

04 – Why Now & How Soon?

SUMMARY

Starship development is moving along nicely. Full reusability of heavy lift vehicles is a complete game changer. And not only this but both SpaceX and Blue Origin have the factories to produce fleets of reusable ships. We need space policy to take full advantage of this capability.

This chapter makes the case that landing cargo on the Moon will start occurring about 2027 and, when successful, crew will start landing in about 2028. Attempts to land cargo on Mars will occur about simultaneously with crew on Mars occurring somewhat after the Moon. We should aim for an Initial Permanent Crew about 2030. Buildup of an International Lunar Base will occur starting in the early 2030s with a transition to a private settlement being in the late 2030s. A large International Lunar Exploration Phase (ILEP) will occur in the mid to late 2030s. Populations of ethnic/national and religious groups will become large enough by the end of the 2030s such that the 2040s will witness the establishment of people-specific colonies.

WHY NOW?

Many books have been written about our future in free space, the Moon, and Mars. But most of these were written many years ago. But can we so confident that the next ten years will demonstrate to all that it is starting to become a reality?

The single most important factor is the emergence of two specific companies, SpaceX and Blue Origin who have the specific vision and sufficient funding to turn those visions into actual reality. Each share the same vision of large populations of humans living beyond Earth. This is a vision that NASA has never adopted and so they never designed nor pursued a path towards that goal.

Both companies realized that, for their vision to become reality, they needed to achieve fully reusable rockets in the (super) heavy lift vehicle class. It has taken 20 years for them to get there but they are both within just a few years of achieving that goal. And once achieved, humanity will find itself at a turning point in that it will be the first time that humanity will begin spreading beyond Earth. This isn't sci-fi fantasy but a probable reality.

But can these companies overcome the remaining challenges to fully reusable rockets? The fact that SpaceX's has landed more than 400 of its Falcon 9 first stages, twice caught its Super Heavy booster on the launch tower, and twice completed pinpoint landings at an imaginary tower in the ocean gives considerable confidence that full reusability is likely. And if SpaceX can show the way, others will inevitably follow.

From the funding side, two of the wealthiest people on Earth (Musk and Bezos) are committing their considerable wealth towards off Earth settlement. And when they bring the cost of access to space down dramatically through full reusability, the halting progress of national space agencies will be swept away by rapid and large-scale progress led by these visionary companies.

I wish that more people understood the historic transition point that we are facing. The younger generation will have their Apollo moments as the first woman sets foot on the Moon, the first humans set foot on Mars, the first permanent foothold beyond Earth is established, and the first human is born off Earth. I am convinced that young people alive will witness all of these things.

HOW SOON?

In this chapter, let's attempt to estimate when different things will happen. Why do so? The main reason is so that you, the reader, will have the sense that the Innovative Plan described in this book is not some far out science fiction vision but an option that is just an optional path given the developments in progress.

BUT FIRST SOME CAUTIONS

The safest thing would be to make no specific predictions whatsoever. No estimate, no chance of being wrong! Yet, how can we be confident that the proposals laid out in this book are realistic. By not just speculating but looking at the relevant factors involved, we can understand what is probable.

Predicting the Future

But it was actually Niels Bohr who is quoted as saying, "Prediction is very difficult, especially if it's about the future". Especially as we consider the development of reusable heavy lift rockets, setbacks and easily happen that throws off the timeline. And setbacks are bound to happen. We just don't know how many or when.

Also, the timeline of the near-term future (e.g. when actual Starlinks will be dispensed) is much more likely to be accurate than something in the distant future (e.g. when an international base will reach a certain size). So please grant some grace when the future unfolds and indicates how far off the predictions were from reality.

Pending Full Funding

Obviously, the Innovative Plan proposes some new steps which will not be possible without being adequately funded. If the space policy decision makers don't adopt these proposals, then things like the Initial Permanent Crew, International Lunar Exploration Phase, and International Lunar Base will not occur. So, our timeline describes when these things will likely happen but that is completely dependent upon timely adoption and funding of these proposals. Any delay in policy will result in a delay of the timeline. If this Administration doesn't adopt these policies and there is, say a three to four year delay, then China's plan on developing a Starship knockoff could affect whether the United States could achieve something like the Initial Permanent Crew described in this book.

"Elon Time"

It has become somewhat of a meme about how Elon Musk predicts the future too optimistically. And there is certainly truth to that. However, how about "NASA Time", or "Boeing Time", or "Bezos Time", or just about anyone else? Like they say, "Space is hard" and so we should expect that things will develop slower than desired. But Elon Time applies more to development than operations. Right now, Falcon 9s are launching every two to three days -- no more delays. The delays that SpaceX experienced in the mid to late 2010s are now past and operations are running a lot more smoothly and frequently. We can likewise expect that Elon Time will wind down after Starship matures through launch tests and they get more into the routine of launching, catching, refueling, and re-launching.

