE FRANCE-PRESSE/GETTY IMAGES

The spacecraft took this photo of the asteroid Bennu from a distance of 85 miles. It is the smallest object ever orbited by a spacecraft. Osiris-REx will gather rocks from Bennu's surface, survey the landscape and explore Bennu's makeup.

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Opinions



HO/AFP/GETTY IMAGES

One of the last full views of Saturn by the Cassini spacecraft, taken on Oct. 28, 2016.

This is exactly the wrong time to retreat from space

On July 20, 1969, astronauts Neil Armstrong and Buzz Aldrin bounded across the lunar surface as Michael Collins orbited above. We now sail across our solar system. Rovers gambol on Mars, the Cassini spacecraft just plunged through a gap in the rings of Saturn, and the Voyager spacecraft soars into interstellar space, more than 13 billion miles away, still sending back signals to Earth.

But proposed budgets drastically cut support for telescopes that tell us about the universe's origins and spacecraft that trace the changes on our home planet. And the United States has stood on the sidelines as nations across the world develop the next generation of land-based optical observatories.

Rarely has there been a more exciting and promising time for space science. Telescopes pointing deep into space detect thousands of planets orbiting faraway suns. Life may reside in the ocean worlds of the moons of Jupiter and Saturn or be revealed in the ancient history of Mars. Gravitational-wave observatories probe the inner workings of black holes, like the

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one at the center of our galaxy. We have the opportunity to understand the origins of dark matter and dark energy, which constitute 95 percent of the universe but remain mysterious. The United States has been a remarkable engine of innovation, creating knowledge for the ages and solving society's problems today. We have the talent and the entrepreneurial spirit to build on our grand history of discovery. We need only the vision and the will.

February 20, 2018

Thomas F. Rosenbaum, Pasadena, Calif.
The writer, a physicist, is president of the California Institute of Technology.

Edward C. Stone, Pasadena, Calif.
The writer is a professor of physics at the California Institute of Technology, project scientist for the Voyager mission and former director of the Jet Propulsion Laboratory.

Discussion Questions: *Answer on your own paper.*

1. What facts are established in the first paragraph? What is the time period covered?
2. The second paragraph begins with "but." What contrast do the writers present?
3. What credentials do the two writers have to give them authority and to indicate their likely perspective?
4. The third paragraph is their persuasive argument. Which three points do you find most interesting?
5. Do you agree with their arguments, especially those found in the last two sentences? Explain why you do or do not agree with them.

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Opinions

The mission to Mars is one stupid leap for mankind



JONATHAN ERNST/REUTERS

Vice President Pence opens the first meeting of the National Space Council.

BY DAVID VON DREHLE
Columnist

• Originally Published October 6, 2017

Juvenal, that biting pundit of the Roman Empire, complained of weak leaders distracting the people with “panem et circenses” — bread and

circuses. In our day, it’s moon bases and missions to Mars.

Europe is splintering. North Korea has gone full “Dr. Strangelove.” Disaster in Puerto Rico. Massacre in Las Vegas. Crickets chirping on Capitol Hill, where Republican promises go to die. With so much to be done and few plans for doing it, the people need to be distracted. So Vice President Pence was trotted out

last week to revive a long-dormant presidential commission and get American astronauts back into space.

Perhaps you thought our astronauts never left space. Haven’t they been space walking, repairing telescopes, performing experiments and making music videos up there for years? Turns out those missions take place in “low Earth orbit,” less than 350 miles from home.

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Millions of kids have ventured farther to attend college than our astronauts have traveled from Earth these past 45 years.

Though Pence's commission is unlikely to tell you, there are very good reasons Americans, and other humans, abruptly stopped going deep into space. It's deadly. It's unnecessary. And to borrow from Gertrude Stein, there's no there there.

Doubtless, Americans could return to the moon, and even stay there for a while. It would cost vast sums, but we have good credit and high tolerance for debt. The question is why. The moon is still the same dead, dusty desert we left in 1972. Ice-covered Antarctica and the Sarahan sands are both far more hospitable to human life than the moon.

