Outbound # 3 - January 15, 2018 - Editor Peter Kokh
(former editor of Moon Miners' Manifesto, #s 1-301 (30 years)

So what happened to OUTBOUND after the first two issues?
Well I had 11 more issues ready to go, way ahead of time, so that I could start concentrating entirely on the first of 4 books I want to write
"**A Pioneer's Guide to the Moon"**

Then someone stole my computer - and (yes, you can kick me) I had not backed up those 11 ready-to-go issues or stored them on a thumb drive.

(*Mea culpa* - "my fault" in Latin, the language of ancient Rome.)

Despite constant efforts and money offered, I never got that computer back, and was without one for about 6 months, until my sister and brother bought me a used Macbook (I'm a Mac man, and Macs are pricey!)

Now I am concentrating on the first book, - so far nearing 300 pages -
I expect it will be at least double that or more by the time I am finished.

After that three more books are on my "want to do" list
√ **A Pioneer's Guide to Mars**
√ **A Pioneer's Guide to the Rest of the Solar System**
(and one I have been wanting to do since an eureka moment, September 1, 1961)
√ **The Omega Factor: What makes the Universe tick, & everything in it**

Meanwhile, here is something I want to share with you.
An introduction to Book #1 (Title above)

Foreword: The Moon: What's in it for Earth? Part I
Zero-G Export$ from Lunar Outposts & Settlements to Earth

Many space enthusiasts are skeptical about the economic feasibility of producing anything on the Moon to send back to Earth. That's another article. Here we want to cite those products that "ship free" and "know-how" processes and technologies that could be developed on Earth, but may not be, as the perceived need is not urgent.

• Environmental technologies developed first on the Moon where the urgency is immediate

Lunar Pioneers will learn to live in harmony with Nature within their mini-biospheres, and learn fast, because they have no choice.

They will be **"living downwind and downstream of themselves"** and there is nobody's back yard to dump pollutants, especially organic compounds made of elements scarce on the Moon. **The processes and technologies they develop - because they have no choice - can then be exported to Earth. And as they are adopted on Earth, these technologies will make a very critical and** significant contribution to the **preservation of Earth's fragile environment for future generations.**

These technologies will include √ stale air and used water treatment, √ products and new production processes that make "total recycling" feasible and easy. They will also produce √ a mindset, beginning at a very young age, of ingrained personal responsibility to preserve their fragile mini-biospheres.

- **Moon-appropriate building materials and variants that could find a niche on Earth as well:**

As so many of the materials that we use on Earth include chemical elements rare on the Moon, we must make do with substitutions. Glass-glass composites ("glax") is a promising area of research in which only minimal demonstrations have been done to date. We might make habitat modules, furniture, vehicle bodies, and other useful products form this material, which could be pre-developed here on Earth as it has advantages such as a substitute for wood. Read:

http://www.moonsociety.org/publications/mmm_papers/glass_composites_paper.htm

New types of concrete; new metal alloys that do not use alloy ingredients rare on the Moon such as copper, zinc, even carbon, are some options. Once developed on the Moon where the need is urgent, such materials may well find a market on Earth in nations less well endowed with mineral wealth.

• **Technology options using elements common on the Moon**

(and excluding elements rare on the Moon)

Even given confirmation of surprisingly large quantities of water-ice in permanently shaded craters at both lunar poles, and recent evidence of unsuspected quantities of water bound up in lunar materials in micro-drops, water will be harvested with much greater effort on the Moon than on our water-rich planet. New ways of conserving water and recycling it with ever-greater efficiency will be an effort that is pursued religiously as need grows with population.

As to mining, pioneers will treat the tailings with respect, as they are necessarily enriched in all elements not yet extracted. When no more elements can be affordably extracted, pioneers will find ways to turn these last-generation tailings into products that are useful. And some of the technologies and processes so developed will help reduce our "trash problems" here on Earth.

The "**throughput**" footprint of the settlement is thus reduced, with the result that population for population, the lunar landscape will be far better preserved than Earth's has been. And perhaps some of these technologies applied on Earth could in time "recover and restore" significant portions of industry- and wastes-wrecked lands here on Earth.