Setbacks

It is highly likely that there will be setbacks which in turn will throw off the timeline. This is especially the case when attempting to perfect reusable heavy lift rockets. So, setbacks are bound to happen. We just don't know how many or when. Like they all say, "Space is hard".

SpaceX hasn't been particularly lucky. (3 failed F1 launches, two F9 explosions, multiple F9 landing failures, Starship prototype crashes, Starship development). But other times they have been lucky including their flawless, first F9 launch and first Starship catch attempt.

ASSEMENT OF LAUNCH INTERVALS

In the Space Development Network, we have developed an on-line spreadsheet in which we attempt to estimate the order and timeline of when different developments will be achieved. You can check out that spreadsheet via the QR code to the right. This book addresses developments occurring now and in the immediate future and so, like many parts of this book, our timeline will need to be updated on an ongoing basis with estimates changing as events play out. The timeline represents our best guess which helps us make policy recommendations in a timely manner.

Findings From the Timeline

As the Space Development Network has developed the probable timeline, three things jumped out at us as a result.

First, cargo to Mars in Nov 2029 is likely off the table. Could they launch a minimal payload to Mars without refilling? How much could they send with just one refilling? Caveat: Quick ChatGPT rocket equation calculation suggests 10-30 tonne payload on surface of Mars without LEO refilling. Consistent with Elon's presentation. So, still might be possible.

Second, flight frequency is critical. They will need to reach a launch cadence of Starship far faster than it took to achieve today's Falcon 9 launch frequency of 3.3 per week. Catching on the tower really helps. Experience with turnaround time also helps.

Third, propellant launches will compete with Starlink launches. Hard to imagine that they will forgo generating more revenue by delaying Starlink launches.

SpaceX already knows these issues and so is likely actively working to overcome them. They must ramp up launch rate very quickly. This is why they chose the tower over oil rigs. An example of why we are surprised by a decision that SpaceX makes but they are looking ahead in detail.

STARSHIP DEVELOPMENT

Cheap access to space (CATS) is the fundamental factor upon which other developments depend. Although Starship isn't the only reusable fleet of heavy lift vehicles in development, it is the one that we know the most about, the most capable, and likely the one that is currently in the lead in terms of being able to support lunar base development.

Progress to Date

Up to the present time, Starship development has lived up to the promise of "excitement guaranteed". We've seen multiple types of explosions, out-of-control spinning rocket stacks, and exploded Starships streaking through the sky. But also, we've seen successful launches, pinpoint ocean landings, and (most amazing of all) the booster being caught three times by the arms of the launch tower. Amazing. But the path to this point has taken 2.5 years which is longer than expected, and we are still waiting for several development milestones to be achieved before it becomes operational.

Upcoming Hurdles

Looking forward, there is still a lot of Starship developments to accomplish while the timeline is beginning to run out. The single hardest hurdle is probably the heat shield being thin enough to ensure that enough payload gets to orbit but thick enough to ensure that the Starship can be reused multiple times. They have been working on this problem for a few years now but haven't completely solved it yet. Truth be told, reusability of the upper stage tanker isn't technically necessary for Artemis or any other program. Expending the upper stage Starship would still mean a cheaper \$ per kg to LEO than the SLS. But if SpaceX is going to be launching Starships for other reasons, then they might as well take advantages of those launches to conduct upper stage reusability efforts.

But there are additional challenges that absolutely must be overcome before Artemis 3. These include a Starship fitted out to be an orbital depot, the full refilling process, and a cargo mission to the lunar surface.

Orbital Depot

Transferring propellant to a lunar Starship in LEO is a requirement before Artemis 3 can occur. The full process includes: constructing, testing, and launching the depot, docking, making good connections, transfer of cryogenic propellants, and storage without boil-off. Already these processes have been demonstrated either in orbit or sufficiently in the laboratory setting (e.g. zero boil off using cryocoolers). For example, during Starship flight test 3, about 10 tonnes of propellant were transferred between tanks using a small ullage burn.

How SpaceX plans on first demonstrating partial propellant depot capability will be to launch a target Starship to LEO and then launch a tanker

Starship which will dock with the target, connect, and transfer propellant. This one test will go a long way to reassuring NASA and the space policy decision makers that SpaceX can keep to the timeline of Artemis 3 before the end of 2028. We estimate that this will probably occur during the 3rd and 4th quarters of 2026. This would mean that two years of test flights would remain until the end of 2028 Artemis 3 deadline arrives. This timeline is dependent upon the latest Starship upgrade (Version 3) doesn't suffer a series of setbacks like Version 2 experienced.

