

How (and Why) SpaceX Will Colonize Mars

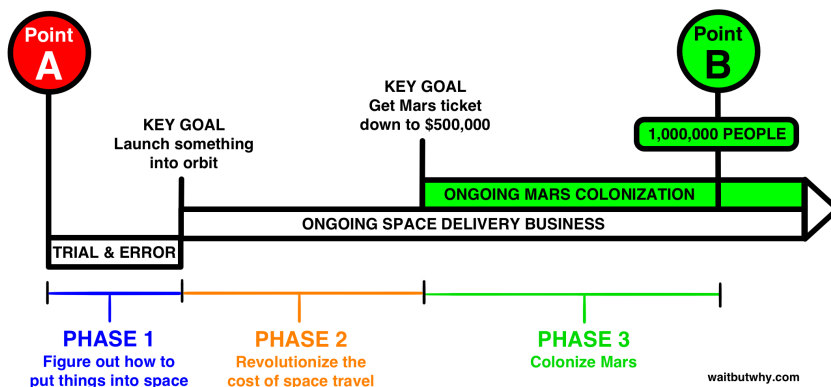
📅 August 16, 2015 By Tim Urban

Phase 3: Colonize Mars

Main Character: The Mars Colonial Transporter

Goal: Put 1,000,000 people on Mars

The SpaceX Business Plan



Today, no one is talking about Mars, and very few people think of Mars as a relevant part of the near future. But unless I've missed something big or something unexpected happens, in about 10–20 years, *people will start going to Mars*. You could go to Mars in your lifetime. Crazy things are on the horizon.

This is one of those topics that's tough to absorb, because as you think about it, your mind will keep drifting back to, "Nahhhh." Learning about what SpaceX is doing and why they're doing it can take you from a place where thinking the prospect of humans moving to Mars is totally ludicrous to a place where you accept the logic that it's actually an important thing to do and something that's possible and even likely to happen. But that's different than really *believing* it'll happen. As you read this post, even if you agree with what you're reading, if you had to quickly bet \$1,000 on whether people will be moving to Mars in 20 years, there's a good chance you'd bet against it, because deep down, your brain hasn't *really* accepted it. And that's fair—your brain bases things on experience, and experience tells it that moving to Mars is not something that people ever do.

But I'm pretty sure your brain's in for some *big* surprises over the next few decades, for a bunch of reasons, and if you're willing to accept that possibility, try to absorb the fact that a section titled "Phase 3: Colonize Mars" might actually—*really*—be based in reality.

Everything from here on is based on the guesswork of Musk and others in the field. Here's those people's best crack at predicting how this will all play out:

Before anything with people starts, there will be a preliminary phase where SpaceX sends spacecraft to Mars without any people. The first step, Musk told me, would be to "send an automated spaceship to Mars just to make sure you can send something there and back"—this should happen before 2020. Then, there would be a handful of unmanned cargo missions to bring equipment, habitats, and supplies, so that when the first people start arriving, they'll be able to not die—they'll need access to water, a place to live, the tools to convert compounds on Mars to oxygen, fertilizer to grow crops, etc. ¹

Then something big will happen. Someone—probably SpaceX, probably in about ten years—will send the first crew of people to Mars. For anyone under the age of 50 who's annoyed they weren't alive and sentient in 1969 to get caught up in the excitement of the moon landing—you're finally going to have your day. Somewhere out there, right now on this Earth, is the Neil Armstrong of Mars. No one knows who they are—they might not even know who they are—but everyone on Earth will know their name soon.

This is gonna be a *big deal*.

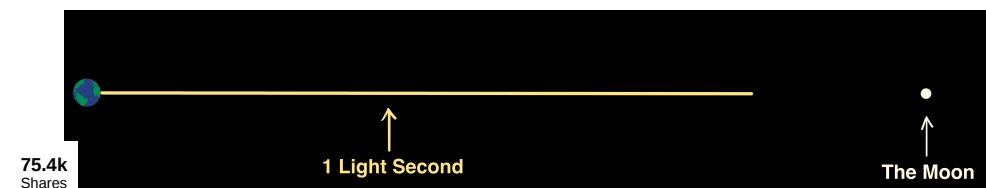
In addition to being the first time a human has set foot on another planet, it'll be *by far* the farthest away from Earth any human has ever gone.

The ISS is about 250 miles (402 km) away from Earth's surface. The moon is about 1,000 times farther away (239,000 mi / 384,000 km) than the ISS. Mars is more complicated. Think of the Earth and Mars as two people running around a track. Mars, on the outside track, takes about twice as long to run around the track as Earth on its inside track. The two planets are usually on totally different parts of the "track," and incredibly far away from each other. But every 26 months, Earth "laps" Mars and they pass next to each other on the track—this is when you want to commute between Earth and Mars.

Depending where they are on their orbits when they pass each other, they can get as close as 34 million miles (55m km) from each other. **Other times**, the moment when they pass will only bring them about 60m miles (100m km) from each other.

Even in the best-case scenario, Mars is **far**. To compare, let's bring back our meter-diameter Earth. So if the Earth is a meter in diameter, the ISS is about 1 inch (2.5cm) away from the surface. The moon is about 100 ft (30 m) away. And Mars, depending on the year, is between 2.5 and 5 miles (4–8 km) away. *Very different story than going to the moon.* If going from the Earth to the moon is crossing the narrowest part of the English channel, getting to Mars is crossing the Atlantic (and getting to the ISS is wading 117 feet (35 m) out from the beach).

One other way to look at it is by absorbing what a light second is:



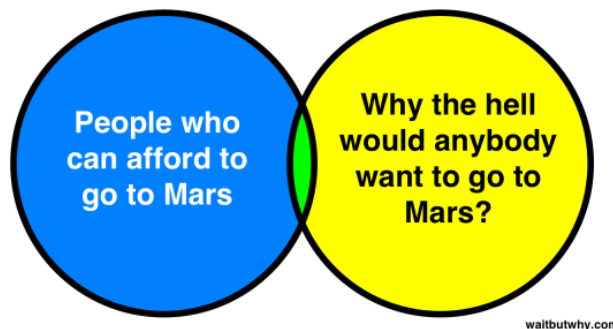
When realizing that Mars, at its very closest, is a bit over three light *minutes* away.

Next time Earth laps Mars and they're side by side is 2016—too soon to do anything. But when it happens again in the summer of 2018, don't be surprised if a vehicle with a SpaceX logo on it touches down on Mars. Musk has thrown out a rough prediction of 2025 or 2027 for the Neil Armstrong of Mars—that famous first step onto the planet. ²

Like Neil Armstrong's famous first step, this will be a great *achievement* for mankind—not a giant leap. The giant leap comes next.

So with the price of a ticket plummeting downwards and the first crewed Mars mission having opened the floodgates, we'll be ready to start colonizing. The big question will be, "Who wants to be the first to pay hundreds of thousands of dollars to go on a possibly-very-dangerous three-month trip to a much colder Antarctica where you can't breathe the air or let the sun touch your face??"

One thing we haven't mentioned yet is the *yellow circle*:



We've worked so hard to get the price into an affordable range, but we kind of forgot to ask why Musk thinks anybody would want to go in the first place.

Musk is aware of this issue and is thinking a lot about the yellow circle. In the email above, when he mentioned that "it is more fun to be on a cruise ship than a bus, so I suspect that the 100 people per flight number grows a lot over time, maybe to several hundred"—this is him thinking about the yellow circle. When he talks about the importance of making a return trip to Earth available, and free, to any Mars resident, that's him thinking about the yellow circle. When SpaceX makes art like [this](#) and [this](#) and [this](#)—that's them thinking about the yellow circle.

