A Road Map to Successful Lunar Access

Here are some ground rules that I believe apply to commercial space operations, as they do any other successful commercial operation.

1) There is always a most cost effective solution, and the one who is most commercially successful is always the one who gets closest to it.

2) Lower cost does not automatically correlate with lower safety. In fact, lower cost can correlate with greater safety; as, for instance, when a system is simpler and uses fewer parts.

3) Government, as has been demonstrated so unmistakably, is inherently incapable of producing a cost effective operating system of any kind.

4) Whenever you try to make one machine perform two unrelated jobs, it invariably does those jobs less well than two machines, each of which is optimized for its job.

Even if the USA builds a functioning deep space transportation system and ignores Rules 1, 2, 3 and 4, someone (the Russians, Chinese, or Brazilians?) will eventually eat our lunch.

There's another rule that is rather general, but especially applies to space systems because they have such small margins for error. It is summed up as: KISS

The following ideas attempt to incorporate these rules and maxims at the concept level.

The tasks that must be accomplished by an Earth/Moon Transport System are, stated generally:

Create the capability to establish a permanent and expandable facility on the Moon, with regular, economical and frequent transport of people and cargo between Earth and the Moon.

My concept for this breaks down as follows:

1) Earth to Low Earth Orbit (LEO)
2) LEO to Geosynchronous Earth Orbit (GEO)
3) GEO to Lunar Space Station
4) Lunar Space Station to Lunar Surface Facility

--- and back to Earth using the same sequence in reverse.

Each stage will use a specialized space vehicle, optimized for its operating conditions.

All of the stages, except the Earth to LEO, will use liquid oxygen/liquid hydrogen (Lox/LH2) propellants "mined" on the Moon (assuming the indications of water ice at the lunar south pole are confirmed) and the Earth to LEO stage will augment its propellant load with lunar O/H.

Each stage will be highly specialized for its task.

Lunar Station may be at L-1 (the La Grange point, between the Earth and the Moon where the attraction of both is equal) or in lunar orbit. The decision on that will be driven by trade offs evaluated after operations, using either option, and their impact upon costs are fully analyzed, with emphasis on recurring costs,

For example, delta V (velocity increment) required to travel from a lunar orbit to the GEO Station may be greater than from
L-1. But operating to and from L-1 to the Moon may trump that deficit.

That issue requires some basic calculations to resolve.

Other factors may surface when the conceptual design for the lunar surface shuttle is examined.

And, of course, the design of each transport vehicle will be affected by the design of the other three and their station location.

The first two stages (Earth to LEO and LEO to GEO) may eventually be combined and become a single stage using a single vehicle design.

But the demands of a trip to GEO in a cargo vessel from the surface of the Earth make breaking that up into two stages look like the better near term architecture.

I expect the Earth to LEO transport to be single stage, fully reusable, vertical take off and landing (SSTO/VTOL).

This is perhaps the most obvious application of the KISS principle.

The SSTO/VTOL vehicle is mechanically simple, but its design challenges the ultimate in rocket science.

The stringent mass fraction (the fraction of launch weight that is propellants) demand of an SSTO/VTOL transport vehicle can be significantly eased in two ways.

First, by making this a very large (Saturn V class) transport.

The larger, the easier it is to achieve the necessary .92 mass fraction, and the greater the chance that it will carry a profitable load.

The rationale is clear: many things do not get bigger nor heavier when the vehicle gets bigger. That includes almost all the electronics, crew accommodations, cargo handling gear, etc.

Secondly, I expect that lunar O/H propellants will be delivered to and stored at the LEO station as water, where they can be electrically dissociated into oxygen and hydrogen as needed, using solar power.

They will allow the Earth to LEO station cargo transport to top off its tanks for the vertical return landing on Earth.

The likelihood that early lunar to GEO return flights will be burdened with much cargo seems rather low, so one way to pay for the flights will be to carry back and sell lunar ice derived propellants in Earth orbit to the Earth based cargo transport companies.

It is (technically) absolutely clear that availability of lunar water in LEO will go a long way towards making SSTO rockets technically feasible by allowing them to exhaust almost all of their propellants getting to LEO.

