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MUSK REVEALS MARS COLONISATION TIMELINE.

As if we didn't have enough to chew on with Flight 9, Musk have given a presentation on Space X's Mars plans going forward.

It's fascinating stuff. Read Owen Louis David's take on it all.

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SUITED TO THE ENVIRONMENT?

Could a comfortable weighted body suite make up for the shortfall in gravity on Mars. Find out what Dougie Smith thinks.

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FLIGHT 9

Did you watch Flight 9? – or Fright 9 would be a better description as each second of these tests seems now to carry with it the prospect of immediate and complete catastrophe! Thankfully there was no Shipastrophe over the Caribbean but the results were a mixed bag. Of course it was nothing short of fascinating throughout, a real rollercoaster ride, as we have come to expect.

Read Mary Khan's excellent description of the build-up and the event itself as well as noting some concerns being expressed about the Raptor engines. Do they work as advertised or should we be worried about underperformance?

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WHY WEIGHT?

By Dougie Smith

You often hear people coming at Mars colonisation from a negative standpoint state quite confidently that it won't happen because our bodies can't cope with the low gravity on Mars – eventually our muscles and bones will dwindle in mass so that we are hardly capable of any movement at all. A disturbing vision of how things will go on Mars!

Well, let's begin by saying in response that this is all evidence-free fantasy stuff with no grounding in reality. We know from NASA research that people on the ISS who use the latest ARED exercise equipment return stronger and fitter from their months' long stint in "Zero G" (the quote marks are in recognition of the fact that it's not true Zero G – the ISS is bathed in gravitational waves from Earth but the "fall" of the rocket creates the condition of weightlessness which is effectively the same as Zero G).

ARED stands for *Advanced Resistive Exercise Device.* The key word there is "resistive".

It's taken a while but after decades of research it has become clear that *resistive* exercise is the key to battling muscle and bone loss. It's not enough to simply exercise by using, say, a running machine – your body needs to work on overcoming resistance from the exercise equipment.

So, this is really good news for supporters of Mars colonisation – we know there is a method of overcoming the problem of muscle and bone loss since most ARED users return with *more* not *less* body mass, and in particular more lean body mass. Remarkable results, but we aren't entirely out of the microgravity woods yet.

Firstly we have to acknowledge that while using the ARED equipment gives us a solution there is a significant downside which is that you need to be on that equipment for 90 minutes to 2 hours (I have seen various figures for the exercise time required in my research which might be explained by the equipment getting more effective over time or by exercise regimes being tailored to individuals). That is a pretty large slab of time during non-sleep hours. No doubt, it needs to be followed by quite significant rest and recovery periods. On the ISS I feel this is not a specially pressing problem. But on Mars? Well there I really do get the

sense that every minute of the non-sleep day is of huge value and needs to be spent wisely. Every minute that gets spent on a rigorous and demanding exercise regime (beyond perhaps an enjoyable minimum workout of say 30 minutes which should be counted more as "leisure" time) means it is not available for useful work. There will be so much to do on Mars in terms of establishing a base and then constructing a city (life support, leisure facilities, landscaping, lighting…excuse the alliteration).

So is there a way we could cut down on the exercise regime, so freeing up time for productive work? Well, yes there is a solution. On Mars we could supplement the 0.38G by wearing a comfortable weighted body suit. This would effectively be a "resistance suit" meaning we have to exert ourselves more than would otherwise be the case and giving our bones the signals to maintain their mass and density, in order to support the additional weight.

So the suit would in effect bring you back to your weight on Earth. If you weighed 100 Kgs instead of weighing 38 kgs on Mars, with the help of the suit you would weigh 100 Kgs again.

On Earth the suit would have to weigh just over 163 Kgs. For a larger person, their surface area would be 2 sq. metres. So that would be something like 80 Kgs per sq metre or 8 grams per sq centimetre.

There are a number of potential metals that could be used. Lead for instance weights 11.34 grams per cubic centimetre on earth (equating to 4.31 grams on Mars). So in theory a suit of just under 2cms' thickness with sealed lead inserts would suffice to meet the desired specification of achieving a 1G effect. How comfortable that would be in practice might required some design work. Obviously such a suit would not cover the face, the fingers and palms or the soles of feet, so some adjustments might be necessary in terms of the calculations which might take us back to a 2cms figure or slightly over that figure. Women of course might not want any weights on top of their breasts. My thinking is that some parts of the suit might be more heavily weighted e.g. over and around the shoulders and the collar bone.

Another question is whether a weighted cap should be worn. This might be important for achieving as near a natural effect as possible. It would be

possible to put quite a lot of weight into the cap.

I also feel it might be easier for the suit to consist of a top with shoulder-and-collar pads and lycra-style shorts extending to the knees.

Now of course we don't really know whether in fact a 0.38G environment with maybe crew completing 45 minutes of exercise on ARED style equipment per sol will suffice to maintain muscle and bone mass, in which case that might prove to be a more attractive solution. But as an insurance against negative effects, having the body suits available for use would be important, certainly for the first couple of missions and maybe going forward for individuals who cannot use the ARED equipment .