Here's the simple way to look at the million-people-to-Mars mission: the world will soon have 8 billion people. Over the span of the 21st century, let's say that 20 billion total people live. To get a million people to Mars within that time, you need one out of every 20,000 people to fall into the middle of the Venn diagram. So assuming those who want to go to Mars will be evenly spread out along the socioeconomic spectrum, it turns into a simple formula:

$$\begin{array}{c} \text{The fraction of} \\ \text{people who} \\ \text{can afford to} \\ \text{go to Mars} \end{array} \times \begin{array}{c} \text{The fraction} \\ \text{of people} \\ \text{who want to} \\ \text{go to Mars} \end{array} \geq \frac{1}{20,000}$$

When going to Mars first becomes an option, the price won't yet be down to \$500,000/person, and almost everyone will be horrified at the prospect of actually selling everything and blasting off to another planet—so both fractions will be way too small.

But that's okay—we won't need a million people in the green zone to get things started. The US turned into quite a thing, but in the year 1605, the green zone on the "colonizing the New World" venn diagram was tiny. The people who settled in Jamestown and Plymouth were very extreme to do so—the first groups to go to Mars will be as well.

No one's exactly sure how the transportation will work, but it'll likely be something like this: the Mars Colonial Transporter will consist of two pieces—the giant, powerful first stage, and the second stage, which will also be the spacecraft. The first stage will launch a spacecraft into Earth's orbit, then come back down (landing propulsively), refuel, undergo a bit of maintenance, and head back up with another spacecraft. This will go on for a while in the weeks leading up to the point where Earth and Mars are next to each other in orbit. Then SpaceX will send up a tanker of some kind to refuel each of the orbiting spacecraft (which also function as the second stage rockets, so they'll have spent a lot of their fuel getting themselves into orbit).

By the time the planets are in place, there will be a group of MCT spacecraft—what Musk calls the "colonial fleet"—orbiting the Earth, fueled up and ready to go, and at just the right moment, the fleet will take off for Mars.

Three-to-six months later, the spacecraft will get to Mars, descend through the atmosphere, and land propulsively. The people will get out, probably to a fun welcome celebration put on by the existing residents, and unload everything over the next few weeks.

About two years later, when the planets are again aligned, right around the time Earth is launching the next colonial fleet, the group of spacecraft that came to Mars two years earlier will head back to Earth, carrying anyone on Mars who's over it.

Three-to-six months later, the spacecraft will arrive back on Earth, land propulsively, and head in for maintenance so they'll be ready to head back to Mars in two more years.

And repeat.

The earliest settlers will have a hard job, like early settlers always do—they'll have to build themselves a livable situation, and eventually, get working on the first Martian city. For this reason, Musk guesses that early on, for every spacecraft that goes to Mars carrying people, *ten* will need to go carrying cargo and supplies.³

Some initial things they'll need:

- **Energy.** Nuclear is a possibility, but Musk thinks it'll be mostly solar. Early on, panels will need to be brought from Earth, and Musk has the idea to make them flexible and inflatable so they can be rolled up (like one of those upsetting [party blowers](#)).
- **Oxygen.** There will need to be an oxygen-producing plant. Plentiful raw materials include atmospheric CO₂ and ground H₂O, so making oxygen won't be that hard.
- **Water.** Lots of ice on the poles and supposedly ice at other latitudes too, as well as ice underground, so I'm sure it'll be a pain in the ass, but they'll be able to create a pipe system that brings plenty of liquid water into the settlement.
- **Food.** Farmers and botanists will be needed, along with fertilizer and a pressurized greenhouse.
- **Inside.** You can't go outside on Mars without a spacesuit or the lack of air pressure will boil your blood, the temperature will freeze you to death, and the sun radiation, without much atmosphere or a magnetic field to block it, will peel your skin off like a serial killer. I'm a big proponent of being indoors on Earth, but on Mars, it's where life happens. For the first few decades at least, Martian cities will be inside large domes. Early settlers will build a smaller [hab](#) to live in while they work on building the larger domed complex. Other insides that will be needed will be for storage, construction, schools, hospitals, and other things humans will need.
- **Rocket fuel.** So the spacecraft can return to Earth. The MCT will use methane as the fuel (for lots of reasons I don't really want to explain and you don't really want to hear). Methane is just CH₄, so again, between Mars' CO₂ and H₂O, this will be doable. They'll also need to make fuel for ground transportation on Mars—rovers, etc.
- **Internet.** This will be taken care of by satellites (probably SpaceX satellites made in the Seattle operation they're starting), and it'll be super fast.
- **Other obvious equipment.** For communication, medical care, construction, etc. etc.

This is a bare-bones list for initial critical survival purposes. But over time, more people will make the migration, the city will be increasingly developed, and the settlers will be able to start building things that make for a decent lifestyle: restaurants, bars, movie theaters, sports facilities, etc.

And then, something will start to happen.

The hardest part will be over, and more people will want to go.

The first return ships will come back with people, and it'll remind everyone on Earth that it doesn't have to be a one-way ticket—and more people will want to go.

The people who come back to Earth will be commended for their courage, some of the people on Mars will write best-selling books about their experience, and others will film a little TV show about the early settlement and become household names on Earth—and more people will want to go.

People on Earth will see gorgeous photos of Martians hiking around on Olympus Mons and in Valles Marinaris, a mountain and canyon far bigger than any on Earth—and more people will want to go.

People will hear about being able to jump off a 20-foot cliff without hurting yourself and watch viral YouTube clips of new kinds of extreme sports that can only be played with Mars' 38% gravity situation—and more people will want to go.

And in case you were wondering if this is going to be a vacation jaunt, Musk explains, "It's not going to be a vacation jaunt. It's going to be saving up all your money and selling all your stuff, like when people moved to the early American colonies."⁴ But he also points to the excitement and novelty of getting to found a new land—an experience that stopped being possible on Earth centuries ago: "There will be lots of interesting opportunities for anyone who wants to create anything new—from the first pizza joint to the first iron ore refinery to the first of everything. This is going to be a real exciting thing for people who want to be part of creating a civilization."⁴

Meanwhile, as desirability increases and the yellow circle grows, SpaceX will continue to innovate, and each 26-month cycle, the price of a ticket will be lower than the last—and the *blue* circle will grow.

When SpaceX starts demonstrating that sending people to Mars is a viable business opportunity, other entities may jump in to compete. Musk doesn't believe any entity in the world other than SpaceX is making strides on this problem in a serious way right now (he doesn't take [Mars One](#) seriously), but if others—either private companies or large space agencies like ESA or the Chinese Space Agencies—join the effort for their own selfish reasons, he thinks that'll be helpful to the cause.

What this all adds up to is that once the first crew lands on Mars, it seems likely that with every Earth-Mars synchronization thereafter, the number of people choosing to migrate will grow—perhaps exponentially. By 2040, Musk thinks there will be a thriving colonial Martian city.

And one day after that, sometime in the future, an incoming fleet will arrive on Mars, and for the first time, the planet’s population will top 1 million.

We’ll have made it to Point B.

Musk probably won’t be around to see us reach Point B. He thinks it’ll take at least 40 or 50 years of fleet migrations to happen, which, if things start in the mid-2020s, brings us to around 2070, when Musk will be 99. But he may get a chance to spend time in a high-tech Martian city. He said he’d like to go later in life, then return to Earth, and eventually head back to Mars for retirement and stay for good—but only on one condition: “I’ll go if I’m certain that SpaceX will be fine without me, and that path will continue.”²

More than any particular Mars population goal, Musk wants to die knowing we’re on our way to what he describes as “the threshold at which even if the spaceships from Earth stop coming, the colony doesn’t slowly die out.” That, he says, “is the critical threshold for us as a civilization to not join the potentially large number of one-planet dead civilizations out there.” A million people is his rough estimate for where that threshold lies, but no one knows for sure.

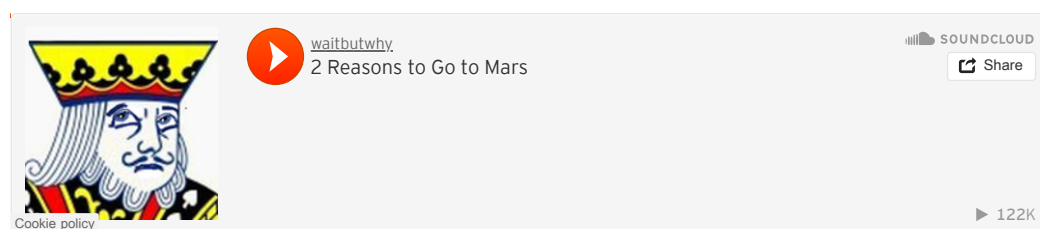
When—if—we do one day get to that point, only then will we have made the giant leap for mankind Neil Armstrong referred to. Humanity’s future will be much more secure and much more likely to survive deep into the future. The hard drive will be backed up. And somewhere out there, Quigley will throw his napkin in disgust.

