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Authors: Ryozo Ariyoshi
GAF CEO/GALIX Founder/President

A Realistic Timetable for Space_062021

By Ryozo Ariyoshi

Space is the new frontier. I am a space man and proponent and supporter of the global space exploration & development industry.

However, at the same time, I do look at timetables for space realistically and with most of my projections, I do tend to lean more on the conservative side. I see a lot of enthusiasm with those who are in the soft power side of the space industry through slogans and optimistic declarations "To the Moon in 2025!" or "Lunar Settlements Within 20 years!" and "Reusable Rockets NOW!" which indeed reflects good spirit and are encouraging and uplifting slogans for those involved in various sectors of the space industry.

Many of us are enthusiastic and optimistic on space timetables but I do not believe that it is realistic to say that human space settlements can be achieved within 20 years or within this generation as it may take more than a century to develop all the required innovative technologies that will make possible 1.) sustainable space habitats on the Moon and Mars and 2.) off world migration involving billions of Earthlings.

There are hundreds of innovative technologies that must be developed first in order for lunar settlements to become a reality let alone transport billions of Earthlings to new "cities" in the terrestrial planets. This essay addresses just some of the innovative technologies that we must master, and obstacles that we must overcome, before we are able to off-world migrate and build moon cities and actually live in them...

REUSABLE ROCKETS

Reusable rockets is not as simple as reusing a tank for military excursions nor like a ship or airplane for transpacific travel. It is easier to build and blast reusable rockets into space but the difficulty is in doing so feasibly and attaining cost-saving objectives in the process.

A lot of space philosophers tout reusable rockets reasoning that this will save a lot of costs but technicians, engineers and scientists know that this is not that easy and there are exorbitant costs to develop reusable rockets and for refurbishing them causing most reusable rockets to remain in storage - nonrefurbished and not reused again.

Reusable rockets are not as easy to R & D as commonly thought by space philosophers and visionaries. Engineers, scientists and even Elon Musk recognize the many challenges that must be overcome before it becomes feasible:

"The difficulty is that reusable rockets require a pure rocket engine whereby the fuel and oxydizers stored on board the vehicle plus propellant mass must be 90% of the entire vehicle weight leaving only 10% for vehicle and payload.

A lot of agencies have done research to optimize weight, efficiency and guidance systems yet you only get a 2% liftoff. Reusable rockets require strengthening the stages, thermal production, etc. that all add weight to the rocket yet must meet 2% liftoff."

Reusable rockets are not feasible at this point due to it being very difficult to build a reusable rocket with necessary additions such as thermal protection, strengthening the stages, etc. plus the significant additional costs of refurbishment.

A realistic formula takes into account weight of supporting structure and weight of empty fuel tanks. This is what makes feasibility of reusable rockets a goal that is still very distant and will require a lot of R & D to insure progress in this area.

It becomes necessary to shed off supporting structure and empty tanks so a lot of the parts cannot possibly be brought back to Earth and need to be disposed of in space in order to be able to make the trip to Moon or Mars and then back to Earth…

I have devised a new term called "Feasible Reusability" which suggests that we should not just push for reusable rockets and demand their production but also thoughtfully consider its feasibility in the process. It would be irresponsible to disregard costs for any new technology.

"Feasible Reusability" will require that rockets carry greater complexity and reduce payload.

NASA & Reusable Rockets

Many are critical of NASA for not trying to develop reusable rockets arguing that only recently space corporations are trying to develop this technology. I have heard many times criticism of NASA that they had abandoned their X15 reusable suborbital space plane technology to opt for another model. I think this is unfair.

I would like to defend NASA in stating that they really did try to develop reusable rockets extensibly and exhaustively but it was a goal that was extremely difficult to achieve even after 199 flight tests for the X15! And in the process developed 5 models including the X15 1, X15 2, X15 3, NB 52A and NB 52B but this X15 program was fraught with technical difficulties that eventually ended its run including the following failed testing attempts:

- ❑ On Nov 15th, 1967, the X15 Flight 191 entered into a hypersonic spin while descending and after reentry started to oscillate violently. Then the airframe broke apart scattering X15's wreckage over 50 miles.

- ❑ A 200th flight which was scheduled for Nov 21st, 1968 was cancelled 6 times due to technical problems which eventually sent it into storage.

This just proves the difficulty in developing reusable rockets that are feasible just for cislunar orbiting 340 miles above the ground which would deem a very tall order developing reusable rockets for trips 702.6 times longer to the Moon.

Thus far humankind has exhausted much time, energy and resources to develop reusable rockets and today it is nowhere near being feasible.

SpaceX reports that the Falcon 9 experienced temperature changes during its flight as well as intense pressures and vibrations from atmospheric wind that cause wear and tear that is very expensive and takes too long to repair sending reusable rockets into storage never to be refurbished.

