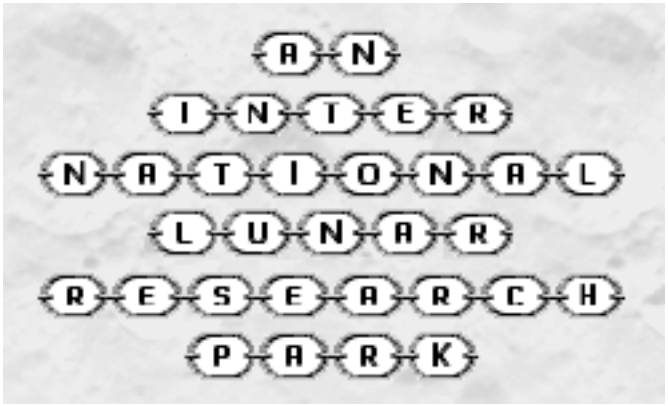


# An Open-ended Lunar Initiative v. 2*

By Peter Kokh and David Dietzler

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## Current Prospects

The United States, under former President George W. Bush, redirected its ISS and Planetary Exploraation-focused Space Program to a "return to the Moon" and "beyond to Mars." This direction will probably continue under President Barack Obama. Meanwhile, China, India, and Japan have launched lunar probes and spoken of putting crews on the Moon. Whether these will be one time "science picnics" å la Apollo or real efforts to establish permanent facilities to support manned exploration sorties and other activities remain to be seen.

## The Question

If each nation picks a different location on the Moon for its surface activities, areas of cooperation are limited to data sharing, tracking, and other support activities.

If, however, some or all national lunar outpost efforts are concentrated at one and the same location, be it at the north or south lunar poles or somewhere else, then the opportunities for shared facilities is enormously increased, and with it could come major savings by reducing unnecessary duplications.

## Shared Facilities: Corporate Partners

Of course, then the question becomes "who will build and provide the facilities to be shared? And right here we have the opportunity to introduce new parties: contractor companies. Possible contractors could include Boeing, Lockheed-Martin, EADS, Antrim, and other names associated with the Aerospace industry, but also other major contractors. To pick a few: Bechtel, Halliburton, Mitsubishi, and on and on.

## Added Players: Enterprise, University Consortia

If we collectively choose to establish not a collection of national outposts, collocated or not, but an "**International Lunar Research Park**" the possibilities for future expansion, elaboration, and outgrowth – *even into the 1st human lunar settlement* – will increase greatly.

## Facility Lists

The lists below are meant to show how great are he possibilities for diversification and outgrowth. The items in **bold** will come first. Plain type next, *italics* last. Note, that this subclassification is just one person's first attempt, and corrective input is most welcome. No one expects to "get it right" the first time! What we want to do is to put out the general concept of how enormously the choice of an International Lunar Research Park could bust the future wide open. After the itemized lists (we surely have forgotten or not thought of many items!) we will give our thoughts on just what must come first.

### National Outpost "Core" Elements

- **base habitat**
- **base laboratories**
- **basic life support**
- **command center**
- **airlock**

### Contractor Corporation Services

- **Site preparation**
- **Spaceport services**
- **Construction equipment**
- **Shielding services**
- **Solar wind gas scavenging**
- **Fuel storage**
- **Fuel production**
- **Power generation**
- **Power storage**
- **Warehousing systems**
- **Thermal management**
- **Waste treatment**
- ISRU Research
- ISRU Manufacturing
- Habitat expansion modules
- Agricultural modules, basic agricultural services
- Biosphere maintenance
- Road construction
- Connector modules

### Enterprise Opportunities

- **Commons with meeting space**
- **Restaurant**(s)**, pub**(s)
- **Recreational facilities**: exercise, sports, dance, theater
- **TV/Radio Facilities, satellite communications telephone system, internet provider**
- Instruction, continuing education – keeping up to date with improved lunar systems
- **Financial services**
- **Hotel facilities** for visitors, tourists, overflow between crew changes
- **Cabbotage** (outfitting) services
- **Surface transportation (passenger, freight)**
- **Vehicle maintenance**
- **Space suit services**
- **Tools, equipment**
- Recycling services
- tour coaches & excursion services
- marketplace
- agricultural production, products
- green (horticultural) services
- reassignment services (new roles for scavenged parts of landers etc.)
- agricultural production
- customization services
- event management
- surface recreation vehicles
- archiving services

### University Consortia

- **Medical Center**
- Continuing education
- Research facilities
- Astronomy installations

### Joint Civic

- **Road planning local**
- **Road planning regional**
- **Environment protection**
- **Environment enhancement**
- **Inter-Sector coordination** (Contractors, Enterprise, National, University)
- Parks, parkways, gardens
- Outstation planning

### Discussion – where you come in!

It would be miraculous if the list above did not have many holes, even if nothing was misclassified. Your input is most welcome!