Time to bring Barney Frank back into this. When you understand the reasons behind why SpaceX is trying to put people on Mars, doesn’t it make politicians like Frank—the one who called the pursuit “a complete and total waste of money”—seem a bit short-sighted?

When I hear a government saying, “Let’s not worry about going to Mars right now when we still have so many problems right here on Earth”—it sounds to me like a person saying, “I’ll worry about my health later when I don’t have so many bills to pay.” There will always, *always* be important problems to address on Earth, but if we allow what’s urgent here to prevent us from addressing what’s important in the big picture, we’re allowing ourselves to take a huge existential risk.

The other reason to go to Mars

There are two major reasons Musk wants us to go to Mars, and backing up the hard drive is only one of them. I’ll let Elon tell you about the other himself, in this one-minute clip from my first discussion with him in the SpaceX cafeteria (the clip is [here](#) if the player doesn’t show up):⁵



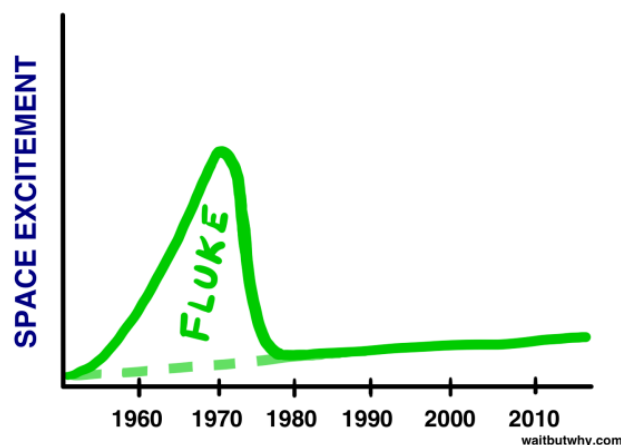
In this post, we’ve talked mostly about the first, very long-term reason to colonize Mars—what Musk calls “the defensive reason”—and in order to see why that matters, we’ve had to zoom way out. But when he talks about his other reason for pursuing Mars—because he believes it will be “the greatest adventure in history”—Musk is zooming way *in*. This second reason isn’t about the far future and the fate of the species, it’s about everyone who’s alive right now and the way we’ll all get wrapped up in the adventure, even if we have no interest in going to Mars ourselves—and how that might change how we feel about the world and our lives.

To hammer in the point, Musk references the Apollo missions:³ “Life has to be more than about solving problems. There have to be things that inspire you—that make you proud to be a member of humanity. The Apollo program is certainly an example of that. Only a handful of people went to the moon—and yet, actually we all went to the moon. We went with them vicariously. We shared in that adventure. I don’t think anyone would say that that was a bad idea, that that wasn’t great. We need more of those things—at least we need *some* of those things.”⁶

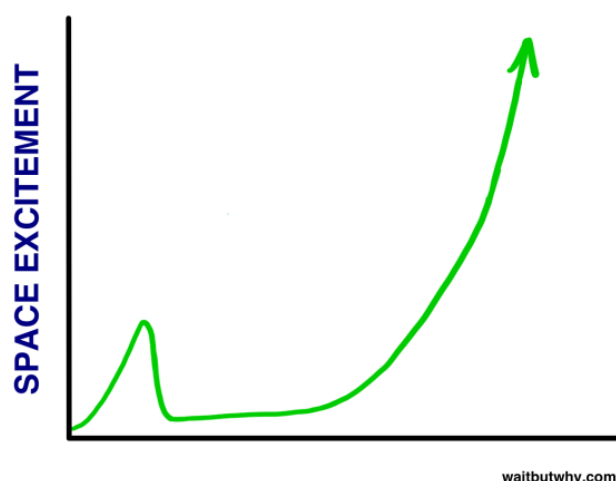
Space used to inspire everyone—that’s why so many children in 1970 wanted to be an astronaut. But I grew up in the 80’s and 90’s, a time when the world’s attention had returned to Earth and space was

back to being a sideshow—and no one I knew really thought about being an astronaut. As Ashlee Vance writes, “It seems unfathomable, but the rest of the space industry has made space boring.”⁶

I’ve always envied everyone who was alive during the excitement of the moon landing in the late 60s. When I’ve thought about *The Story of Humans and Space*, the 1960s always seemed like a fluky decade of supreme excitement in the middle of an otherwise calm and steady trajectory:



But now, I’m seeing the moon landing more as a precursor of something *much* bigger. Without realizing it, we may be standing on the precipice of one of the great leaps in biological history, and the moon landing may later be seen as the first labor contraction in the birth of an entirely new era for life on Earth. And somehow, we may actually be alive as that new era dawns.



Of course, this is the optimistic story—which is what you’d expect to hear in a post about SpaceX whose main source is Elon Musk. There are many other less fun ways this story could play out. Maybe a \$500,000 ticket to Mars proves totally impossible. Maybe Musk is wrong in his assumption that there’ll be plenty of will if he can just offer the world a way. Maybe life on Mars turns out to be a living hell that breeds insanity and quickly descends into a lawless nightmare. No one can be sure.

That’s the thing about stories—you don’t know what happens in the pages you haven’t read yet.

But my gut says that we’re probably much closer to the *beginning* of *The Story of Humans and Space* than the middle or the end. It seems like we’re right around the end of “Chapter 1: Confined to Earth”—maybe on the very last page. And as the story moves forward, it may begin to take place on a much wider stage than the Earth, making *The Story of Humans and Space* ultimately indistinguishable from *The Story of Humans*.

It’s no more possible to predict what will happen in those chapters than it would have been for a farmer in 2500 BC Mesopotamia to envision our world today, but SpaceX—the world’s most ambitious company—is on a mission to write the first pages of Chapter 2 and launch the story in a hopeful direction (assuming you consider a long-lived human species is a hopeful concept).⁷ Let’s finish up this post by imagining what might happen if they succeed.

A SpaceX Future

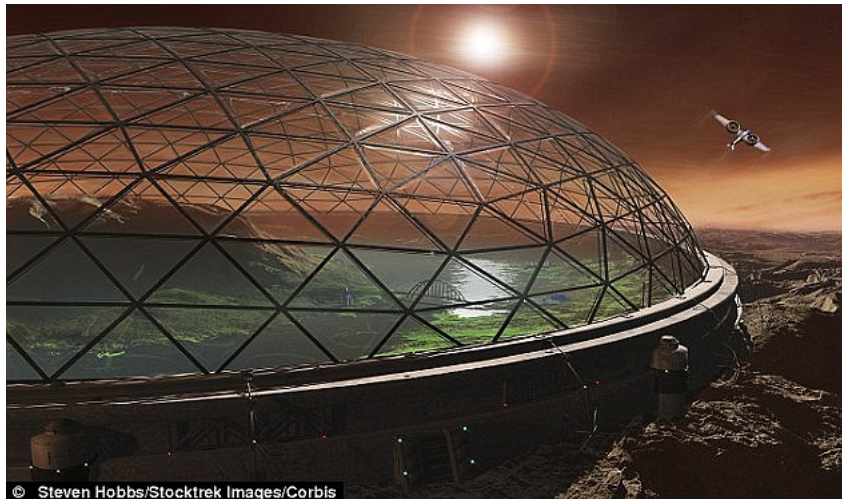
Pondering a SpaceX future starts with the question, “If we get a million people onto Mars...what happens next?” Here are some possibilities:

A Blue-Green Mars

Fish need to live in the ocean. Their whole life plan is based on being in the ocean. And if you take a fish out of the ocean, it’s going to agonize for a few minutes and then die.