* The percentage of raw materials mined that ends up in landfills is a negative indicator. To conserve energy, lunar industrial parks may be arranged so that waste heat from those operations that require higher operating temperatures supplies those that need somewhat less, in a "**Thermal Energy Cascade**". It would make sense to design industrial parks on Earth to do likewise: reusing and reusing waste heat, which is potential energy.

• **Education of youth in environmental responsibility.**

The lunar settlement experiment will surely fail if living right, given the strictures of the lunar environment does not quickly become "second nature," and anything but a resented burden. This means raising children and youth accordingly. A "4th R" ~ Recycling, must be added to the curricula. Assigning recycling chores, a year of "universal service" in the water/air treatment systems or in bio-waste recycling operations would make sense. Community survival is at stake.

• **Art Form Options that work on the Moon, will also work on Earth**

Totally inorganic art forms will have their own unique beauty and could catch on here. Check out:

http://www.moonsociety.org/chapters/milwaukee/painting_exp.html

The above is not an exhaustive list of "Zero-G Exports from the Moon to Earth.

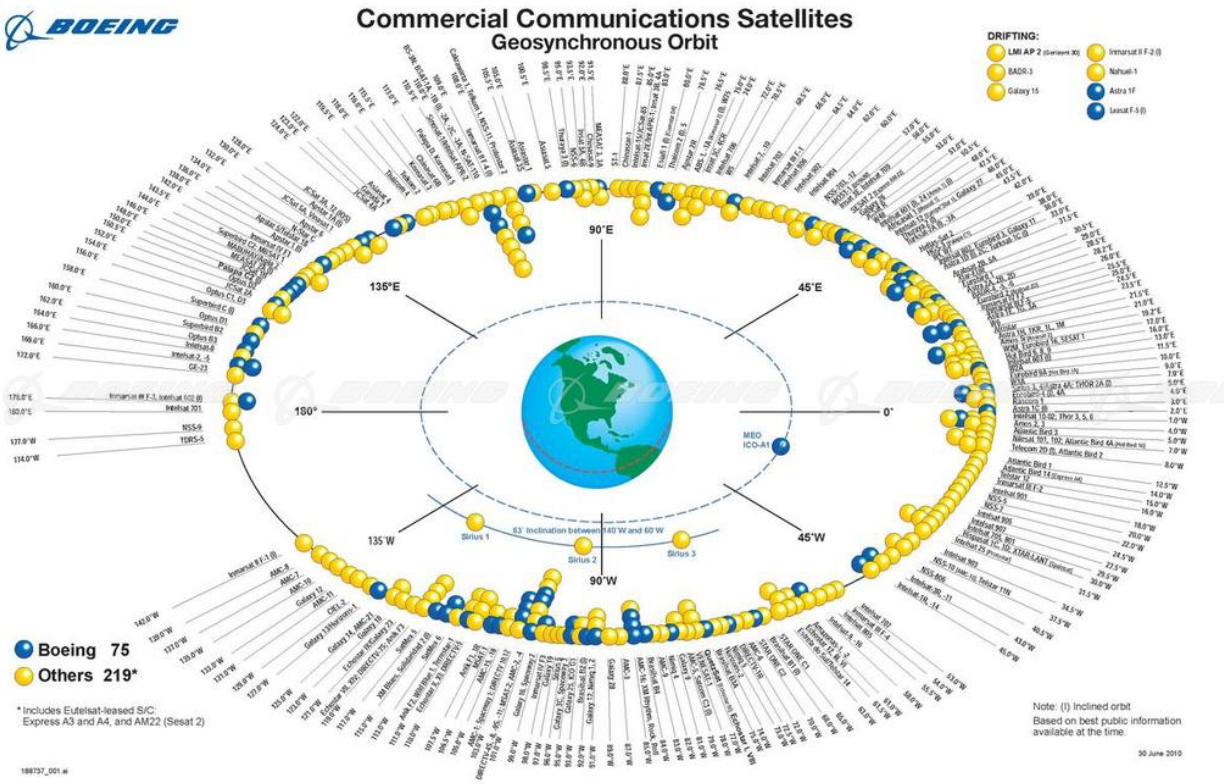
• **Social Experiments to maximize productivity of all inhabitants**

Making a frontier economy work will depend on everyone doing their part: no room for slackers and/or those who add to the burden. This means taking cradle-to-grave steps to minimize anti-social behavior. "Out-the airlock" solutions may seem severe, but chain-gang labor should not be dismissed for the stubbornly uncooperative. Handling the handicapped so that any burdens are offset with plusses will be a challenge. The lessons for Earth will be significant.

