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WELCOME TO THIS NEW EDITION – STARSHIP CLOSE TO LAUNCH!

It's an exciting time for the pro settlement community. Space X are now very close to the third IFT launch – and this time it will be a genuinely orbital attempt. I am sure you are as excited about this as we all are at *The Aresian*.

Our stand-out article this issue is Owen Louis David's *"Introduction to Terraformation"*. This will be invaluable if you haven't yet got up to speed on the challenges and opportunities presented by terraformation. If we are really going to make a success of Mars colonisatipn eventually we need to create a near facsimile of Earth, so that humans – who obviously evolved over millions of years to live on the home planet – can truly feel at one with the planet. This means being able to breathe freely and walk across its surface without protective clothing and without dying from the cold, the radiation and the lack of air pressure.

The Aresian makes Mars accessible.

STILL CAUSING WAVES

The book *"A City on Mars",* by Kelly and Zach Weinersmith, continues to cause waves within the pro-settlement community. A lot of scepticism and opposition has met the arrival of this downbeat book. In this edition we have another take on the book by Johnny Davis. See page 7.

THE STARSHIP STORY – LATEST INSTALLMENT

By the Editorial Team

Where are we at?

Space X now have the essential FAA approval to launch the Starship as the third IFT (Integrated Flight Test).

Here is what we know at time of publication. The two stages will be made up of *Booster 10* and *Starship 28.* The number 28 gives you an idea of how intense has been the Starship development programme over the last couple of years.

There has been speculation that Musk's increasing involvement in US domestic politics is provoking opposition within the Biden Administraion and this might be slowing down approvals.

It's worth mentioning that Space X has achieved an incredible rate of production already for the Starship and its boosters.

There have been reports that the opportunity might be taken on IFT 3 to undertake some initial testing of cryogenic refuelling technology (ultimately there will be several refuelling launches to "top up the tanks" of Moon and Mars-bound starships). This is of course critical technology. It's one thing to get to Earth orbit but if you want to explore the Moon and Mars mastering the art of refuelling in orbit is essential. This will be a first in space if Musk and his team can pull it off.

A launch in late February or early March seems most likely. However there have been some issues recently preventing a full Wet Dress Rehearsal (test-filling the tanks in advance of a real launch). The delays might relate to newly installed equipment piping fuel from the on-site tank farm.

Musk commented on x.com on 12 February that *"Starship* (sic) *were meant to fly and our next one launches in about 3 weeks, but I recommend waiting for a few more test flights before hopping on board".*

Planets to order – terraformation will be humanity's biggest engineering project ever.

By Owen Louis David

Can I have a planet to go? In the cosmic café there's plenty to choose from. There are now thousands of exoplanets pn the menu and some of them look quite promising as homes for humanity. But for the foreseeable future we are pretty much constrained to look within our own solar system for a second home for humanity.

Mars, our cousin planet, can answer many of our needs. It has plenty of land, water and solar radiation. We can use that Holy Trinity to make us a home. But of course the main drawback is that we will be stuck indoors most of the time and even when we go out we will have to wear space suits and breathing apparatus to keep us alive and minimise the risks of radiation. Of course, as I have argued here even within those constraints we can make Mars a fantastically stimulating and welcoming home but there's no point in denying how much better it would be if we could walk in the open air and breathe freely in more Earth-like temperatures, really explore the Red Planet's wonderful topography.

Is the concept of terraformation – the idea of making a planet more like Earth - a pipe dream?

Well most important endeavours start with dreams. "Terraforming" was first coined by science fiction writer Jack Williamson in 1942 but in 1961 Carl Sagan brought the concept into the world of legitimate science. At the time Sagan considered Venus was the best candidate, based on some pretty sparse and misleading data on the planet. Admittedly in terms of size and mass, Venus is close to Earth (its surface area is about 90% that of Earth's and its mass is about 81%) but there the resemblance stops. In all other respects its characteristics are distinctly un-Earth like. A single Venusian day can last for 119 Earth days. The average temperature is something like 453 degrees Celsius. And the atmospheric pressure is around 93 times that of Earth. None of that is conducive to human colonisation.