The Earth’s atmosphere is humanity’s ocean. Every cell in our bodies has been designed to work in the exact conditions that exist on the surface of the Earth—and our demeanor standing on the surface of Mars would match the demeanor of a fish after it’s caught and flopping around in a bucket on a boat.

When you buy a fish as a pet, you get a fishbowl to create a tiny slice of ocean in your house for the fish to live in. When we first move to Mars, we’ll live in a humanbowl—maybe one like this: ⁵



Our humanbowl will be a little bubble of Earth surface conditions, regulating the temperature, air pressure, oxygen levels, and incoming solar radiation to be *just* the way we like them—and the way the food we’ll grow likes them. If it weren’t for the glass ceiling far above you with a red sky ⁸ beyond it, and the fact that you can jump super high, you might forget you’re not on Earth.

And as a temporary plan, a humanbowl works fine. But life on Mars isn’t a temporary activity—the idea is for a growing human population to live there for thousands of years. That’s why Musk calls Mars “a fixer-upper of a planet.” ⁶

So the next challenge after colonizing Mars will be something even harder—we’ll have to turn Mars into our *home*.

We have a word for this. Terraforming. Terraforming a planet means changing its conditions to match Earth’s. And that’s the power of technology—with enough of it, we could literally Earthify an entire *planet*.

How exactly we’d go about this is highly speculative, of course, and right now all we have is a handful of potential strategies. But the basic process should go something like this:

1) Melt the huge amount of ice on Mars’ south pole.

There’s enough ice on Mars to cover the whole planet with an ocean 36 feet (11 m) deep. If we could melt it, we’d start a chain reaction. We’d melt some of the ice, which would release a lot of CO₂ that’s currently trapped inside of it, along with water vapor coming off the now-liquid oceans. These greenhouse gases would densify the atmosphere and begin trapping more and more sun energy, which would further heat things up. More heat would melt more ice, release more CO₂ and water vapor, trap in more sunlight, and heat things up even more. An overall temperature increase of only 7 F (4 C) is enough to trigger this runaway greenhouse effect.

There are lot of ideas about how to get this runaway process started—ranging from putting mirrors in space to direct more sunlight at the planet to exploding nuclear bombs on the poles ⁹ to directing an ammonia-laden asteroid to smash into the planet. ⁷

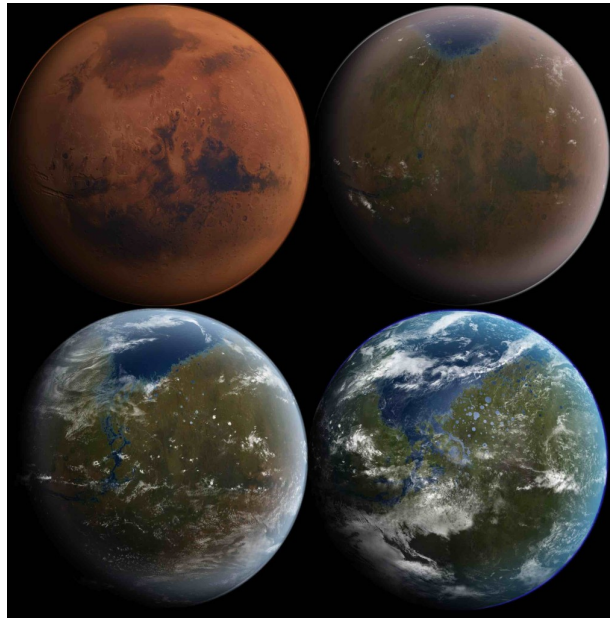
2) Speed things up by pumping super greenhouse-y gases into the air.

Humans could accelerate this process by creating factories that convert elements on Mars into greenhouse gases. CO₂ would work, but scientists have other, specially-designed gases in mind too that are far more potent at trapping in sun energy—like methane or chlorofluorocarbons (CFCs).^[8]

3) Plant stuff

We'd start with microbes that could survive in a place like Antarctica, then moving onto simple plants like mosses, and eventually, vast evergreen forests.

Then, things start moving by themselves. NASA planetary scientist Chris McKay says, "You don't build Mars, you just warm it up and throw some seeds."^[9] In other words, if you do steps 1–3 above, eventually, this will happen:^[10]



And when that starts happening, one by one, our life-on-Mars problems will begin to be solved. Mars will have weather, the temperature will be cold, but livable, the pressure will be low, but livable—and all of these things will get better and better with each passing year. People will be able to walk around outside without a space suit. But for a long time, not without a mask. Which brings us to the hardest part of terraformation—

4) Make the air breathable.

Because of both the photosynthesis factories we'll build and all the real photosynthesis from the new plant life, oxygen levels on Mars will be increasing. But slowly. This is the one step that with our current technology, we can't do within a century or two. Scientist estimates for how long until the Mars air becomes breathable range from 300 years to multiple millennia.^[11] So unless there's a technological breakthrough, for many generations, life on Mars will mean wearing masks outside.

One day, probably more than 1,000 years from now, Mars will be completely terraformed. When that day comes, you'll see a picture like this—^[12]

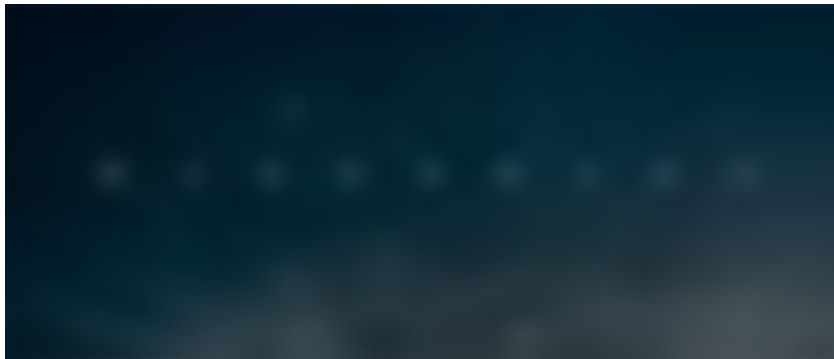


—and you won't know which planet you're looking at. Earth and Mars will be two normal places that take three months to travel between—just like America and Europe only 100 years ago, before airplanes allowed you to zip back and forth between them. Someone could choose to live their life on Earth but go to college on Mars. A retired couple on Mars might decide to voyage to Earth as an extended travel adventure. Businesses can have headquarters on each planet. Earth people and Mars people will be in close touch, emailing and texting and watching each other's movies and TV shows (no phone calls or Skype convos though—because data transfer is limited by the speed of light, a message sent from one planet takes between three and 22 minutes to get to the other, depending on the planets' locations¹⁰).

All of this is possible. In a [paper](#) on the subject, aerospace experts Chistopher McKay and Robert Zubrin conclude that “a drastic modification of Martian conditions can be achieved using 21st century technology.”

Beyond Mars

One day, this video might be real:



When writer Ross Andersen [asked](#) Musk about the prospect of moving beyond Mars to other places in the Solar System, Musk was optimistic: “If we can establish a Mars colony, we can almost certainly colonize the whole Solar System, because we'll have created a strong economic forcing function for the improvement of space travel. We'll go to the moons of Jupiter, at least some of the outer ones for sure, and probably Titan on Saturn, and the asteroids. Once we have that forcing function, and an Earth-to-Mars economy, we'll cover the whole Solar System.”

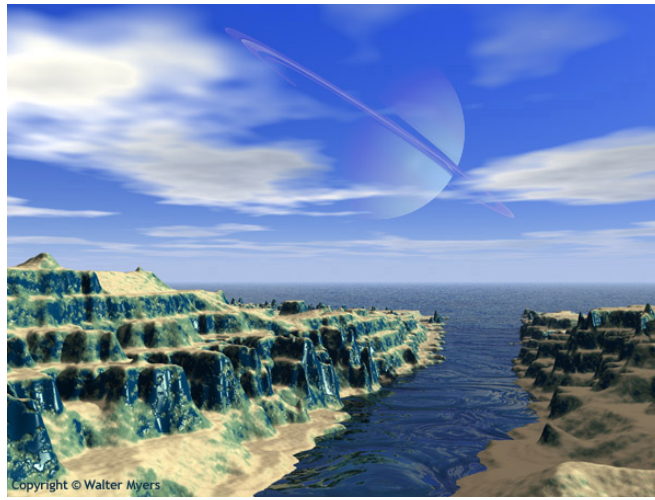
But, he added, “the key is that we have to make the Mars thing work. If we're going to have any chance of sending stuff to other star systems, we need to be laser-focused on becoming a multi-planet civilization. That's the next step.”