A moon base makes zero sense on its own terms, so it's pitched as a trampoline to Mars. Face it: The Red Planet has the best PR in the solar system. What Scientology is to creepy movie stars, Mars travel is to swashbuckling billionaires. Elon Musk, Richard Branson and Jeffrey P. Bezos (owner of The Post) have all set their sights on the fourth rock from the sun, with Musk saying he hopes to die there — "just not on impact."

Boosterish scientists report that midday temperatures may reach a balmy 60-plus degrees on the Mars version of St. Tropez, but Musk better pack a heavy snowsuit to go with his Speedo. Having virtually

zero atmosphere to hold the warmth, the planet cools off overnight to around 90 degrees below zero at the equator. The average temperature, according to NASA, is 81 below.

Still, a human traveler to Mars should make the most of its airless monotony, because there is no coming back. The long passage through the vacuum of space will expose astronauts to intense and prolonged bombardment by cosmic rays and unimpeded solar radiation — a death sentence for which NASA has no solution (though scientists continue to seek one). At the Hotel Mars, you can check out any time you like, but you can never leave.

What's more, Mars is a dead end. As fatally desolate and brutal as Mars is, our neighbor planet is the most habitable destination for many, many light years in any direction.

Science fiction can be seductive. Of course we want to boldly go where no one has gone before. But space exploration is a job for robots, not humans. Nature has adapted us exquisitely and precisely for life in one particular ecosystem in one remote corner of an incomprehensibly vast universe.

But here's the good news: It's a really nice ecosystem! Earth is blanketed with a breathable atmosphere, and the gravity's just right to hold us in place without crushing our bodies. There is snow for skiing, and there are beaches for tanning. Land and seas teem

with food — so much that the ever-growing human population has never been better nourished than today. There are wondrous things to see, such as Yellowstone, the Louvre and Willie Nelson.

The vice president touted the commercial prospects for humans in space, but that, too, is a distraction. There is no economic enterprise (apart from space tourism) that can be done more efficiently by humans in space than by space robots or humans on the ground. It's all pie in the sky.

Other promoters of moon bases and Mars colonies are doomsday theorists, grimly laboring under the belief that humans are going to destroy the Earth and need to have a lifeboat ready. This is dangerous thinking. For all the troubles in our current home, they are small compared with the problems of living in a terrarium on a frozen rock under skies composed of 95 percent carbon dioxide. If we have money and energy and brainpower enough to build settlements on distant wastelands, we are better off deploying those resources to preserve the bountiful planet we already have.

The vast and murderous universe has conspired to maroon the human race — but what a wonderful island we're on. Rather than go in search of dust bowls to die in, let us send our robot eyes and ears to explore the lifeless seas of space, marveling at their findings while giving thanks that we're not with them.

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PRO-CON | *A Difference of Opinion*

Letters to the editor, guest commentary and the columns of *Post* columnists add to the mix of opinions and diverse points of view that *The Washington Post* provides to stimulate conversation, encourage dialogue and introduce expert perspectives.

Read the letter to the editor contributed by Robert Zubrin and Homer Hickam. After discussing and summarizing their main points, read a reader's response to their ideas.

Letters to the Editor • Opinion

We have the technology to build a colony on the moon. Let's do it.

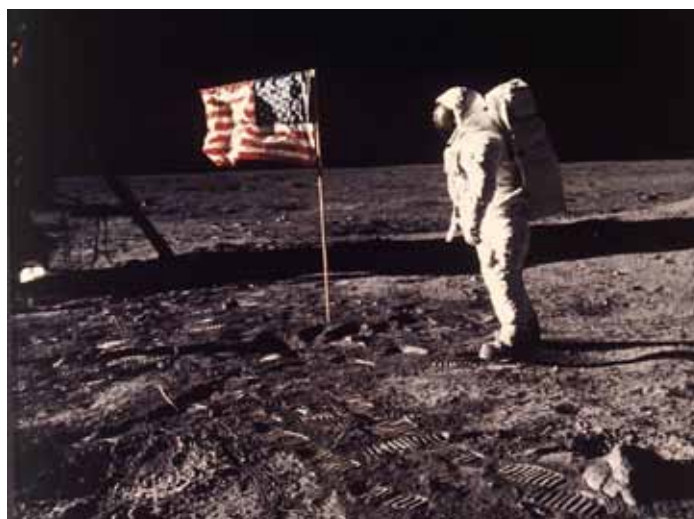
December 10, 2018

Late last year, President Trump directed NASA to “lead the return of humans to the moon.” For most folks, the meaning of this was pretty clear: Americans would soon walk on the moon again.