For Mission One a precautionary approach might suggest the suits should be worn. A final thought: they could be combined with a radiation protection

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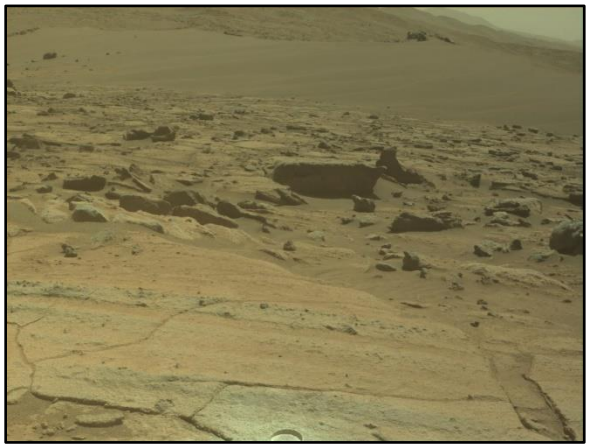
PICK OF THE PICS



Credit: NASA

This pic, taken by the Perseverance rover earlier this month. Wouldn't it be great to be among the first humans to survey this area!

The location is Jezero Crater.

Do send in your favourite pic from Mars! We'd love to see it.

Flight 9 – Before and After.

By Mary Khan

BEFORE

Really – the build-up to Flight 9 was beyond nerve-wracking. We were so on the edge of our seats by the time launch day arrived on 27 May that we might as well be crouching in mid-air.

What can I say? There has been so much rumour and counter-rumour, supposition and speculation…real hall of mirrors stuff.

So it's ended up that I have been finalising this article on launch day – well I hope we really have got to that point.

Rather than replay the whole rollercoaster ride, I thought it was worth recapping what the mishap studies revealed about the disastrous Flights 7 and 8 that ended with explosions over the Caribbean.

It seems that the Flight 7 failure was centred on those nasty old oscillations causing a major equipment failure. But Flight 8 was not a repeat of that failure - instead a rocket engine malfunctioned spectacularly. Space X have confirmed that the two failures were *"distinctly different"*. Most observers and commentators agree. Space X indicated that with respect to Flight 8 one of the central Raptor engines – up till now pretty reliable - suffered an (undisclosed) hardware failure which created *"inadvertent propellant mixing and ignition"*. It seems there was a knock-on effect from that Raptor failure, resulting in the other two central Raptor engines closing down, at which point control of the rocket was lost.

Now, those who like their glass to be half full rather than half empty were pretty pleased with this announcement. The implication seems to be that the osciallation problem has been resolved.

A successful Flight 9 is crucial to Space X being able to go ahead with its ambitious of plan of landing a Starship on Mars in 2026 with a Tesla Optimus robot as the sole occupant, with humans to follow in 2029 or, possibly, 2031.

Well that was the before now follows the after, naturally enough.

AND AFTER…

What a huge relief! The Starship made it to its sub-orbital trajectory without exploding over the Caribbean… That was enough for me! The Booster return was not perfect but Space X were trying out a demanding angle of entry, intentionally testing the first stage to its limits and beyond, it seems (on the plus side it did get to a rather abrupt landing burn). So I don't think we can exactly call the Booster return a failure since it was being given a real workout.

The door to the "Pez" dispenser on the Ship designed to allow the release of dummy satellites also failed to open. A shame but not critical in terms of Starship development would be my take on that. Unless of course the door failure was something to do with internal pressurisation issues which might relate to more systemic issues.

Soon after the Pez failure, the Ship itself appeared to suffer some propellant (methane it seems) leakage that sent it into a spin, resulting in a loss of attitude control. So the Ship had a largely uncontrolled return to Earth, although reports suggest Space X did manage some degree of control before it reached the ocean.

OK, for me Flight 9 represents real, albeit incremental progress. If you want a more challenging view, try *"The Angry Astronaut"* – he has a video out on his You Tube channel quoting extensively from an article by Will Lockett.

This really suggests there are fundamental design flaws in the Starship relating to its size and Space X's aggressive stripping out of the normal heat suppression materials around the rocket engines. Essentially the suggestion is that the Raptor engines have been underperforming compared with their design specification. Given their under-performance, mass associated with safety features such as fire suppression has been extracted and the engines have been pushed beyond their natural limits (generating excessive heat and vibration), in order to lift what is in fact a very small payload (much lower that what was originally touted). Lockett argues that the new Raptor engines won't resolve the problem.

The Angry Astronaut has his own take, suggesting that it was a mistake to build the upper stage (the Ship itself) out of stainless steel as opposed to carbon fibre (as originally planned) as steel is so much heavier than carbon fibre.

I have no special access to the Starship programme but my gut feeling is that Space X probably have the cream of the crop of space engineers working for them and that they will be fully aware of all the fundamental challenges involved in building and flying a spacecraft this big. This is the Musk Method: don't be afraid of testing the limits – that's the way you get the best possible. Clearly there are problems with the possible underperformance of the Raptor engines (being far less powerful than we were led to believe) and the way they are being operated. Raptor 3 might inject some progress.

Onwards and Upwards – Musk's latest thoughts on the path to Mars.