The Shuttle was also meant to save money with its reusable rocket however its refurbishment costs amounted to up to $1.5B per launch! Refurbishment costs were for engines that needed to be replaced after several flights, a lot of required inspections and repairs between missions, solid rocket boosters needed constant updates once they were recovered from the ocean and the external tanks had to be built new again for every flight.

Cost of Transplanting 1B Earthlings from the Earth to the Moon is Not Realistic

I keep returning to my emphasis on market forces that have an effect on the space industry and its programs. Elon Musk's SpaceX charges $60M to billionaires for space travel orbiting the Earth.

And if we apply a formula based on the cost of offworld migration per migrant at a thousand times more than the $60M that Elon Musk and SpaceX charges billionaires for just orbiting the Earth, then the total cost per Earthling to off world migrate would be $6,000S ($6,000 Sextrillion) ($6,000,000,000,000,000,000) – and that is with 21 zeros - for offworld migration of 1B Earthlings.

The costs itself does not support rosy projections of being able to achieve off world migration of 1B Earthlings by year 2050 or even by the turn of the century for that matter…

A lunar base manned by humans up to 10 astronauts is realistically possible by 2040 or 2050 however transporting 1B or even 1,000 humans to live on the Moon or Mars is not going to happen within a few decades.

FOOD & Regolith

Bringing prepared foods for 2 years - just for one man - would require heavy payload and take a lot of room. Bringing seeds to grow is lighter but the Moon and Mars regolith is made up of volcanic ash not suitable to grow vegetables.

Shipping food or soil to the Moon 240,000 miles from Earth, or to Mars 140,000,000 miles from Earth, is just not sustainable and a great number of major innovative technological breakthroughs would have to be first be achieved to even start to plan for this objective.

Lunar and Mars soil has no organic nutrients and thus again, we have to transport another life sustaining supply of fertilizers from Earth to make terrestrial regolith usable.

Infrastructures and material for hydroponics or aeroponics would all have to be transported from Earth and this is still not feasible as it involves tremendous costs thus this is nowhere near becoming a reality. Regolith can only store 30% of the water than Earth soil and does not contain reactive nitrogen – an essential ingredient that plants need.

In Jan 15th, 2019, China announced that most of the seeds it attempted to grow in lunar soil did not sprout except for just one seed which was cotton seeds….

Moon Dust

Moon dust, the powdery sediment that gets caught in every nook and cranny of space suits, is a major problem that need to be solved. First hand experience by the 12 astronauts who walked on the moon between 1969 and 1972 and they complained of lunar hay fever that irritated their eyes, lungs and nostrils.

MEGASHIELDS TO DEFEND AGAINST RADIATION: Long way off

The process to develop such shields has barely begun and it may take a long time to build a massive anti-radiation mega shield.

The market forces come into play again: There is no profit incentive to develop megasystems to avert solar storms or defend against comets and asteroid strikes thus the R & D for such megasytems is insignificant and minimal at and until present. Lack of any profit incentives represent a not insignificant obstacle for the R&D of said megasystems.

We may never be able to develop megasystems against Solar Storms and Comet strikes. If we cannot even revert a smaller scale thunder storm, rain cloud, hail storm, etc. how can we even think to avert massive solar storms, asteroid & comet strikes?

Solar storms damage power grids and knock out satellites and major systems that are necessary for space survival including communication lines from Earth – vital to humankind's survival on the Moon or Mars.

High Radiation Levels in Space and on Moon & Mars

The Earth has a powerful magnetic field that protects us from cosmic rays which is absent in the other known terrestrial planets. Only the Earth has a protective bubble called Magnetosphere – which deflects radiation from space.

High levels of radiation in space, on the Moon and Mars and also on all the other terrestrial planets pose great risk to human health and well being.

- ❍ When you stand on the Moon, you are exposed to 200 times the radiation than when you stand on Earth.

- ❍ High levels of lunar radiation cause a number of human ailments including cataracts, cancer, etc.

The 2nd option is to live indoors with structures made of anti-radiation blocks consisting of loose ballast aggregate and could contain basaltic fibers and/or magnetite.

There is another major issue to address. Are we able to live an "indoor" life never having the chance to step outside without having to wear a space suit that is not an easy task to fit into and get out of due to harmful radiation and is this the quality of life that humans would choose or elect to live?

Space Gravity Level Causes Numerous Health Problems in Human Beings

Space gravity levels are 1/3 that of Earth. Before we even attempt to live on the Moon, we must first successfully solve and deal with space gravity induced health ailments and diseases in human beings including bone loss of mineral density, kidney stones, eye damage, breakdown of the immune system, etc.