The space agency, however, had another idea. In February, NASA announced that it is planning to build the Gateway, a mini-space station that would orbit the moon — for no apparent reason.

The vague description of the space station on NASA's website offers little clarity. There's no certainty as to when it would be built, what it would be used for or why it is needed. Half a billion dollars are already dedicated to the Gateway this fiscal year without any obvious plan to do anything with the money except spend it. Beyond that, the budget isn't known but is certain to be huge. NASA further revealed the obtuseness of the project by noting that it doesn't know whether it would be permanently crewed or only occasionally visited or what exactly the astronauts would do when aboard.

As for landing people on the moon, NASA is vague about that, too. Apparently, if we wanted to build a lander sometime in the future, it would rendezvous with the Gateway for some reason and then attempt a landing.



NEIL A. ARMSTRONG/AP

Astronaut Buzz Aldrin is photographed on the moon by Neil Armstrong during the first lunar landing nearly 50 years ago.

This is all just plain weird. It's like building a big, expensive aircraft carrier, positioning it off the European coast and requiring passengers going from New York to Paris to land there first and do something (although what isn't known) until another airplane is built to pick them up to carry them to their destination. This, we suspect, is not the best way to get to France.

Rather than build this murky Gateway, which we frankly doubt the American people will understand or support, we believe the best expenditure of time and money is to simply make it a national goal to build a base on the lunar surface. Such a base would be similar to the U.S. South Pole Station and constructed for the same reasons: science, exploration, knowledge, national prestige, and economic and technological development for the benefit of the U.S. taxpayer.

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This plan, which we call Moon Direct, doesn't take rocket scientists to comprehend (although we both hold that title). And we could accomplish it in just three discrete phases: First, we deliver cargo to the lunar surface and initiate robotic construction. Second, we land crews on the base, complete construction and develop local resources. And third, we establish long-term habitation and exploration. ...

SpaceX's Falcon Heavy booster, which can launch 60 tons to Earth orbit and 10 tons to the moon, could easily handle the first phase. And NASA's Space Launch System, still in development, might eventually be used along with heavy lift rockets such as Blue Origin's New Glenn and the United Launch Alliance's Vulcan. (Blue Origin's founder, Jeffrey P. Bezos, owns The Post.) Rather than spend a fortune and take years to build a Gateway for obscure reasons, we could immediately go straight to the surface of the moon and set up shop.

The key to crew operations, the second phase of building our moon base, is a spacecraft we call the Lunar Excursion Vehicle, which would operate outside our atmosphere and therefore need no heavy heat shields or Earth landing systems. The LEV would fly from Earth's orbit to the lunar surface and back again. New York to Paris, Paris to New York. Nothing could be simpler. All we would need to do is get to the airport — in this case, low Earth orbit — where the LEV would be "parked" for refueling and used again and again, just like a passenger airplane.

"Paris," by the way, should be near one of the lunar poles — where sunlight shines nearly all the time and ice deposits sit in permanently shadowed craters. By

combining solar energy with lunar water, we could produce rocket propellant for the LEV to use to fly back to Earth and to travel around the moon. This water would also be available to support human life.

A key goal of the second phase is to get propellant production going on the moon. Until it is, we would send the LEV with fuel for the round trip on a heavy-lift rocket to orbit, followed by a relatively cheap, medium-lift rocket with the crew. The crew would rendezvous with the LEV, park their capsule in Earth orbit and then ride the spacecraft to the lunar base. After they complete their mission, the crew would blast off from the moon with the LEV, fly back to their capsule in Earth orbit and journey home, leaving the LEV behind for its next crew.

It's simple, straightforward and very doable with the technology at hand.

The third phase would have continuous operations, including propellant production on the lunar surface. With this infrastructure, all it would take to get to the moon is a medium-lift rocket and the clear weather to launch it.