By Owen Louis David

Elon Musk gave an intriguing speech on 29 May to Space X employees gathered at Starbase in Boca Chica focussed on the corporation's Mars mission plan. The new Space X plan is quite radically different from anything else we've had previously presented in coherent fashion. So it is well worth getting a handle on how Musk and Space X are now thinking.

Here are some of the key points.

- Space X currently plans to launch 5 Starships to Mars in 2026. However, Musk does caveat that more strongly than he normally does but, nevertheless that is an interesting Stage One for a Mars Mission involving the landing of far more Starships previously was suggested.

- The plan is to manufacture 1000 Starships per annum at the future Gigabay at Starbase. I would certainly put this is in the "doable" basket given the amazing progress Space X have made in manufacturing Starships.

- A Starship capture in the "chopstick" arms could happen within the next 2 to 3 months. "We'll see!" is my reaction to that one.

- The presentation included close-up video of the new Raptor 3 engines which are breaking all sorts of records. The engine has already been tested 300 times.

- Space X are focussed on the Arcadia region of Mars for landing. From the visual display it looks like the JPL-recommended Erebus Mountains area which we have frequently reference here at *The Aresian*. So that's good to know. Obviously the main attraction of the site is the accessibility of water ice just a few feet below the surface, but also that fact it is only about one degree outside the prime solar insolation zone for Mars which will maximise insolation to power the PV energy systems.

- Musk revealed a timeline slide showing the planned development of the colony. This seems quite different from previous iterations we have seen and is much more

ambitious that previously seen. I set out the timeline in detail below

- Musk states that deciding on government and rules on Mars will be up to the Martians (surely he means Aresians!). It's good to hear that stated clearly and loudly by the someone who has been subject to some pretty lurid criticism.

The timeline

Here is Musk's timeline for the Mars colonisation programmes – probably the most important part of this talk…

2026

5 landers landing 10 tons each (so 50 tons in total). I am slightly puzzled by the low tonnage. Is this in order to make a first-time landing easier?

The objectives will be to prove we can get to Mars, to land the minimum number of vehicles required to maximise learning (presumably that means around the landing area in order to ensure a safe landing for the humans who follow) and to demonstrate key technologies required for Mars transit and landing.

Musk has confirmed that Tesla Optimus robots will be a strong component in the overall programme – so the first steps we see on the surface of Mars will likely be those of an Optimus Robot.

(Remember, Musk is only offering 50-50 odds on being able to achieve this in 2026, so we might have to take this part of the plan down to the next launch window. Given the low tonnage it looks like this might be an expendable stage in the overall development programme.)

2029

20 landers with a payload of 75 tons per ship (so 1500 tons in total). Clearly, a major step-up in tonnage for Mission Two.

The aims for this mission are to land initial infrastructure, confirm resource availabeility; also prepare landing areas and deliver equipment for people.

So these objectives make it sound like this is still an automated prep mission and that humans will land in the next launch window ie in 2030/31.

2030/31

100 landers with 150 tons per ship, so 15,000 tons of cargo landed.

The main objectives this time round would be resource mining and propellant generation, building of roads and pads. Priorites would include habitat construction and increasing power generation and storage.

For the record, I don't think we can possibly be talking about creating tarmac roads on Mars! So I am presuming that the plan is to

create dirt roads, similar to those found in Australia – or maybe ice roads, as found in North America. So the major effort would be boulder and dune clearance and smoothing of the road surface using robot rollers.

2033

500 landers at 300 tons per ship. That means a total cargo tonnage of 150,000 tons!!

The goals would be to increase independence from Earth (I am presuming that means a huge expansion in manufacturing and agricultural production. Other priorities would including mining and processing of Mars resources, global mobility (I would interpret this to mean development of point-to-point Starship services and maybe rocket hoppers to serve more local mining settlements perhaps) and global communications (I'm presuming this would mean the creation of a satellite internet service covering the whole of the Red Planet).

My thoughts.

This is a far more ambitious plan than I have ever seen set out in any detail by Musk or Space X. Landing on Mars 150,000 tons of stuff in 2033 is incredibly ambitious, especially when you consider each Mars-bound Starship might require 5 or more refuelling Starship launches. So we might be talking about 2500 refuelling Starship launches within a pretty narrow launch window. No one can fault Space X for their ambition except it may be excessive. I mean – how many people would be required to deal with the 150,000 tons of cargo. How many people are you going to send with that amount of cargo. This will still be very early on in the colonisation process.

It's perhaps telling that the presentation doesn't give details of the number of people on Mars at these key dates. We'll look at the timeline again in our next issue.

WEATHER REPORT!

Here's your update for the weather on Mars provided by the Curiosity Rover in Gale Crater.

For the nearest Sol to **28 May 2025** we have a *high* of **minus 28 degrees Celsius** (minus 20 degrees Fahrenheit) – the same as in last month's figure. The low for the same date, was a little warmer (by 3 degrees compared with last time at **minus 80 Celsius** (or minus 112 degrees Fahrenheit). Given we are now in late autumn in this part of Mars now, moving ever closer to winter, the marginal warming is perhaps. counterintuitive. We can expect something a bit colder next time!