• **Retirement: switching to more relaxed forms of productivity.**

Better child-care options (such as preretirement part time grand-parenting?) are needed to free adults in their prime for economically productive activities.

You can see how already crowded GEO is. If in every slot that now carries one satellite, we put platforms each of which could then carry say a hundred satellites, including solar power satellites placed, tended and repaired if needed by a robot - GEO's GNP could could be much higher yet.



More about the Book - I have long disagreed with the prevalent consensus that the place to start is at the Moon's South Pole, digging up ice filled craters for rocket fuel, separating H2O into Hydrogen and Oxygen (H2 and O2).

The ice is at the bottom of craters two miles down. The equipment will have to be lowered down there in pitch black darkness. Can you imagine what will happen when this equipment fails or there has been a life-threatening accident?

Those ice reserves should be saved for the needs of people who will go to the Moon to live.

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The Moon's economic future lies in production of items out of which giant platforms can be built, then shipped to Geosynchronous Earth Orbit, in pieces to be robot-assembled on arrival, and to be placed in the limited number of slots allotted, each platform able to host a hundred or more previously free-orbiting satellites. Robots, teleoperated from Earth, would put together the pieces to make platforms, then place these satellites on the platform, and service them as needed.

Keep in mind that GEO is quickly becoming saturated as is, and that if GEO were a "Nation" it would be in the top 20 nations in terms of gross national product. It takes only a fraction, 1/23rd I believe, of the fuel to bring the needed platform products down from the Moon, as it would to bring the same units up from Earth's surface.

Products shipped down the gravity hill from the Moon, including Solar Power Satellites, could help Earth's total Global Product to grow beyond expectations, and more importantly help save and protect Earth's global environment, allowing countries to shut down any air- and water-polluting plants.

It all depends on another idea - **another place on the Moon to mine ice** - to be used as "water" should be used.

And another idea of **where first settlers should go on the Moon to tap other needed resources,** as well as water-ice, that they will need to build their towns and provide everything else they will need to have - and it definitely will not be at either pole.

Where? I'll keep you in suspense for now.
(Maybe until Book 1 is printed.)

A clue: there is nowhere else on the Moon that can fill the bill. **It's along an "interface" between two very different types of Lunar terrain, the resources of both needed to make the plan work.** Now in that last sentence, I gave away the answer. There is only one answer.

Email me if you think that you "got it!" (kokhmmm@aol.com)

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The Moon: What's in it for Earth? Part II:
Lunar Materials to Grow Earth's Economy

How the Dream began

In the early 1970s, Princeton physicist Dr. Gerard K. O'Neill publicized a scenario in which we would go to the Moon, mine lunar materials near the equator and sling them into space with an electromagnetic "mass driver." There they would be used to build space settlements to house workers in comfortable and pleasant surroundings, workers who would use more lunar materials to build hundreds or thousands of gigantic solar power satellites to feed our planet's ever more voracious appetite for energy. Thus began the L5 Society. "L5 by '95" was a battle cry.

In response to Congressional requests, NASA even produced a comprehensive "Space Resources and Space Settlement" report in 1977 on the scenario and related ideas for Congress. It is still worth reading and belongs in every space enthusiast's library.

While the scheme was logical, too many of the needed technologies were still in the conceptual stage. To their credit, O'Neill's Princeton team produced successively three working model mass-drivers, each progressively more powerful and convincing.

The logic of using "lunar materials" to build giant structures in Geosynchronous Orbit is impeccable:

It would take only 1/23rd the fuel to "downport" (down the Earth's gravity well) material's from the Moon on the gravity well's shoulder down to Geosynchronous Earth Obit **as it would to "upport" them** up that steep slope the much shorter distance from Earth's surface. And this, goes the logic, would make solar power sats much less prohibitively expensive.

It is the unique economic potential of Geosynhronous Orbit (Economic Gross Product within the top 20 Nations) that makes the existence of potential construction materials on the shoulder of Earth's Gravity Well so significant.