If we're serious about going to the moon, let's just go there. Next year will mark the 50th anniversary of the first moon landing, reminding us of the sort of things we as a nation once accomplished. We should resolve now to do no less.

Let's put aside these murky plans to orbit the moon in a can for no good reason. Let's build a base on the moon where not only Americans can take small steps in the peaceful pursuit of knowledge, but also where the world can take giant leaps toward opening of a new frontier.

Robert Zubrin is president of the Mars Society and Pioneer Astronautics and the author of "The Case for Mars."

Homer Hickam is a former NASA engineer and the author of multiple books, including the memoir "Rocket Boys," which was made into the film "October Sky."

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Forget the colony on the moon. We should shoot for space achievements of real value.

December 13, 2018

I take exception to the Dec. 11 Tuesday Opinion column by Robert Zubrin and Homer Hickam, “Let’s be bold and build a colony on the moon.” Space has provided society with innumerable benefits, from preventing a third world war (thanks to spy satellites and, ironically, nuclear missiles) to communications, weather prediction and scientific discoveries. But space is not a 21st-century analogue of a romantic New World or Trekish Final Frontier.

Humans need a very finely tuned set of environmental conditions to survive, from temperature to atmospheric composition to a protective magnetic field. The notion that the moon or Mars could be a replacement for our Earth slowly degraded by climate change and pollution — whether natural or man-made — does not pass the giggle test: We already know that the moon and Mars are unsuitable for human habitation, and if they could



BILL ANDERS/NASA

Moon shot taken on Apollo 8, the first manned mission to the moon.

be made habitable, it would be easier, faster and more productive to apply those remedies to Earth.

Proponents of this fabrication mislead young minds whose talents could otherwise be channeled toward space achievements of real value and for which human physical presence is completely unnecessary, such as a radio astronomy observatory on the radio-quiet far side of the moon.

Antonio Elias, *McLean*

Discussion Questions: *Answer on your own paper.*

1. What are three main ideas presented by Zubrin and Hickam?
2. Notice how brief reader responses are. The writers must be specific and address main ideas with which they agree, disagree or have additional information to add for clarification and elucidation. What is the main point made by Antonio Elias?
3. In what areas might the three writers agree?
4. Do you find one piece more compelling and persuasive than the other? Do you need additional information before you agree or disagree with the writers? For example, read more about the Gateway project to see if it is fairly represented.
5. What do you think about establishing a lunar base?

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PRO-CON

Select one of the following opinion pieces. After establishing the point of view of the writer, write a response. Do you agree with the writer — especially on certain points? Do you disagree with the writer — especially concerning particular arguments? Do you partially agree, but qualify to what extent? Be sure to be specific in your examples to counter or elaborate on the topic.

- *Buzz Aldrin: The next giant leap for space exploration*
February 3, 2016
https://www.washingtonpost.com/news/in-theory/wp/2016/02/03/buzz-aldrin-the-next-giant-leap-for-space-exploration/?utm_term=.10792a7cec2c
- *“The mission to Mars is one stupid leap for mankind”*
By David Von Drehle, columnist
Oct. 6, 2017
https://www.washingtonpost.com/opinions/the-mission-to-mars-is-one-stupid-leap-for-mankind/2017/10/06/24078102-aac2-11e7-850e-2bdd1236be5d_story.html?utm_term=.13133f70395d
- *“Tom Toles: If you are prepared to die, the Mars colony is a good bet for you”*
September 28, 2016
https://www.washingtonpost.com/news/opinions/wp/2016/09/28/if-you-are-prepared-to-die-the-mars-colony-is-a-good-bet-for-you/?utm_term=.50755b63e105
- *Three cheers for space robots*
By Daniel Britt
January 7, 2019
https://www.washingtonpost.com/opinions/2019/01/07/three-cheers-space-robots/?utm_term=.8ddb3f52cb80
- *“No, human space exploration is not a dead end”*
By Marillyn Hewson, chairman, president and chief executive of Lockheed Martin Corp.
Oct. 13, 2017
https://www.washingtonpost.com/opinions/no-human-space-exploration-is-not-a-dead-end/2017/10/13/808f257c-af88-11e7-a908-a3470754bb9_story.html?utm_term=.c954a50cd31c
- *The Cassini mission embodies the best of humanity*
Post Editorial Board
September 15, 2017
https://www.washingtonpost.com/opinions/the-cassini-mission-embodies-the-best-of-humanity/2017/09/15/d2944c66-9a3a-11e7-b569-3360011663b4_story.html?utm_term=.6ccc55a32aad

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Inside e-Replica

Explore e-Replica | *Search and Monitor*

Conduct an Advanced Search

Are you looking for media coverage of space exploration, the latest discoveries or the people involved in specific projects? Take advantage of e-Replica search features.