On top of that, treating space gravity induced ailments on the Moon requires transporting medical equipment and machinery 240,000 miles from Earth. Medically treating 1B moon inhabitants or even just 1,000 moon inhabitants is a near impossible task– just another example of the logistical challenges relating to medical needs for a large scale transplant of 25% of Earth's population to the moon. Medical equipment & machinery alone is not enough for you need those that know how to use them – meaning doctors in over a hundred specializations plus the thousands of technicians (lab, Xray, blood test, etc.) and nurses.

zeroG: Zero Gravity or microgravity causes Spacefarers to experience Bone Loss of Mineral Density 1.0 -1.5% per mo. Postmenopausal women can experience bone loss of up to 3%/mo.
Status: No solution yet.

Loss of Bone Mass: NASA reports that some astronauts could lose up to 20% of bone mass within 5-11 days.
Status: No solution yet.

Kidney Stones: Zero gravity or microgravity can remove calcium in bones which end up in kidneys contributing to kidney stones.
Status: No solution yet.

Eye Damage: Microgravity causes fluid and blood pool to the head causing structural damage to the eyes.
Status: No solution yet.

Immune Sytem Goes Haywire:
Status: No solution yet.

Distance from Earth to Transport Medical Supplies: This is a major expense and just not feasible since Space Stations on the Moon are 240,000 miles from Earth and Mars is a minimum of 34M miles (56M kilometers) from Earth.

If in the last 75 years, humankind has barely started to R&D technologies to treat space related health problems including many gravity and radiation induced ailments and diseases, so how can we expect to solve these problems within the next century? I believe my statement is accurate because the formula I used is based on the progress made thus far in this area for the past 75 years up until today.

On top of that, treating space gravity induced ailments on the Moon requires transporting medical equipment & machinery 240,000 miles from Earth. Medical equipment & machinery alone is not enough, for you need those that know how to use them – meaning doctors in over a hundred specializations plus the thousands of technicians (lab, Xray, blood test, etc.) and nurses.

The obstacle for lack of progress in this area is again, the absence of any profit incentive. This will require large scale investment yet private corporations will not invest in space health because there is zero profit incentive in the near future. <u>In national space budgets, getting to the Moon is more of a priority than treating space related ailments once you get there</u>.

Lowering the Bar Might Be More Attainable and Within Our Reach: Space Tourism & Robotic Lunar Bases

Space Settlement and off world migration requires hundreds of innovative technologies but maybe we should lower the bar and first try to do something more doable and within reach like:

❍ **Space Tourism:** Involving SSO, Low Earth or Polar Orbits highlighted by visits to space hubs.

Space tourism carrying private citizens into SSO (sun synchronous orbits), Low Earth or Polar Orbits (North to South and within 30 miles of the N & S Pole).

❍ **Robotic Lunar Bases:** Eliminates the many dangers and risks that are associated with human space bases.

❍ **Expanding the CLPS commercial Landers Project**: Happening now.

SUMMARY

I am not trying to discourage space enthusiasm. No, in fact, I am a "Spaceman" and a strong advocate and supporter of the space industry. I indeed do recognize the value of, and role that rosy projections for space timetables play and that is to stimulate a new generation of space enthusiasts to "reach for the cosmos" and also has the effect of generating governmental support for national space agencies, therefore, I do not want to discourage "space dreaming" and this swell of support for space industry advancement. I am just providing a balanced view to this topic by presenting a realistic timetable.

The second objective for this paper is to suggest lowering the bar to set more realistic goals such as space tourism involving SSO, Low Earth or Polar Orbits highlighted by visits to space hubs, and in addition, robotic lunar bases and expanding the CLPS Commercial Landers project, etc.

Optimistic Timetable by Bernard Foing

To present a balanced look and perspective at space timetables in this paper, I am including a more optimistic timetable for space as articulated by Bernard Foing.

Bernard describes the following midterm roadmap for lunar exploration and settlement:

2003-2020:	Moon village orbital fleet
2013:	Robotic village starting with ChangÉ3
2021:	CLPS commercial landers
2023:	Artemis 2 astronauts cislunar
2025:	2 astronauts surface for short duration
2028:	Extended stays
2030:	10 astronauts on Moonbase; Permanent human presence; Use

resources.

2040:	100 inhabitants; First baby born; Moon interplanetary space port
2050:	1000 on the Moon
2060:	10,000 inhabitants living in moon cities; Republic of the Moon
2030:	Astronauts on Phobos
2035:	Astronauts on Mars
2045:	Permanent human presence on Mars

I hope the above schedule becomes a reality! It would prove my timetable wrong but I would be exuberant and delighted for it would be a reason for all nations and citizens to rejoice for humankind and for celebrating the mind blowing leaps & bounds in space-related innovative technology that made possible the continual progress and advancement of the global space industry.