And that will also make them economically competitive with any multiple stage rocket operating from Earth to LEO , because the latter will throw away expensive stages as we have for generations; stages that their stockholders would have to replace for every flight.

Nor will the SSTO/VTOL rockets need super long runways to land nor have to carry complex and heavy wings and landing gear to orbit and back, for use only during the final few minutes of their flight.

They will land as helicopters and the Apollo Lunar Lander did, vertically on light, shock absorbing legs, ready to be refueled and take off again after the kind of routine servicing and maintenance provided now to commercial jet liners.

If He3 (helium 3, postulated as a nuclear power source) turns out to also be a lucrative export product for the Lunies, the same tankage can be used, as demand and supply dictate.

And a small section at one end of the cargo module will accommodate people traveling to or from the Moon.

So all of these vehicle will, to some extent, use lunar ice derived propellants.

The LEO to GEO transport vehicle (LTGTV) will also be large in order to accommodate the large cargo carried in the Earth to LEO stage. That is not a problem of design, but more one of meeting the obvious economic requirements; that the cargo carried to LEO can be immediately loaded on to the LEO to GEO transport with minimum handling.

That points to a removable cargo module, probably of Shuttle ET (external tank) proportions. That will be transferred to the LTGTV from the ETLTV at the LEO docking facility.

The transfer may consist of replacing the ETLTV propulsion module with the nearly identical LTGTV, with the primary differences being engines optimized for vacuum operation and smaller propellant tanks.

That creates an image of that facility in the mind’s eye.

Initially there will be a pair of docking “ways” with ETLTV and LTGTV in parallel locations and Canadarms (the teleoperated arms developed for the International Space Station) to swap cargo pods on propulsion modules.

Early on there may not be much coming back from Luna in the way of bulky cargo, but that will change as the Moon begins to produce its own exports.

That makes the SSTO/VTOL even easier, because it will either not carry a cargo pod back, or the pod will be empty, making landing propellant requirements minimal, even though availability of lunar O/H would allow ample topping off.

Note that the cost of lunar O/H will be an additional incentive for the ETLTV operators to make their rockets true SSTO’s (that can carry their own return propellants) as soon as possible.

The financial advantage may lie with the operator who does not use lunar propellants, or with the operator who does, and therefore can carry more cargo to LEO.

But that decision will be made in a Board Room, and not by NASA bureaucrats!

Once confidence in reliability has been established, and tourist demand rises, the cargo module can be re-designed to accommodate passengers.

Here I want to insert another point.

Passenger jets do not have ejection seats nor emergency parachutes for their passengers.

Over half a century into the Space Age it is time that we dispensed with the test pilot image of space travelers and concentrated on making space vehicles operate as commercial aircraft do.

It is a measure of the resistance to commercialization that NASA has inflicted upon us that we are still bogged down thinking of escape towers and parachute landings.

Think back to fifty years after the Wright Brothers flew and compare the burgeoning jet age of 1953 to where we are today in commercial space travel.

Our space transport cargo modules will be designed from the beginning to (as our commercial jets do) tolerate anything short of mid air disintegration and still complete whatever flight they are engaged in.

The cargo module becomes the driver for all the other stage cargo (and eventually, passenger) vehicles.

Once to GEO, another transfer will take place, with the cargo pod winding up on the GEO to Lunar Station transport.

The GEO to Lunar Station transfer vehicle will be a straightforward space tug, large enough to accommodate the very large pod, and derived from the LTGTV as that was from the ETLTV.

The GEO Station can be similar to the LEO Station, with added features to protect occupants from solar flares and to provide decent living conditions for the operators.

Water filled walls and other means to provide radiation protection, and spun up habitats to fight the effects of extended weightlessness will be essential features.

I can see the crews working in weightless conditions supervising the automated transfer of cargo pods.

There’s little use in hauling a large pod to GEO and then not taking it to the Moon, so the entire series of vehicles and stations is really sized and configured by the cargo pod, which is sized by economics; specifically, its capacity must be determined by the load that will earn the operators a reasonable profit after the system is fully operational.

Initially, that seems to be determined by the value of propellant costs saved by hauling them back from the Moon instead of up from Earth.

I leave that as “an exercise for the class” to work out, but am open to alternate criteria.