The effort above is an attempt to start a discussion and to keep us, nationals of the various countries contemplating lunar surface activities, from being blindsighted to the enormous advantages to be gained not only by collaboration between the various national agencies, but *by restraining agency hubris and by taking the plunge to invite corporate, enterprise, and university consortia as equal partners in a joint "human" effort.*

The idea is for the national outpost agencies to buy or lease or tent equipment and services from the contractors and enterprises as their needs change and expand. This should provide not only substantial cost savings but a greater variety and supply of equipment and services.

Agencies need not provide quality and other specifications, because corpor-ate and enterprise personnel would be just as much as risk from improperly designed and manufactured equipment as would national agency crews. Toss out the mind-boggling bureaucratic paperwork, and down comes the costs.

Corporation employees would need housing, and all the other life support services as needed by the agency crews so it is natural, that as they begin to construct pressurized modules and other equipment from lunar building materials that they could provide for expansion of national outposts as well at considerable savings.

The national outposts would be "anchor tenants" so to speak, but as in shopping malls, in time their share of the economic value of total activities and facilities at the site might become, even though essential.

Some sort of Civic Council representing all of these Parties would be needed to make decisions that affect every-one, decisions about growth directions, environmental safe-guards, and so on. As this unfolds, the International Lunar Research Park will have become the first lunar settlement!

It is time for humanity to open the next continent, one across a different kind of sea. The "out of Africa" effort is ready for the next act. Only humans as a species, not horse-blindered agency managers, have the vision to grasp what is needed – and it is *not a collection of agency outposts!*

### What Comes First?

**Frankly, national agency planning puts the cart before the horse. Why? Two things come first, and no one is giving either of them more than trivial attention.**

### Part I: Developing *now* the Technologies needed for using lunar resources

We are not going to anything of lasting significance on the Moon unless we learn how to process useful building materials out of the elements in moondust. Known by the uppity Latin term *"In Situ"* Resource Utilization *("on location"* works just fine!) various processes have been proposed to isolate oxygen and other elements, but few have been tested either in laboratory scale or (more importantly) in mass production scale. How do we advance the "readiness" state" of these technologies? It is important to have them ready to go when we land on the Moon. Getting there, and then having to scratch our heads for additional time-wasting decades makes no sense. But that is the path we are on.

This topic is the subject of **"Improving the Moon Starts on Earth"** in MMM #s 132,133, Feb/Mar 2000.

### Part 2 – Site Development

No site on the Moon, no matter what advantages are touted on its behalf, is anything but "unimproved" land, what in might be called "Florida swampland."

Before the first national agency manned lander sets down on a chosen site, it makes sense for a corporate contractor to have already "improved the site" – conferring on it various advantages that will make outpost deployment, construction, and operation so much easier. Indeed, Carnegie-Mellon University, a contestant for the Google Lunar X-Prize, has just proposed that establishment of the first spaceport be contracted to the university to be done by telerobotics.

www.post-gazette.com/pg/09063/952880-115.stm

This is the subject of the article, **"The Developer's Role"** from Moon Miners' Manifesto #131, December 1999.

**Both articles are combined in one Online Paper:**

**"Improving the Moon & the Developers Role"**

**www.lunar-reclamation.org/papers/improving_moon_paper.htm**

**Also relevant, "The Outpost Trap"** serialized in MMM #s, 198, 199, 200 September, October, November 2006

**www.lunar-reclamation.org/papers/outpost_trap.html**

**<PK/DD>**

## Lunar Research & Development Priorities List: 1-5

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**1a) Space Transportation:** cheap access to space – CATS, from inexpensive expendable and/or reusable Earth to LEO launchers to ion drive or sail propelled craft for transport from LEO to LLO, L1, etc.

