"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

# Moon Miners' Manifesto

& The Moon Society Journal

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Contour crafting hangar-like shelters for habitat and activity modules from Earth may be the first Lunar Industry

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# About Moon Miners' Manifesto – "The Moon - it's not Earth, but it's <u>Earth's</u>!"

- MMM's VISION: "expanding the human economy through off-planet resources"; early heavy reliance on Lunar materials; early use of Mars system and asteroid resources; and permanent settlements supporting this economy.
- MMM's MISSION: to encourage "spin-up" entrepreneurial development of the novel technologies needed and promote the economic-environmental rationale of space and lunar settlement.
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## In Focus 回 It's time to get beyond lunar "exploration" – robotic or human

"A 'new world' can be far more thoroughly explored by those who come to live there, than by scouts reporting home after time- and money-limited exploration sorties." PK A New World vs Old World Encore

We've pointed this out again and again – consider the exploration and settlement of North and South America and Australia. If we really want to explore the Moon thoroughly (Mars too, for that matter) we have to move beyond the exploration phase, and plunge into settlement.

What we need from explorers is only a sufficient sampling of conditions so that immigrants can come properly informed, quipped, and motivated to make this strange new world their home, getting comfortable with their surroundings. In the process they will have to leave some things to which they had been attached behind, and willing to embrace the new beauty and challenges of living on this virgin world as more than a "fare trade."

**Not everyone will be up to such a challenge.** In centuries past, their likes stayed behind in Europe. That's fine. Earth's beauty and advantages are many.

At the top of the list is **learning to produce material needs that the pioneers cannot afford to keep importing from the world they have agreed to leave behind.** PK

## Making it on the Moon: Bootstrapping Lunar Industry

By David Dietzler

#### **Site Preparation**

The first thing that must be done before the construction of a lunar industrial facility is determining the best place to locate it. This will demand robotic and manned surveys on the Moon. The best location for the first industrial settlement will have plenty of flat ground with very few boulders on a mare/highlands "coast." Ilmenite, basaltic mare regolith, KREEP, pyroclastic glass deposits, highland regolith and lava tubes should be reasonably nearby. Polar ices should also be accessible. A location in Mare Frigoris might be best.

Once a site is selected it needs to be prepared. The site must be leveled and small craters must be filled in. Boulders must be dynamited and the rocks pushed aside. Markers must be placed to indicate the locations of solar panel farms, landing pads, roads, walkways, a warehouse, a pad for production machinery and inflatable habitat modules. Robotic bulldozers and graders will be called for. There must also be a solar panel farm and wiring systems to recharge the batteries in the bulldozers and graders or these machines will be powered by tethers or microwave beams from the solar panel farm. Receiving antennas on the machines will just be low mass wire meshes with some Zener diodes and this will not burden the 'dozers and graders. This would free the machines from the burden of heavy battery or fuel cell packs and the need to shut down and recharge for several hours at a time. Robots that can drill holes in boulders and place explosives will also be needed. Logically, all the robots will retreat to extreme range when boulders are blasted! Perhaps they will go hide behind some hills!

Clearly, the first payloads to the Moon must be solar panels and associated hardware along with several bulldozers and graders. Robots to deploy the solar panels and wiring systems will also be needed. To protect the machines during nightspan it might be desirable to have infrared lamps to keep parked machines warm and power storage systems to energize the lamps. Batteries, flywheels or fuel cells come to mind. Fuel cell systems will require insulated tanks to store liquid hydrogen and liquid oxygen, plumbing systems, water electrolysis systems, and re-frigeration devices to liquefy hydrogen and oxygen. That sounds like a complicated mess when compared to batteries or flywheels; however, there is an important advantage to the use of fuel cells for nightspan power storage. Fuel cell systems can also double as rocket fuel storage facilities with the addition of some extra equipment like pumps and flexible corrgurated metal hoses with attachments to "gas up" rockets. The first few payloads might be landed with one-way rockets.

For the sake of economy it would make sense to reuse those rockets. Instead of propelling rockets and propellants from LEO to L1 with electric tugs, LH2 and LOX alone could be transported. Better yet, water could be transported. Water will be much denser than cryogens and it won't need heavily insulated tanks to store it. The water could be converted to cryogenic propellant at the L1 space station that precedes surveys on the Moon and the reusable landers could be fueled up to deliver cargo and water to the lunar surface. On the surface, electrolysis devices for fuel cell produced water and cooling systems could produce propellants and store them.

If a device for producing oxygen from regolith is included, like a vapor pyrolysis or magma electrolysis system, then propellant loads from Earth could be slashed by 8/9s since one weight of hydrogen is burned with eight weights of oxygen. Hydrogen production on the Moon will have to wait for awhile since this is more involved than oxygen production. Even then it will be preferable to burn metals instead of precious hydrogen and metals production is also more involved. Also, a completely different kind of rocket will be needed to burn lunar metals with lunar oxygen. So it becomes necessary to land some more machinery including excavators to dig up regolith and feed it to the oxygen generators. It should be possible to equip bulldozers with mining shovels so that they can do two jobs instead of one.