- Select Advanced Search under the Search option.
- Type in the subject or area of your search under Find Results.
- Select the time frame under Date.

Work in pairs to locate information about the following. Be sure to record the headline, byline and date of publication. Summarize the information in one paragraph.

Monitor Future Coverage

Locate the Monitor feature. Set your topics to receive the most specific results. You will be alerted when the person, project or event involving your topic appears in *The Post*.

Select and establish monitors for three of the above topics.

Find the Answers

Apollo missions	New Horizons
Bennu	Odyssey spacecraft
Chang'e 4 probe	Orion
China National Space Administration	OSIRIS-Rex
Hubble Space Telescope	Parker Solar Probe
InSight explorer	Space Force

Use the e-Replica Search feature to find the answers to these questions. All were covered in *The Washington Post*.

1. What problem did China's Chang'e 4 spacecraft overcome?
2. How did the China National Space Administration solve this problem?
3. What images has Osiris-Rex sent to NASA?
4. What has the New Horizons spacecraft done since it flew past "Ultima Thule" on January 1, 2019?
5. On January 9, 2019, NASA reported a glitch affecting the Hubble Space Telescope. What was the problem? Were engineers able to find a solution?

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BUSINESS

Virgin Galactic craft crosses threshold of space



CHRISTIAN DAVENPORT, JHAAN ELKER/THE WASHINGTON POST

Richard Branson's company got ahead in the race for commercial spaceflight once its manned spacecraft reached more than 50 miles high.

BY CHRISTIAN DAVENPORT

• *Originally Published December 14, 2018*

MOJAVE, Calif. — Virgin Galactic launched a spacecraft more than 50 miles high Thursday, reaching the Federal Aviation Administration's definition of space and capturing a long-elusive goal for the company founded by Richard Branson that one day wants to fly tourists through the atmosphere.

Though it did not reach orbit, the flight was the first launch of a spacecraft from U.S. soil with humans on board to reach the edge of space since the Space Shuttle was retired in 2011. And it effectively opens a new era in human spaceflight, one where companies are working to end governments' long held monopoly on space, aiming to push farther faster.

Though it just scratched the lowest edge of where many believe space begins, the launch had huge implications for a growing industry

aiming to fly civilians on a regular basis. The flight was bold and risky, and following a fatal crash from four years ago, reminiscent in its daring of a bygone era of human spaceflight.

It comes at a time when NASA is still forced to rely on Russia to fly its astronauts to orbit and faces criticism that its aversion to risk has replaced the youthful audacity that helped it put men on the moon.

With the flight — taking place on a chilly morning shortly after sunrise — Virgin can claim an edge

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in the race for human spaceflight, as a number of companies, including SpaceX, Blue Origin and Boeing, work to develop spacecraft capable of flying people.

With two seasoned pilots in the cockpit — Mark “Forger” Stucky and C.J. Sturckow — the vehicle known as SpaceShipTwo was ferried to an altitude of about 43,000 feet by a mother ship. Like a bomb, the spacecraft was released into a free fall before the pilot ignited the engine, propelling the spaceplane faster than the speed of sound.

Soon, the vehicle pointed almost straight up, as it streaked through the same skies over the California desert where Chuck Yeager first

broke the sound barrier in 1947. The spacecraft reached a height of 51.4 miles, hitting a top speed of Mach 2.9, before descending and returning to the company’s space port in Mojave.

On the ground, a gaggle of press, space enthusiasts, including Branson and his guests, watched the flight, tilting their heads skyward. Branson, wearing a leather bomber jacket, hugged his son as the spacecraft raced upward and a commentator called out the altitude.