**1b) Lunar derived fuels / propellants** for lunar landers after some initial development on the Moon. Ion drives and sails are only good for cargos, not manned craft, given the great length of time they require for travel to LLO and therefore exposure to Van Allen Belt radiation, as well as life support. Thus we also need orbital fuel depot infrastructure. *The cost barrier must be broken.*

**2A) Life Support Systems** for prolonged (months, even years) human stays in space

**2B) AI robotics** for the majority of work done in space

**3) Production of oxygen**, other gases, metals and ceramics from lunar materials (some of this is included in category 1, for the production of rocket propellants on the Moon, given the assumption that lunar derived fuels will be cheaper than boosting them from Earth to LEO,

although this assumption might be challenged depending on how much infrastructure on the Moon and in space would be needed, when it would be needed, how low the cost of launching to LEO goes, and how many manned flights would be called for given that robot power not manpower will do most of the work

Lots of research has been done on Oxygen production and most of it has been done with simulants only on laboratory bench top scales for short periods of time. Much more research must be done with real regolith using equipment that is built to work in vacuum, low G, hard radiation and temperature extremes for extended periods of time-years, not just weeks or months. Understanding the chemistry of regolith refining is just square one. A vast amount of R&D is required to build the equipment that does the work from shovel to final product and to determine which processes will scale up from the lab bench to the industrial level, work reliably for years in the lunar environment, demonstrate the greatest economy in terms of labor, time and energy required; require the least amount of input from Earth (some processes will require chemicals from Earth that must be carefully recycled) and the most amount of "Moon-makability." We will need to replicate this equipment on the Moon from lunar materials to expand production rather than constantly import devices from Earth hench the need for "Moon-makability" otherwise the cost of ISRU will be too high.

Prerequisite to production of lunar materials is energy production. It's going to take a lot of energy to smelt or refine regolith so we will have to land substantial payloads of reflectors, concentrating lenses or mirrors, solar panels, batteries and/or fuel cells and fuel cell reactant storage equipment, cables, switches, invertors and possibly small nuclear reactors. We will need to expand energy production as materials production grows and this takes us to the next category:

**4) Lunar manufacturing**: what to make and how to make it as well as what to make it from. Once we get past the hurdle of producing gases, metals and ceramics on the Moon we have to figure out how to make more devices for producing them from the gases, metals and ceramics available on the Moon. It won't be much use if the regolith refining devices require large amounts of gold, copper, zinc, flourine or other elements from Earth. We cannot upport huge masses of equipment, even with what passes for "cheap access to space" in the future, because even CATS will still be expensive compared to transportation on Earth. We must upport a seed of regolith refining and manufacturing devices that can replicate itself in order to refine more regolith and produce more materials as well as make things from those materials like solar panels, power storage systems, habitat, farm modules, robots, vehicles, machine tools and mass drivers for launching millions of tons of lunar materials into space for SPS construction.

To grow the mighty tree of space industry on the grand scale envisioned ever since O'Neill wrote "The High Frontier" from a tiny seed amassing perhaps just hundreds of tons will require a lot of brainpower, real world experience, and some sophisticated AI robot software as well as hardware. At this time even the experts can only take shots in the dark as to what that seed will consist of. It's fun to speculate about the payloads this seed might consist of, but only after some extensive R&D on the ground and on the Moon during NASA's RTM program and some high paid teams of mission planners have had years to work on this will we know exactly what the lunar industrial seed will consist of. Because of the high price of even CATS in the future it will be essential to minimize the mass of the lunar Industrial seed machines, maximize the use of local materials, and maximize the lifetime, durability and efficiency of the seed. Also, the seed must be reasonably priced. What good will it be to use a one-ton machine that costs a billion dollars if a ten ton machine can do that job and be transported to the Moon for much less than a billion dollars? In other words, when does miniturization start costing more than rocket transport?

As for nanomachines, I have no doubt that nanotechnology will be involved in lunar industrialization but I don't go as far as suggesting that a few kilograms of nanobots will replicate like a growing algae bloom and lunar colonies will emerge from that. I do not have anything against that scenario, I just don't buy it. I would love to be wrong but I suspect that lunar industrial seed will amass several hundred to several thousand tons and even that will be tiny compared to the millions of tons of lunar industry and SPSs that emerge from that over time.

**5) Space construction.** We have never built anything as large as a solar power satellite in outer space. What will it take to do this? We can presume that lunar aluminum, silicon and titanium, possibly some steel and glass, will be used but how will billets of metal from the Moon be turned into SPSs? What machines will be needed? How do we get those machines in space? Launch them from Earth or make them on the Moon and launch them from the Moon or will a combination of Earth launched and Moon made/Moon launched machines be used? Will we need a space colony and 10,000 space workers or will we just station a small human crew in space and use thousands of robots teleoperated by humans on Earth and on the Moon?