In that way, colonizing Mars isn't just important because we expand outward and back up the hard drive, but also because colonizing Mars turns us into a species that *knows how to expand to new planets and terraform them*. It builds us what is probably the most important skill a species can have if they're to survive for a long time.

With enough time, we'll move out to many other bodies in the Solar System, and we'll terraform each of them into a place humans can call home. This opens up some *weird* possibilities. Like hiking through a forest with Jupiter hovering overhead:¹³



Or a day at the beach, with Saturn out on the Horizon:¹⁴



The Solar System could become one vast world for humans. Maybe Jupiter's moon Europa becomes known as the Solar System's tech hub, while Saturn's Titan becomes the place you have to move if you really want to be in the entertainment industry. Maybe some people will spend their whole lives on one heavenly body, while others will be avid travelers and brag that they've set foot on 12. Maybe the Solar System's Grand Congress will make "Earth history" a required class in school, and students all over will grow up yearning to one day visit what they'll refer to as the Cradle of Civilization, to see its huge animals, famous cities, and ancient ruins.

Outward

We won't stop there. Spreading through the Solar System will buy us lots of time, and lots of time will lead us to magical new technologies, and at some point, we'll be capable of making the long journeys to other stars and the Earth-like planets circling them—becoming a multi-solar civilization. Like the earliest settlers to the New World in the 17th century and the earliest settlers to Mars in the 21st century, at first, only the boldest will choose to make the multi-decade migration. And similar to the past, with time, moving your family to other solar systems will become commonplace.

The limitation of the speed of light will mean someone might receive daily updates from an old friend circling another star, but they'll actually be catching up on what happened ten years ago in the friend's life, and if they respond with a question, they'll have to wait 20 years for the answer. The distance will isolate populations from each other, and with enough time, humans in different solar systems will no longer be the same species.

The light of consciousness that flickered on millions of years in the past on humble little Earth will spread throughout the galaxy and into other galaxies, branching into thousands of different life forms. Most beings in the lineage will be hazy on where it all started, but those who know their history will be able to tell you all about the Great Leap, that pinnacle moment in antiquity when their primitive ancestors emerged from the womb and became conquerors.

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Extra Post #2: [The Deal With the Hyperloop](#)

Extra Post #3: [SpaceX's Big Fucking Rocket — The Full Story](#)

And a new one, written in 2017, about a whole new Elon company: [Neuralink and the Brain's Magical Future](#)

Two other posts that reframed what I thought I knew about the world:

[The AI Revolution: Road to Superintelligence](#)

[The Fermi Paradox](#)

Or for something a little less existential crisis-y:

[How to Name a Baby](#)

[10 Types of Odd Friendships You're Probably Part Of](#)

[Why Procrastinators Procrastinate](#)

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Sources

Researching this post involved over 100 sources, most of which are cited in the little gray source footnotes or in hyperlinks throughout the post. Rather than list every one of them here, which isn't that useful for anyone, I'll talk more broadly about how I went about my research:

- **Conversations.** I was amazingly fortunate to have a lot of access to Elon Musk during this process. I used that access to ask him my still-unanswered questions after having done significant research and to try to dig into the deeper philosophies behind why he's doing what he's doing. I also had extended conversations with a number of senior SpaceX staff, NASA astronauts [Sunita Williams](#) and [Karen Nyberg](#), and several senior NASA and CASIS staff at the recent [CASIS conference](#).
- **Websites.** My Chrome has had a psychotic couple months and I was all over the place during my research. I found sources the usual ways—googling, scanning the bibliographies of relevant Wikipedia articles, etc. But I found myself on a few especially-helpful sites again and again—[spacex.com](#), [nasa.gov](#), [space.com](#), and this convenient [list](#) of manned space launches. Some good stuff on Reddit too, like the [space](#) and [spacex](#) ¹¹ subreddits. I also used this post as an excuse to dig into the sites of two of my favorite space-obsessed internet writers/artists: Randall Munroe's [xkcd](#) (which is full of fascinating comics and posts about [rockets](#), [planets](#), and [probes](#)), and Jason Kottke's [kottke.org](#) (where I filtered space-related posts using the [space tag](#)).
- **PDFs.** A useful research technique—google “[thing you want to learn about] pdf”. It's amazing how many rigorously-researched papers from the world of academia are just sitting around the internet with no one to hang out with. For example, you can do a google search to read about the deal with the satellite industry and come up with a hit-or-miss list of not-that-thorough articles, but if you add “pdf” in there, you quickly find [this](#), which ended up being my main source about the satellite industry, and [this](#), which told me everything I wanted to know about space debris.
- **Books.** Like it has for all of these posts, Ashlee Vance's [Musk biography](#) was full of useful tidbits that I used for the post. I also coincided writing this post with listening to the audiobook of [The Martian](#) during all showers and commutes, which wasn't useful to the post at all. But the book is awesome and deliciously technical-in-a-fun-way, and if you liked this post, you should probably read the book.
- **Watching Musk interviews.** If you want to hear more from Musk, there are a ton of Musk interviews on YouTube, many of them gathered on [this page](#). Some good ones: Musk's [interview with Sal Khan](#), his [interview and Q&A at MIT](#), and this [interview](#) where they kept stressing him out by asking him really personal questions. There are also a million awesome videos of SpaceX and other companies' rockets and engines in action, which can become quite the rabbit hole.
- **Documentaries.** Not SpaceX related, but I'd recommend a couple fantastic documentaries about the Apollo and Space Shuttle programs: Ron Howard's [In the Shadow of the Moon](#) and the six-part [When We Left Earth](#).

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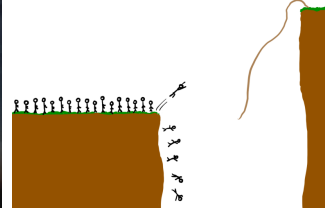
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Name



maria juchkov • 23 days ago

Absolutely love the series! But I have a few questions...

If Mars is to be the Plan B for Earth, why send people back to Earth? And when the time does come that Earth will become uninhabitable will SpaceX & Mars be able to cope with a mass exodus?

And further more, does Elon have any plans for what type of economic system will be on Mars? After all, what's the point colonising Mars, only to live unsustainability & trash it too...

[^](#) | [v](#) • [Reply](#) • [Share](#)



stephenshenfield • 2 months ago

The author neglects the medical effects of switching between different gravity environments. Even with well-designed exercise routines, astronauts who spend any length of time in space suffer serious physical disabilities on return to earth. Among other things, this will deter people from returning to each after even a couple of years on Mars (plus 6--12 months in space).

Another problem is the selection of colonists by ability to pay initially very high fares rather than by possession of needed skills, good physical and mental health, age, etc. If selection is based on criteria such as these most of those selected will not be able to afford the fare, so a lot of money will have to be raised from wealthy people who will not themselves be able to go to Mars.

The technical aspects of development of extraterrestrial colonies are outlined, but there is hardly any discussion of political and economic systems. The assumption seems to be that these will resemble those on earth, which is likely to be impracticable, especially at the early stages, and would also be undesirable, seeing what a mess these systems have made of earth. If two or more space powers set up their own colonies on the same planet what will the relations between them be?