The Moon and GEO are a natural team literally "made in heaven," a 2-way economic case of "Location, Location, Location."

http://www.permanent.com/images/t-gravity-wells.gif

Enter The Giggle factor: Many of those old "L5ers" are still around. But others, also convinced that Earth's future depends on Solar Power Satellites, but not spiritual descendants of O'Neill, are **reluctant to back plans that call for lunar sourcing of materials.**

It will take too much of an effort, gobbling up too many years of lead time, to industrialize the Moon to the point where lunar raw materials could make a significant and timely difference. And on the NSS Space Solar Power Committee, this division between O'Neillian believers and those never caught up in the L5 Space Settlement dream is quite obvious, with both sides talking past each other.

But in contrast to "many years" it would take "decades of more" to build the giant space settlements he proposes.

Long overdue critical distinctions

1. Distinction between parts made on the Moon and those made here on Earth

This part of the puzzle's solution is something I contributed way back in MMM #19, September 1988, pp. 3-4, **"A Strategy for Following up Lunar Soil Processing with Lunar "M.U.S./c.l.e."**

In this plan, we would seek to produce on the Moon everything needed there that was **M**assive, **U**nitary (we need many of the same), and **S**imple. We would produce **on Earth for up-shipment, things that are c**omplex, **l**ightweight, and **e**lectronic**.** Now there are sure to be many things that do not fall neatly into one of these two divisions.

But if they can be divided into **"MUS"** and **"cle" subassemblies**, then we have the problem of sourcing solved neatly.:

Basic simple lunar industries will produce the lion's share of what is needed weight-wise while terrestrial industries will provide the rest. This article is online at: http://www.moonsociety.org/publications/mmm_papers/muscle_paper.htm

2. Lowering the expense of developing "in situ" lunar resources into building materials

In our article "Glass-Glass Composites" we suggested that just the opposite of the "spin-off" process, "spin-up" would yield prototypes of technologies needed on the Moon or elsewhere in space at much less research and development cost.

Here, instead of a high-cost NASA crash program, entrepreneurs examine the list of needed technologies and examine each for possibly profitable terrestrial applications, then pre-develop those technologies precisely for those terrestrial uses.

This article is also online at: http://www.moonsociety.org/publications/mmm_papersglass_composites_paper.htm

3. Starting up the needed Lunar Industries

Even given the distinctions and novel approaches that greatly reduce the challenge of creating an industrial complex on the Moon capable of contributing the major fraction of the mass of Solar Power Satellite construction elements, the idea of lunar industrialization remains "science-fictional" to many.

Well the Moon Society has addressed that as well, in our concept (Peter Kokh and Dave Dietzler) for an **"ILRP: I**nternational **L**unar **R**esearch **P**ark**"**

Online at: www.moonsociety.org/india/mmm-india/m3india2_Winter09.pdf

4. The ILRP would be fully international, quite resistant to any one nation's budgetary pressures or waning of resolve, as is the International Space Station.

√ The basic enabling parts (spaceport, warehouse, recycling operations, and more) would be constructed by a contractor consortium,

√ Individual national space agencies could ship up their outpost modules and plug in, free to concentrate on the science and research they came to do.

√ Other corporations and enterprises would be welcome.

√ This kind of critter could in time morph into the first lunar university.

5. Identifying feasible lunar materials and how to produce them

This is a task to which Dave Dietzler and his "ILRP Team" has dedicated itself. What alloys of iron, aluminum, titanium, and magnesium, the four "engineering metals" are feasible on the Moon, given the low abundance of some of the usual alloy ingredients for each? The team has identified several feasible options and how we can go about isolating the needed components from the mishmash of moondust in which minerals have not been concentrated into mine-worthy lodes, absent geological processes that work in the presence of water.

6. Switching to more efficient, cheaper space transportation systems

We have written often over the years about the flawed philosophy of NASA space transportation architectures. (1) We need orbital refueling. (2) we need to design all components for salvageability and reuse, all the way up the line from Earth orbit to lunar landing. The Apollo and Apollo on Steroids approach of Constellation now in its disguised reappearance as "SLS" are insane.

"Getting into space" has to be about "getting into space," not providing money for the constituencies of key Senators and Representatives, or catering to the current stable of industrial-military complex providers.

The Commercial Route alone holds hope. **But is anyone listening!** There is more work to be done, especially in deciding trade-offs between what can be most cheaply made and shipped from whence to where. ##