It wasn't long before people came to the realisation that Mars was the only realistic candidate for terraformation, given the state of our technological development.

So what are the problems with Mars and how could we fix them, to make the planet a real "home from home", a New Earth?

A fundamental problem on Mars is that the atmospheric pressure at something like 0.6% of Earth's is far too low. We need more atmosphere, a lot more. Actually trillions and even quadrillions of tonnes more. Ideally we would like it to be a *breathable* atmosphere, but let's make it a *survivable* atmosphere first!

Of course the a very low density atmosphere means that unless we are protected by a space suit, our bodies won't be able to function

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properly. Even with an oxygen tank on our backs without a pressurised or MCP space suit we wouldn't be able to breathe as our lungs are designed to function at around 1 Bar pressure ie the pressure on Earth.

So what can we do to get that pressure up?

Well heating up the planet will make a good start. Mars's nighttime temperatures go cryogenic (even though a balmy 30 degrees Celsius awaits you on a summer's afternoon). We need to warm up Mars and there are a number of choices. Musk has spoken semi-seriously about the possibility of exploding nuclear bombs over the poles to release the frozen CO2 and water as gases. That would be a quick fix but I have never been convinced it will be countenanced for a number of reasons.

However, nuclear power could certainly be used to warm the planet and specifically to process regolith to release gases.

Solar power wouldn't be much use as you would be losing solar radiation at the surface. However solar power satellites beaming down power from orbit to the surface or reflector satellites reflecting insolation on to the planet would be a very useful addition process.

My favourite solution though is the one proposed by NASA scientists to carpet vast tracts of the planet in a transparent aerogel material. This will have the effect of heating up the surface of the planet's regolith, so releasing gases. This will be a big undertaking of course but relatively simple and certainly something that could be within the capacity of a rapidly growing Mars economy.

There would a case I think for dedicating much of Mars's industrial activity – perhaps as much as 50% of output to the production of greenhouse gases. It's important to note here that there are many different types of greenhouse gases – it's not just a question of releasing CO2. Other greenhouse gases are incredibly powerful at trapping heat. For instance chlorofluorocarbons (CFCs) and perfluorocarbons (PFCs) are thousands of times more powerful than CO2 in retaining heat within the atmosphere. We need to be generating perhaps 15 trillion tonnes of atmosphere per annum in order to have a chance of producing a "useful" atmosphere within a couple of centuries.

Another important factor here is that the denser the atmosphere, the better able it is to protect humans on the surface from harmful cosmic and solar radiation – a major plus.

As Mars heats up thanks to its thickening atmosphere, so the ice will melt and water will begin to flow freely over the planet's surface. Mostly freely flowing water is an important aspect of Earth's environment. Remembering that Mars's atmosphere is likely to have a high CO2 level to begin with this combination will actually be perfect from raising crops. With free flowing water comes the water cycle (where water evaporates from the surface and then condenses to form rain clouds). While rain is a pain, it is also has huge benefits. Not least is the fact that rain washes away dust – sends it into the regolith, into rock crevices. Rain also helps cleanse the atmosphere of dust. As we

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know, dust is a problem on Mars - one that has been exaggerated (it won't stop us colonising Mars) but one that we could do without. With water flowing freely on Mars, dust storms will begin to decrease in both frequency and intensity. Likewise, just getting about the planet and operating machinery, rockets and so on will all become easier as Mars becomes more dust-free. Another great advantage of free flowing water is that it allows for hugely increased agricultural production – securing the food supply for a growing Mars population.

Some parts of Mars will become more habitable at a faster rate than other parts. The massive Hellas Basin (some 2,300 kms wide) has a depth of just over 7 kms, meaning the atmosphere is much more dense at that location (about twice the average on Mars).

We might see the Hellas Basin becoming the "breadbasket" of Mars thanks to its denser atmosphere and its relative warmth.