[^](#) | [v](#) • [Reply](#) • [Share](#)



Summer of Love (bob) • 5 months ago

Tim, I'm afraid Musk sold you a load of manure on Mars. It is unlivable for humans and always will be. Reference the failure of the earthdome projects and you'll quickly realize domed cities don't work even on Earth, muc

1 [^](#) | [v](#) • [Reply](#) • [Share](#)



2ndGenSunRoad • 5 months ago

We on Earth are not in Energy paradise to sustain life on other planet, but actually in Energy prison;

"No device can generate energy in excess of the total energy put into constructing it".

<https://the-fifth-law.com/p...>

1 [^](#) | [v](#) • [Reply](#) • [Share](#)



GregWA • 6 months ago

"measuring contest"...have you actually read the history of Nazism or Communism? They weren't measuring anything...they were and are evil totalitarians hell bent on killing those who disagreed or would not submit (like radical Islam). And if you think this level of evil is restricted to modern times, read some more history. Musk and his family colonizing Mars as a modern day Ark story would not result in evil being excluded. I like science and I like science fiction, speculation, the rest, but please keep religion and politics out of it. Scientists, myself included, are typically no more qualified to expound on these things than anyone else. So I offer this post in that spirit: just one guy's opinion based on a little knowledge and much less wisdom.

p.s., Americans weren't horrified by the Soviets larger penis (first satellite/human in orbit), they were horrified that the Soviets could now deliver nuclear weapons to America, with no warning or protection possible. Did you miss that bit of history or does that just boil down to a "penis measuring contest" for you? Sorry for the attitude, but I'm an old guy losing patience with how little people have learned from all of humanities mistakes.

2 ^ | v • Reply • Share >



The_Unknown • 8 months ago

What about the reduced gravity on Mars? It's 38% of the gravity on earth if I recall correctly. Research has shown that microgravity in the ISS has a detrimental effect on muscle mass and bone density and even on organ function. Sure the first two can probably be solved by exercise but the organ function can't. And even if there's a big difference between almost no gravity and 38% of earth's gravity, there's no telling what the effect of long term (years or decades) exposure to this reduced gravity will be on human organs.

Reading these series of posts I do believe in the colonization of Mars but this reduced gravity has gotten me wondering about the long term feasibility of all this.

1 ^ | v • Reply • Share >



Ante Renic • 9 months ago

Tim, take note. Your "what is an orbit" blue box gets several things wrong.

1) You said ponds have no high and low tides due to their lower mass than that of oceans. Their mass is completely irrelevant as acceleration is always the same, regardless of mass. Ponds don't experience high tides because there is no water that comes over from the back of the planet. Similarly there's no low tides because the water has no route to take to the other side of the planet.

2) The trajectory of a ball being fired at too high a speed would not look like that. It's not like it would circle for a bit and then start moving straight through space. The Earth is still acting on it, regardless of distance. As it moves further away, the curvature of the trajectory will become lower and lower, but it will always curve a little bit, it will certainly never become straight, not in the manner depicted, anyway.

3) Thrown objects would only fly in a circle if the source of gravity was in the center of the circle. This means that the trajectory of thrown objects isn't a circle even before they hit the ground. If the ground was a straight line (which it is if we zoom in enough, as in most physics problems) and gravity acted exactly downwards all the time, the trajectory would be a parabola (no air resistance). If the direction of gravity changed such that it's always perpendicular to the velocity, the trajectory would be a circle, as I've explained above. If the gravity, however, does change direction but is not always perpendicular to the trajectory, as is the actual, realistic (and drawn) case here, the trajectory would be something between a parabola and a circle. Note that trajectories can also be ellipses; in fact, a circle is mathematically merely a special case of an ellipse (just as a square is a special case of a rectangle).

For the third note you can just add a blue square thing which says that the trajectory isn't exactly circular, but whatever.

Also note: Tesla started with 30 million, not 70 million. Elon's share of Paypal's sale was 130 million, so 100 went to SpaceX.

^ | v • Reply • Share >



Ralph Fischer • 9 months ago

Main reason for bad wind and temperature on Venus is the fact that it got almost no rotation.

In order to colonize Venus i assume first it needs to be hit by some pretty big Asteroid to start a rotation.

Might even need a mass close to the moon.

2 ^ | v • Reply • Share >



Ralph Fischer • 9 months ago

I think you got that one wrong: "Humans have never experienced a mass extinction event, and if one happened, there's a reasonable chance it would end the human race"

Humans faced black death and that took quite a bite into population.

Not to mention that we WITNESS a mass extinction event right now while reading. It is caused by many many humans totally ignorant to the fact that their actions are about to kill loads of liveforms, including bees. High chance that the mass extinction event for humans is just waiting for new years day.

^ | v • Reply • Share >



Nicole Song ↗ Ralph Fischer • 9 months ago



Right, but the bubonic plague only killed about a third of Europe's population. It didn't even spread to any other continents. I'd say we're fine, it was not a huge event in humanity, unless you're strongly Euro-centric.

3 ^ | v • Reply • Share >



Brandon • a year ago

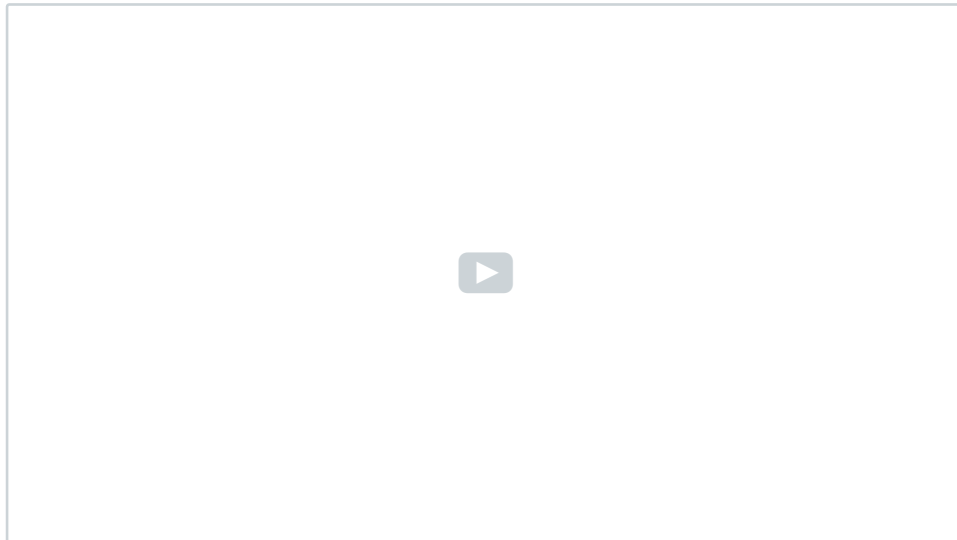
I'm wondering whether the Martian calendar will start at year 0 from the day the first human set foot on the planet. That would be so huge. Finally not a religious calendar, but a true scientific calendar celebrating every 669 martian days the moment the first humans set foot on the planet.

5 ^ | v • Reply • Share >



Hans Nelson • a year ago

Have you seen the "Economics of Airline Class" video by Wendover Productions on YouTube? I just happened to have seen this the other day, and it seems like it would be an interesting idea to toy with on the Mars Colonial Transporter. Thoughts?



^ | v • Reply • Share >



Michele • a year ago

How much space debris was added when the United States shit on the world's collective face in 1985 by destroying a satellite in orbit, and again in 2008?

4 ^ | v • Reply • Share >



Isabella Pintor • a year ago

great article it took me an hour to read it but.. it was worth it

1 ^ | v • Reply • Share >



Nicolas Stabilini • a year ago

I'm really concerned about horoscope... how would astrologys get an astro-chart for a human born in Mars? (btw: I think horoscope is big big ball of bullshit)

^ | v • Reply • Share >



ImmortalWind • a year ago

Hey Tim, I was researching a little bit about Voyager's destination and it's actually NOT heading to Proxima Centauri as you seem to imply (unwillingly) in the Voyager section above. You might want to change this sentence.

3 ^ | v • Reply • Share >



Blaine • a year ago

One thing I haven't yet seen anyone address is how the 38% Earth-gravity on Mars will affect humans that live there for long periods of time. Would a Martian-born-and-raised person who traveled to Earth be weak and unable to walk (or walk with great difficulty, bearing three times their normal weight) under the influence of the heavier gravity? If their muscles had only experienced the lighter gravity of Mars, wouldn't living on Earth be incredibly difficult for them? I feel like Martians would be at a physical disadvantage if they ever left their home planet. Am I wrong here?