Lunar Cargo Landing

Successful Starship HLS cargo landing and lunar ascent is required to be demonstrated before NASA precious astronauts are sent to land in that hardware. We have witnessed multiple small lunar landers crash or tip over after landing. However, it would not be accurate to presume that, because other landers failed to land, that this means that Starship will likely also experience such problems. SpaceX has far more money and workers to work on the problem than these much smaller companies. Also, SpaceX has extremely extensive experience landing its boosters. Finally, from the standpoint of physics the angular momentum of tall, heavy objects is actually a lot easier to control than shorter, less massive objects. For example, consider how difficult it is to balance a pencil compared to a broom.

Tentative Conclusion

Put all together, it will be challenging but not feasible for Starship HLS to deliver crew to the surface of the Moon by the end of 2028. When that is accomplished, it then mostly comes down to ramping up the scale and rate of operations rather than the challenge of developing the Starship.

PERMANENT BASES

Initial Permanent Base

NASA does plan on establishing a permanent presence on the Moon and SpaceX has even rendered both an image of a vertical Starship as a base with lots of windows as well as inflatable habs at their base which looks surprisingly like our InstaBase concept. Unfortunately, this is pretty much the extent of NASA's vision. Their vision is limited to a few government astronauts for increasingly long stays conducting more science

missions by collecting more rocks to add to the Apollo collection. Given the full capability of the Starship and Blue Moon fleets, we believe that the vision should be far greater in order to match with the expected capability.

It is our view that the establishment of humanity's first permanent foothold beyond Earth (on the Moon) should be considered a much higher priority than Artemis 4 and 5. Specifically, we propose that the StarHab with the Initial Permanent Crew with all of that historic significance follow as the next mission after Artemis 3. It's not a good idea to delay the establishment of an Initial Permanent Base and Crew resulting in a temptation for China to seize that historic prize.

So, if we assume that Artemis 3 is followed by a StarHab mission, when could that be accomplished? Our timeline indicates that it could be achieved approximately in mid-2028 with the Initial Permanent Crew landing on the Moon in late 2028. If we factor in unanticipated delays, then it could be pushed into early to mid-2029.

International Lunar Base

We propose that no other crew be sent to the Moon for the first 6 to 12 months of the Initial Permanent Crew (IPC) to make that history the focus of America's lunar program. But, during that time there certainly can be routine cargo landings in preparation for the International Lunar Base (ILB).

So, according to our estimated timeline, about four, 100-tonne specialty habs could be delivered to the lunar surface by the end of the IPC phase. So, by the end of 2029, NASA astronauts could be sent to quickly establish the American core of the ILB. Throughout 2030, additional specialty habs could be sent interspersed with international partner (e.g. ISS) astronauts. Then, throughout the 2030s, there would be the International Lunar Exploration Phase parallel with the growth of the ILB.

MARS MISSIONS

We are guessing that SpaceX will not be able to accomplish cargo missions to Mars using the November 2026 window. But they would be very well positioned to conduct a larger set of cargo landing attempts in the 2029 window. Our guess is that it might be as many as ten cargo landing attempts. If one crashes, the telemetry will be sent back and the

landing software adjusted for the next attempt. Historically, less than ten attempts were needed to master the ability to land:

- Seven - Falcon 9 attempts
- Four - Starship prototype landing attempts
- Four - Starship booster soft splashdowns
- Five (so far) - Starship upper stage soft splashdowns

Although there is some uncertainty, our best guess is that SpaceX will succeed in reliably landing cargo with the 2029 window so that they will attempt crew landing on Mars in 2031. Even if they are unlucky and it is 2033 or even 2035, that's less than 10 years from now -- still amazing!

PRIVATE SETTLEMENT

The earliest, most expensive kilograms and seats will be purchased by those with the deepest pockets which are government and not private individuals. So, the first habitats will be established by countries in the form of an ILB. But, if our proposal that an Artemis 2.0 coordinates countries to fund their own companies to competitively provide hardware, soft goods, and services, then the International Base will begin to receive very wealthy, private individuals and eventually the 75 million millionaires on Earth will have the opportunity to move to the settlement portion of the International Base. So, when will those arriving will be more private settlers than government residents? That's really hard to estimate because it is further out in time. But our estimate is that this cross-over point would occur perhaps in the late 2030s (for fun let's say 2038). And when will there be enough of one people group (e.g. Japanese speakers) such that they would pay those companies to construct the new habitat as little colony separate from the ILB? Again, a wild guess but perhaps right about 2040. Since the Moon is 70 times closer than Mars in terms of round trip, we estimate that a million people (not all in the same settlement) would be established on the Moon by perhaps 2045.

What do you think? Is this pure fantasy or based upon a reasonable consideration of the relevant factors?