“It’s been 14 long years to get here. We’ve had tears, real tears, and moments of joy. So the tears today were tears of joy,” he told reporters afterward. “It was maybe tears of relief as well. When you

are in the test flight program of a space company you can never be completely 100 percent sure.”

Stucky, the pilot in command for the mission, said it went as smoothly as it could have — and well enough for him to perform a victory barrel roll as the spacecraft returned to Earth.

“That was rather incredible,” he said. Seeing “the dark sky was great. Everything just worked great. ...We had tons of extra propellant. Had plenty of time to look around.”

Virgin Galactic has nearly 700 people who have paid as much as \$250,000 for its suborbital joyrides — more than the 560 or so people who have ever been to space.



JONATHAN NEWTON/THE WASHINGTON POST

Dave Mackay, chief test pilot for Virgin Galactic, climbs into a simulator for a test flight at the company’s headquarters. Virgin is preparing to launch people into space in the next several weeks.

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Eventually the company wants to fly six passengers at a time. The FAA plans to formally honor the pilots of Thursday's flight by awarding them commercial astronaut wings at a ceremony in Washington next year. For Branson, the launch was the culmination of years' worth of lofty dreams and tragic setbacks as he sought to build what he calls "the world's first commercial spaceline." He founded Virgin Galactic after buying the rights in 2004 to the technology behind SpaceShipOne, the spacecraft funded by Microsoft co-founder Paul Allen that made it to the edge of space three times that year, winning the \$10 million

Ansari X prize and becoming the first privately funded vehicle to fly humans to space.

Thursday's launch was also a major milestone for a growing commercial space industry, which for all its triumphs has yet to show it can routinely fly humans into space. But that may soon change.

Blue Origin, the space company founded by Jeffrey P. Bezos, also plans to fly tourists, though to a higher altitude and with a rocket that launches vertically, not a spaceplane. (Bezos owns *The Washington Post*.)

Its first test flights with humans on board are scheduled for next year.

SpaceX, the company founded by

Elon Musk, and Boeing are under contract with NASA to fly astronauts to the International Space Station, the orbiting laboratory, as early as next year.

As the plight of Virgin Galactic shows, ending government's long-held monopoly on human spaceflight has been difficult. Despite the long odds, Branson started his quest to open space to the masses with his typical bravado, vowing the company would soon be taking tourists by the hundreds on awe-inspiring jaunts to the cosmos.

But years passed, the program suffered delay after delay and in 2014, a fatal setback: The spacecraft



RINGO H.W. CHIU/ASSOCIATED PRESS

Virgin Galactic's SpaceShipTwo crashed Oct. 31, 2014, in Southern California's Mojave Desert. One pilot was killed and another seriously injured.

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came apart midflight, killing Michael Alsbury, the pilot.

In 2016, he unveiled a new spaceplane, dubbed Unity, and the company started its test program again, slowly pushing the envelope on test flight after test flight. Thursday's flight was a key milestone that the company says will push it closer to flying tourists from Spaceport America, Virgin Galactic's futuristic launch facility in New Mexico.

Branson said he has invested nearly \$1 billion of his own money into the venture. "Space is not cheap," he said.

Now Virgin is looking forward to selling more tickets and making

the company commercially viable, he said. Once the test program is finished, he said the operation will move next year to Spaceport America, the futuristic facility in New Mexico where it intends to fly its tourist flights. Branson has said he intends to be on the first commercial flight.

The company is now building two more spaceships in anticipation of the price coming down and more people signing up to fly.

Virgin's ultimate goal is to build spaceports around the globe, "and we're operating multiple times a week at each one of those and enabling tens of thousands of people to experience space," George Whitesides, Virgin

Galactic's chief executive, said in a recent interview.

Eventually, the company would like to turn those spaceports into "future hubs for a network of intercontinental transportation nodes" where the spaceships can transport people across the globe in a matter of hours.

In the long term, the company wants to fly "into major airports because we have a winged vehicle that can integrate smoothly in traffic patterns," Whitesides said.

That goal is still "many years out," he said. "But that's the evolution — so that at the end of it you've built up, step-by-step, a capability to go between continents in an hour or two."