8 ^ | v • Reply • Share >



Michael Pang → Blaine • a year ago

Yes I'd imagine that to be the case - although they're genetically the same so it's nothing a few months of working out shouldn't be able to fix.

^ | v • Reply • Share >



iamGrimalkin → Blaine • a year ago

How 38% gravity will affect humans is unknown, because no-one has ever been in 38% gravity for

long periods. However, research in the ISS and other space stations does give an idea of what zero gravity is like. Bone density and muscle mass does increase after long periods in zero-g, but it is possible to mitigate that by using the right exercise machines for 2 hours a day (if I remember correctly).

^ | v • Reply • Share >



Drabes → lamGrimalkin • a month ago

I think you mean muscle mass and bone density decrease...

^ | v • Reply • Share >



lamGrimalkin → Drabes • a month ago

Yes, I did mean that, thanks for the correction.

^ | v • Reply • Share >



Babette • a year ago

You said : "The spacecraft provided the rest of the boost after the rockets dropped away, using fuel from the big, for-some-reason-orange fuel tank."

At first they wanted to paint it white, until they found out that it saved 3000 kilo's not to. That's the reason why the thing was orange. Funny I remembered that detail but pleased to fill you in :-)

5 ^ | v • Reply • Share >



iykcvth • a year ago

good article ;)

^ | v • Reply • Share >



guest • 2 years ago

The article talks about a lot of awful people in positions of power who weren't using space technology for positive things like Musk wants to, but for "measuring contests" like America vs. the Soviet Union, and other destructive military applications that continue the international measuring contest and line the pockets of politicians like Mr. Shelby. Now the US only wants to improve their space tech because another measuring contest is on the horizon -- and it's with some very scary people who are mixing mythology in with their measuring contest.

The Middle East is a mess enough to begin with, but now we've got Iran to deal with, firing off rockets for their moon god? As if that wasn't bad enough, there's the perpetual Iran-Saudi (Shia-Sunni) divide in Islam, vs. the Jewish government in Israel and whatever's left of millennialist Christianity in the United States government (not millennials as in teenagers with smartphones, but a sect of Christianity that believes in ushering in the Revelation through a massive, population-culling war in the Holy Land).

Imagine a sequel to the US-Soviet space race that boils down to a holy war, using cutting-edge technology to fulfill the prophecies of Bronze Age storybooks. 100 million people already died as a result of the global US vs communist "measuring contest." 100 million more died before that because Adolf, Tojo and Benito had a measuring contest with Franklin, Winston and Josef. On the micro level, a young man, the nephew of a local legislator, was brutally murdered in Chicago over the weekend because of a "measuring contest" over who had the better pair of sneakers. People have been assaulting each other over having the opposing US presidential candidate's bumper sticker on their car. This is what you call intelligent life?

Why the \$%& does Elon want to save a species of \$%&#-flinging monkeys who are hard-wired to pursue these immature, but globally destructive, "measuring contests," whether in the name of money or ego or the claims of their gods? Why doesn't he focus on making the Martian mission a real-life Noah's ark instead? Just him and his family taking the animals and plants on a trip to get away from the god-botherers and their "measuring contests."

^ | v • Reply • Share >



Ed Jagger → guest • a year ago

It's because Elon Musk is a very astute businessman. The radiation and low gravity environment will not allow long-term human survival on Mars, even with an artificial atmosphere, hydroponics, underground shelters. Human physiology and development did not evolve to exist in such an environment. Musk secretly knows this. It's the reason there are no plans for practice colonies on the Moon (which is much nearer). I agree that his modernised space-freighter system will make him more money than God - and he is doing a very good job of advertising Space X using this 'Mars mission to save humanity' But I'm afraid in the end it boils down to profit and share-holders, like everything else.

^ | v • Reply • Share >



Steve → Ed Jagger • a year ago

Read more about Musk. This is an easy story to tell about him, but it's not supported by evidence. The evidence is very good that he is actually hell-bent on colonizing Mars.

Also, the radiation concern, while nonzero, is way overblown. Here's some info:

<https://www.reddit.com/r/sp...>

1 ^ | v • Reply • Share >



Jonas Friedmann → Steve • a year ago

You are hopefully right. There is a German physicist named Harald Lesch who says it

makes no sense to colonize the mars. He says more or less it is not possible to create an atmosphere because the Mars has no magnetic field. We are not able to increase the mass. And solar winds will shave off any atmosphere we could build up. And even if it would be possible to create a stable atmosphere, the two moons Phobos and Deimos will rub at the atmosphere. Following they lose their energy and crash into the Mars. Than everything is destroyed again and for 100 thousand years no living will be possible again. What do you think?

^ | v • Reply • Share >



Steve → Jonas Friedmann • a year ago

Well, it's always about the quantitative facts. It took Mars (hundreds of?) millions of years to lose its atmosphere; if we come up with any way to terraform it within thousands or tens of thousands of years, that method will easily be able to keep up with the solar winds.

As for Phobos and Deimos, I haven't heard of that. They're pretty small as far as moons go -- 6 and 10 km radii -- so their impact wouldn't destroy everything for 100,000 years. Could be a problem, but a civilization able to terraform a planet should have some ideas about that -- e.g. blowing them into smaller chunks to make the impact far less severe.

However, in any case, what matters for whether or not people go colonize Mars isn't what will happen in the end, but what they believe will happen. If people believe that colonizing Mars isn't a doomed venture, and want to do it, then they'll do it, right or wrong.

^ | v • Reply • Share >



inservo → Steve • a year ago

you definitely need to work on your perspective. There are much much much more non-US citizens on planet earth and maybe (hard to imagine for the standard US dickhead, I know) some have political systems that are maybe not perfect but at least do soemhow work.

If you want to throw your country in the trashcan, do us all a favour and go on but do not take everyone else with you.

^ | v • Reply • Share >



Steve → inservo • a year ago

Was this supposed to be a reply to me? I don't see the connection.

2 ^ | v • Reply • Share >



Hayley Mac • 2 years ago

Is anybody else up for moving to Mars for four years to escape the Trump presidency? We can clean up the mess when we're back in 2020.

2 ^ | v • Reply • Share >



guest → Hayley Mac • 2 years ago

Stop bringing politics into this. Your type is exactly the kind of tribalism that's makes the Squeegle alien or whatever his name is root for humanity's imminent demise. All I pointed out above is that there are people who stab each other over sneakers and start world wars over "measuring contests" like the article talked about, and that maybe Musk is trying to back up junk data that belongs in the recycle bin. He should focus on saving polar bears and elephants, instead of "Never Trump" or "Never Hillary" monkeys who fling poo at each other because their guy is better.

1 ^ | v • Reply • Share >



Hayley Mac → guest • 2 years ago

That comment was meant in light-hearted jest. I assure you I have no intention of moving to Mars.

Ironically I've just watched the latest episode of South Park and it appears Cartman has had the same idea.

1 ^ | v • Reply • Share >



Yian Huang • 2 years ago

Why aren't they colonising the Moon first or simultaneously, as a proof of concept and/or to get people excited?

^ | v • Reply • Share >



Dan Apted → Yian Huang • 2 years ago

Your question is very appropriate. Colonization of LEO is the first step, Colonization of Geosynchronous orbit is the second step. Colonization of L1 and L2 orbit is 3rd step. Lunar colonization is 4th step and industrial mining/colonization of the asteroid belt is 5th step and colonization of LMO (Low Mars Orbit) is the 6th and final step before we invade Mars. Just figuring out where to land on Mars as a first step in the invasion is a decades long study and decision making process that should be left to the people living in LMO. They will be the ones who survive the

process that should be left to the people living in Earth. They will be the ones who supply the products and knowledge about living and operating so far from home to the souls who descend to the surface.