Of course as we work hard to thicken the atmosphere, to make it possible for us to move about on the planet, the terraformation scientists and engineers will be looking to increase the oxygen content.. On Earth oxygen makes up something like 20% of the atmosphere. On Mars the proportion is much less – there, oxygen currently make up only about 0.17 % of the Red Planet's atmosphere. We may need an even higher percentage than 20% on Mars, to trade a lower density (similar to the density in high mountainous regions on Earth) with a higher oxygen content (meaning that people can get enough oxygen from a lower density atmosphere).

The great thing about the oxygen part of the terraformation process is that we can probably let nature do the heavy lifting via our little microbial helpers. Currently the clever money is on cyanobacteria (so called after their blue-green appearance). These micro-organisms use photosynthesis to produce oxygen.

We can help the process on by again devoting large parts of Mars's industry to oxygen production e.g. splitting water and CO2 to create huge quantities of oxygen. Electrolysis and the Sabatier reaction are well known. They are energy intensive processes but we know they can deliver "the goods".

Once again we may find that this is a staged process. The whole of Mars won't suddenly develop a breathable atmosphere. Some regions will be oxygen rich before others. We may find again that Hellas Basin is ahead of the field. If it is the first area on Mars to develop Earth-like flora, it will also be the area with the highest levels of oxygen since plants generate oxygen.

So does an Earth-like atmosphere mean an Earth-like planet? Well we are more than halfway there but there are other things we would want.

Thickening the atmosphere will go a long way to making humans safe from health threats due to radiation at the surface. The more air molecules you can put between you and outer space, the safer you will be. However, Mars also suffers from the absence of a magnetosphere. Earth's magnetosphere contributes hugely to reducing

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the space radiation risk. It's difficult to see how we could replicate Earth's molten iron core which generates its magnetosphere. However we might be able to create the equivalent of a magnetosphere, with satellites deploying radiation screens in orbit or "Faraday cages" being placed over human settlements.

Of course Mars could also do with a boost to its gravity as it is currently only 0.38 of Earth's. Would we ever bother to try to up that figure? One can imagine at some future date that with advanced technology we could bring material from the asteroid belt to add mass to Mars. However, given we can get very close to replicating Earth's gravity by simply wearing weighted clothing and boots, it seems to me that won't be a priority.

The aim should be to produce an atmospheric pressure equivalent to, say, the Tibetan plateau but with a higher concentration of oxygen. That will mean we have warmer temperatures and free-flowing water on Mars.

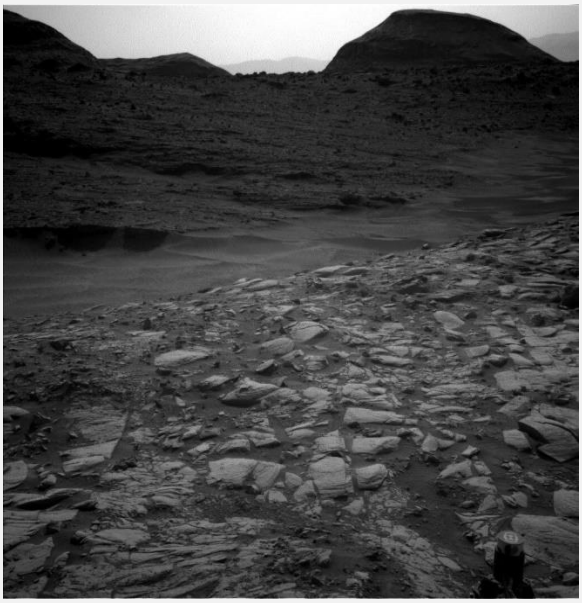
On present technology we might be talking about thousands of years to achieve this but some parts like Hellas Basin will be hundreds of years ahead in the process. There are also many reasons to be optimistic about the prospects for terraformation, not least the strong likelihood that continued advances in technology (e.g. improved rocket technology) allowing us to exploit the asteroid belt.

THE LATEST WEATHER ON MARS

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

For the nearest Sol to **14 February 2024** we have a *high* of 6 degrees Celsius (43 degrees Farenheit) - could be the UK in winter, folks! - and a *low* of minus 69 Celsius (or minus 92 degrees Farenheit).