The point is to always think in economic terms !

This must not be seen as “footprints and flagpoles”!

There was a time for that.

Now we must move on.

This is an enterprise that will begin to generate its own finances from the gitgo, or it will either not happen or soon be overtaken by others who DO pay attention to the rules I cited at the beginning, just as the space launch industry is about to be now.

Adding the necessary delta V capability to the Pods for each leg of the trip is straightforward rocket design, and I will not bore you with my particular concepts … but there is one extremely important point buried in what I have said.

Recycling existing rockets into bastardized elements or versions of the building blocks I’ve defined above will kill any chance the concept has for being commercially successful.

Every rocket flying these days is vintage ‘60s technology, no matter how much in the way of upgrades have been incorporated.

It is akin to trying to make the Lockheed Constellation compete commercially with the Boeing 787 by hanging auxiliary jet engines on it … as we did with the B-36 lo these many years ago.

Trying to make a silk purse out of the Space Shuttle elements will merely show that it is still a sow’s ear.

The Shuttle’s engines have to be rebuilt after every flight at tremendous expense at the same time that commercial jet engines are flown until a bore scope shows some sign of wear and tear on turbine buckets and flame buckets. And that allows literally thousands of hours of operation between overhauls.

Can we do that with rocket engines?

Of course we can, and we will.

Those who claim rocket engines will never achieve such reliability should recall that the engine in the F-80 (in which I learned how to fly jet fighters) had a time between engine overhauls of fifty (that’s 50!) hours!

The only question is whether we will get around to it much later (probably after the Chinese have shown that it can be done) or now.

The same goes for using the “traditional” management methods on this new enterprise.

Does anyone really believe that the organization that barely managed to fly five times a year using a system that costs $850,000,000 per flight and has a catastrophic

failure rate of two out of 114 will successfully follow the road map I have described?

The same goes for the once nimble and innovative aerospace corporations that have grown fat and lazy since their Apollo days.

No way can they follow this plan.

My proof is the aborted X-33/Venture Star fiasco.

It spent $1.3 billion of our taxpayers' dollars to prove that they did not know how to do what I have described above.

Not the technology, though that is also true, but the conceptual approach.

Think about this.

If LockMart had really believed in the Venture Star, nothing could have prevented them from building it, because it would have given them a hammerlock on all world wide space launches and an expanding market for the foreseeable future.

Instead, I believe their board members wiped their brows in relief when they realized that the steady production of expendable vehicles would now continue indefinitely.

I do not believe that they deliberately proposed a configuration that they knew would fail.

But if they had, it would have looked a lot like X-33/Venture Star!

So there it is.

There is nothing defined in my proposal that cannot be designed, built and operated with presently fully developed, proven technology.

So there is absolutely no reason for NASA to be involved at all.

Read their charter.

It says nothing about NASA designing, building nor operating COMMERCIAL SYSTEMS!

And does anyone really believe that NASA is in possession of ideas, technology or even talented people that are not available to commercial space companies?

As a matter of fact there are hundreds of outstanding people now working at NASA who will leap at a chance to work on a project such as I have described at a dynamic, for profit company.

So let's get on with it.

But don't just think frontier and science; telescopes on the far side of the Moon; jumping off place for Mars, although it will bring all that.

I want to live to see, and perhaps to visit Las Vegas on the Moon. They will invent whole new ways to enjoy life in one sixth Earth gravity.

The buildings can be transparent roofed with radiation absorbing materials that will literally float on the atmosphere inside. That means that in combination with the lower gravity there will be no architectural limit on their size.

One sixth gravity is just enough to allow us to fly by flapping rather small wings, swooping and soaring on indoor thermals as even a hawk would envy,

Think of swimming or ballet dancing in one sixth gravity.

The arts will discover whole new dimensions of expression
that open up vistas we can not even dream of now.

And it all depends upon what I have described in the Road Map.

And the success of that depends upon observing the four points I cited at the beginning.

Do I think I have described the only way that it can happen?

No.

I’m not that egotistical.

But I believe that I have described a way that it can happen.

And we must fight off each and every attempt to have the government do it, no matter how it is disguised, justified or camouflaged.

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