^ | v • Reply • Share ›



Amit Vikram → Dan Apted • a year ago

Because Mars is more hospitable than moon. Mars' gravity is 38% of Earth's gravity while moon's gravity is nearly 16.7% of that of Earth's. So humans can get use to Mars' gravity much easily. Also there is cosmic radiation. Mars has an atmosphere although relatively thinner than that of Earth, it shields off some cosmic ray particles and humans can build their habitats underground for extra protection. While moon has no atmosphere whatsoever. So underground habitats would also not protect from radiation effectively at moon. Also there is possibility to terraform Mars. The main reason Mars and moon don't have a thick atmosphere like earth is because Earth has its own magnetic field which protects atmosphere from charged particles of solar wind, while Mars and moon don't. Mars didn't had any protection from solar winds which stripped apart its atmosphere. Mars has Dry ice (frozen CO₂) sheets in its poles and if we nuke them, it will release that CO₂ in atmosphere and hence thickening its atmosphere in which plants can grow, increased atmospheric pressure will prevent water from boil off at low temperatures and hence liquid water would be able to sustain on its surface and the green house effect will warm up the Mars a bit which is currently very cold. The solar wind will again strip that atmosphere, but it is a very slow process and therefore we would have millions of years to get a solution for that problem.

^ | v • Reply • Share ›



David Sabo → Dan Apted • 2 years ago

Musk intends to skip all that and go straight to Mars. His reasons are very appropriate - i.e., the intermediary steps aren't really necessary, and the Moon isn't all that well-suited to colonization in the near term. Tim's article lays this all out reasonably well.

To Yian's question more directly, colonizing the Moon has a different set of challenges - but most importantly, for Elon, it's aiming too low (literally and figuratively). The moon also is not as well suited to long-term survival of a self-sustaining colony and cannot be terraformed the way Mars can. So the proof-of-concept idea really would be proving we can build greenhouses on the Moon, but it's not the same.

That all said, if it gets cheap enough under SpaceX's leadership to toss stuff up into space, I am sure people will want to do cool things with the moon, too!

1 ^ | v • Reply • Share ›



iamGrimalkin → David Sabo • a year ago

What do you mean that the moon can't be terraformed the way Mars can? If you mean adding a breathable atmosphere that won't set on fire, the moon has a smaller surface area than Mars so will probably need less buffer gas, and if you are launching it as nitrogen from Earth you won't need as much delta-v to get it there. So in some sense it might be easier.

^ | v • Reply • Share ›



Deven Kale → iamGrimalkin • a year ago

The moon is too small. Its gravity isn't strong enough to support an atmosphere thick enough or dense enough to be breathable by humans.

^ | v • Reply • Share ›



iamGrimalkin → Deven Kale • a year ago

Yes it is. The atmosphere would eventually be lost to space without a magnetosphere, of course, but it isn't that much lighter than Titan, and that has an atmosphere thicker than Earth's.

^ | v • Reply • Share ›



Deven Kale → iamGrimalkin • a year ago

The mass of the moon is 54.63% of the mass of Titan. That's similar to saying \$546,000 isn't that much less than \$1,000,000. It's a huge difference.

The atmosphere on Titan is as dense as it is because of what that atmosphere is made of. In fact, Titan's atmosphere is not only thicker than Earth's it's also denser at 1.5 bars even though Titan is far less massive. Although this could partially be explained by being protected by Saturn and having a weaker Solar Wind as well.

Your question was about having an Earth-like atmosphere though, and I'm no physicist so I can't do the calculations myself but I trust the experts I've read/heard who say that you can't get a sustainable Earth-like atmosphere on the moon more than a dozen or so feet thick, and it would be nowhere near dense enough to be breathable.

^ | v • Reply • Share ›



iamGrimalkin → Deven Kale • a year ago

Just run the numbers and it turns out you're right, the moon can't have an atmosphere

even for relatively short periods. You're right, Titan's higher mass can make a difference when you have an edge case like the moon, as can its higher density and lower temperature.

^ | v • Reply • Share >



lamGrimalkin → Deven Kale • a year ago

Yes, you can't get a sustainable atmosphere on the moon. You can't get a sustainable atmosphere on Mars, either. The point is, it can take long enough to leak out for you to live there in the meantime, and you can help hold it there with an artificial magnetic field.

^ | v • Reply • Share >



Dan Apted → David Sabo • 2 years ago

I understand his desire and share it, but he(read we) need to pay for it and we need people to be prepared for the trip and the stay. By putting up the aforementioned first steps we have the funding for the other steps. A LEO vacation or stunt or lark is far fetched as is a honeymoon on the moon. But I can rationalize how some people might be able to pay for it if the SpaceX re-usability model becomes reality. Furthermore I can envision how Hilton, or Amazon, or Trump might even fund a hotel or at least a bed and breakfast in LEO or even on the Moon. The profits from it and the taxi service to get you there are literally sky high. If they are as big as I can imagine then so is a convention center in LEO or at L1 or L2. With enough demand then we must mine asteroids or other objects to harvest the least expensive building materials if you want to attract the most visitors. That gets us the materials to go to LMO and with that distance orbiting farms and more harvesting of materials from asteroids. Then there is the money, the infrastructure and the people trained to work and live in space to actually invade Mars. You can't go to Mars and sustain a colony without knowledge and money. The first steps get us there. Attempting to skip those steps is attractive folly.

^ | v • Reply • Share >



ameba#23234 MdR • 2 years ago

I noticed a mistake or just can't find any source on that venus has any oxygen in upper or lower atmosphere.

" Randomly, at the top of Venus's clouds is a layer where the temperature and pressure are similar to those on Earth, and because oxygen and nitrogen both rise in Venus's dense atmosphere (like helium does on Earth), the air in that layer might actually be close to breathable."

^ | v • Reply • Share >



jmac → ameba#23234 MdR • 2 years ago

Try this:

<http://onlinelibrary.wiley....>

^ | v • Reply • Share >



Mario • 2 years ago

"In the last few thousand years, humans invented the concept of being "inside," and now almost all people think of home as somewhere indoors—maybe in the future, a giant, artificial space habitat that has mountains and rivers and trees and millions of people will be the equivalent of the invention of "inside" as it applies to an entire world" That was beautiful! I just started singing "imagine" in my head

^ | v • Reply • Share >



Hendu71 • 2 years ago

I wonder which one is technically most difficult: "Fixing" climate change, building a colony on mars, or building a Star-Wars-like floating "Cloud City" on Venus?

^ | v • Reply • Share >



Michael Pang → Hendu71 • a year ago

IMO they're easiest to hardest in the order you gave, but the first two mostly depend on peoples' collective will.

^ | v • Reply • Share >



Nobody • 2 years ago

Anybody knows what the hell did just happen at Florida? Or more like, what will it cause?

^ | v • Reply • Share >

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Nadeem Adnan

The possibility depends is to enable individuals from different lands in the world to be the primary candidates to the another wave of people that will be selected to go to Mars. As reported by <http://www.theboringstate.com>. Even people from a nation such as Egypt, Pakistan, Saudi Arabia, have heavily shown affair and they really like to go The Red Planet. A very interesting text can be read here : <http://www.theboringstate.com/.../hello-houston-problem...>

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Caleb Mayo

thanks for this and for rocking out in general. in case you go around updating things, the radiation shield idea seems real enough now to merit a mention under blue-green mars. many smarties note, given the missing martian magnetosphere, that cosmic and solar radiation will slowly strip away whatever atmosphere we whip up, so it seems there's some place in the convo for a note about making that evap not happen. NASA image here includes fun words magnetosheath, magnetotail and magnetopause: <https://www.popularmechnics.com/.../magnetic-shield.../>

as exciting: looks like by blocking radiation we can probably start some of that sweet, sweet melting. seems relevant and likely. apologies if you already heard this stuff and thought about putting it in the piece and i'm now just one more voice telling you to spend time on something other than whatever should be your main project right now kinda like how i'm out here posting on a comment section instead of generating content oh dear god--

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Michelle Oblack Smith

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Mohammed Saud

How small is your penis exactly? I need to know... for research purposes only

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