PICK OF THE PICS



Credit:NASA

A dramatic pic taken by the Curiosity Rover from the edge of the Gediz Vallis channel in Gale Crater. Stunning stuff!

WHY BE SO NEGATIVE?

A review of Kelly and Zach Weinersmith's book *"A City on Mars"* is pretty much a regular feature now! This month we have Johnny Davis's take on the book.

Why be so negative!? Having read the book, that's the exclamation/question I'm left with. The Weinersmiths seems like reasonable folk who study the arguments. They set out the pros and cons, but when you get down to it, their analysis is not rational – they seem to pump up the negatives while ignoring the positives.

As others have pointed out, the book's title is weird, given how they look at all sorts of space settlements in all sorts of locations. Was this part of game plan enabling them to confuse the issues around Mars colonisation.

By the end of the book I was none the wiser as to why they want us to *"Wait and go bigger".* They seem to want our species to become peaceful and wiser. Don't we all but that can never be a precondition for Mars colonization.

Had they confined themselves to addressing the prospects for human colonisation of Mars, I think their gratuitous negativity would have been more exposed. Of all the possible locations for what they call "space settlements", Mars is the most obvious, the most attractive and the most compelling.

Mars has virtually all the resources that human civilisation needs: water, oxygen, carbon dioxide, iron ore, an Earth-like range of other minerals, plentiful solar radiation and almost as much terra firma as Earth. Mars's economic potential is huge! But at every turn the Weinersmiths negate and diminish.

OLYMPIC RECORDS NEAR OLYMPUS MONS?

At some stage Mars will have its own Olympics or an equivalent. Maybe it will be staged at the base of Olympus Mons, given the name connection. The question I have though is what records might be susceptible to being broken on Mars?

For sports like pole vault, high jump and long jump there is a good chance we will be able to break records. We will be substantially lighter in terms of weight on Mars (though, with exercised, our muscles will retain their strength) and there will be less wind resistance thanks to Mars's thin atmosphere. Of course, if these events take place outdoors, athletes would have to wear some sort of special suit with a lightweight breathing apparatus system

that might provide them with enough oxygen to cover each time they participate (maybe up to three minutes for these sorts of events). After they make their jump they would have to retire to a pressurised hab where they could breathe freely. Of course, as on Earth, there could be indoor athletics events where the need for such apparatus could be avoided. But currently world records for indoor and outdoor events are kept separately.

One point to bear in mind is that on Earth there are rules in place to prevent artificial oxygenation of blood to improve performance. Mars participants using breathing apparatus would certainly have to ensure that their oxygen supply was not "unnaturally" rich compared with what is available in air on Earth.

I am quite fascinated by the issue of whether we will be able to run faster on Mars. You might think we could but this is a complex issue. On the Moon we found that normal walking wasn't very effective in such a low gravity environment. Essentially running (like walking) is controlled falling. With the aid of gravity we fall forwards (require no effort on our part) but our musculoskeletal system (usually!) prevents us falling flat on our faces. It is quite possible that as with the Moon our means of locomotion on Mars will vary from what we know on Mars. It's no impossible that the gravitational pull on Mars – which is between that on Earth and that on the Moon – might prove a little tricky for us. Intuitively is seems unlikely we will be able to moonwalk. But we might find ourselves between two "sweet spots" – the floatiness of the Moon and the strong gravitational pull of the Earth, propelling us forwards.

The European Space Agency has found through its experiments that we might walk at a much slower rate on Mars. So will the same be true of running? The jury is still out on that. The Apollo astronauts only managed something between 1.4 and 3.1 MPH speed with their "moon walks" with very restrictive spacesuits. but in other environments, humans might achieve much greater speeds.

In the future *"World Records"* will likely become *"Earth Records"* and, in the Red Planet's case, *"Mars Records"*. So at a higher level, we might well have at a higher level "Solar System Records".

I think this brief assessment of the subject suggests that as with so many other aspects of Mars settlement, sport is going to be one of those areas where the people of Earth have to leave behind their "terracentric" views and accept that there is a bigger playing field out there for humans.

Please respond via *Mars Futures Forum* with any views and suggestions about this issue of *The Aresian*.