Getting hydrogen to the Moon is an interesting trick. Liquid hydrogen is not very dense, requires large tanks and has to be kept super-cold. Hydrazine, N2H4, could be sent to the Moon and this could be decomposed with catalysts to hydrogen and nitrogen. These gases would be liquefied and stored and the LH2 burned with lunar LOX while the nitrogen is saved up for the establishment of Closed Ecological Life Support Systems (CELSS) and human inhabitation of the Moon. Hydrazine is liquid at "room temperature" so it is easy to store and transport. Liquid ammonia, NH3, is another candidate for a hydrogen carrier. It can be liquefied at "room temperature" if it is pressurized. Ammonia can also be decomposed with catalysts to hydrogen and nitrogen. So the first payloads to the Moon will include but not be limited to:

- 1. General purpose teleoperated robots
- 2. Solar panels, supports, motors, reflectors, wiring, switches, invertors, etc.
- 3. Power storage systems, probably fuel cell systems complete with insulated tanks for cryogens, piping, pumps, valves, electrolysis and refrigeration systems that can double as a rocket propellant depot
- 4. Microwave transmitters and/or tethers
- 5. Bulldozers and graders that can also excavate
- 6. IR lamp systems
- 7. Oxygen generators (e.g. vapor pyrolysis or magma electrolysis)
- 8. Tanks of N2H4 or NH3 and catalytic decomposition devices

#### Early Development

Once the site is leveled out and large rocks removed, it will be developed. Landing rockets will cause dust to spray all over and dust could damage machinery especially if it gets into bearings. Dust sprays could disaffect solar panels also. Several landing pads will be made. Wheeled robots with microwave generators could sinter or melt the basaltic ground to a depth of several inches at least. Bulldozers could berm up regolith around the pads. With three pads one rocket could be lifting off while another lands and a third one is waiting for service. Landers or "Moon Shuttles" might have wheels on their landing legs so they can be towed off the pad. The landing pads should be fairly big. A diameter of one hundred meters will allow a large margin of safety if a rocket is a bit off course. The pads would be located about a kilometer away from the habitat so that the chance of a Moon Shuttle rocket going off course and crashing into the habitat and killing everyone is very low. Roads from the landing/launch pads to the habitat and work area will be paved with microwaves.

Lunar workers will need a nice hard floor made by microwave roasting of the basalt as is done for the landing pads and roads to mount production machines on. Plain old ground is no good. Spacesuited human workers and robots would kick up dust and some machines like power forging hammers would pound or vibrate into the dusty surface. The floor might be thicker than the pads and roads. A large foil or aluminized Mylar parasol to shield machines and workers from the hot sun could be erected and teleoperated robots could work the production machines. Now and then humans will have to go outside in turtleback spacesuits to do some work. There will be microwaved walkways from the habitat modules to the production machine area. There will also be a warehouse consisting of a microwaved pad with a parasol to store cargo containers as they arrive by Moon Shuttle.

In addition to solar panel farms there must be power storage for nightspan not only to keep machines warm with IR lamps but to power lights, radios, computers and mechanical life support systems in habitat modules. A small nuclear generator would help. The microwaved basalt pads will serve as "thermal wadis" and cool slowly after sunset. That will be easier on the machines. Sudden thermal shock can crack metals. Even at the poles there is darkness 20 to 30% of the time or roughly six to nine Earth days at a time. With only about twice as much power storage equipment than needed near the poles it is possible to overnight anywhere on the Moon. In the distant future there could be a solar power satellite at EML1 and a circumlunar power grid with solar panel farms around the Moon to supply full power at all times.

Secondary payloads to the Moon will include but not be limited to:

- 1. More solar panels, wiring systems, power storage, possibly a small nuclear generator
- 2. At least two rovers, preferably more, in case one breaks down with microwave generators to make pads and roads
- 3. Inflatable habitat with mechanical life support systems and some tanks of oxygen to inflate the habitat
- 4. Parasols with support poles
- 5. Running lights, flood lamps and radio antennas.
- 6. Supplies of dehydrated and freeze dried foods, drinking water and medicines

At least this much should be in place before human crews move in and start working. The bulldozers and graders with shovel attachments must cover the inflatable habitat with at least a meter of regolith for radiation, thermal and micrometeoroid protection. Without shielding humans could make only brief sorties on the Moon. It is foreseeable that robots might experience glitches that halt the project and humans become necessary to get things going again. Space workers could land and stay inside their spacecraft for a few days until they get the machines up and running.

#### Excavating

The 'dozers and their shovels are just the beginng. Massive amounts of regolith must be moved to support a serious Moon mining operation with the goal of building mass drivers, solar power satellites and other constructions in space. A slusher system seems best. This consists of a bucket attached to some steel cables. A winch pulls the bucket through the dust and it picks up a load. The load is lifted and dumped into a truck or an ore car on rails. A second set of cables wrapped around some pylons with pulleys at the edge of the excavation is pulled on by the motorized winch and the empty bucket is dragged out and readied to scoop up another load of regolith. This will be more efficient than making the 'dozers scoop up a load, carry the load and their own weight to the refinery, dump the load and drive back to the hole, and repeat the process. The slusher can work continuously. At first trucks will haul Moondust to the refinery on microwaved basalt roads perhaps. Later on, a railway system will be constructed. Cars riding on steel rails will endure much less rolling friction and that will save energy. They won't kick up dust either. When the slusher has dug up a pit and can dig no more it can be relocated. Rail systems can be extended to the new dig site. The Moon Shuttles will land a few more payloads at this time:

- 1. Slusher system consisting of cables, bucket, motorized winch, pylons
- 2. Hauling trucks

#### **Materials Production**

There are many proposals for the extraction of materials from lunar regolith. The regolith is rich with oxygen, silicon, iron, calcium, aluminum, magnesium, titanium and has significant traces of manganese, chromium,

sodium, potassium and phosphorus. Even without complex electrochemical systems for extracting these metals there are resources of great value. Mare regolith is basaltic. It can be dug up, melted in a solar or electrical furnace, and crude castings can be made in molds dug into the ground and finer castings can be made in iron molds. It can also be sintered instead of cast. Sintering means that the material is compacted into molds and heated only enough for the edges of its particles to fuse together. This can make worthy items like bricks, blocks, tiles, slabs and rods without as much energy as full melting and casting requires. Basalt can also be melted and drawn through platinum-rhodium bushings to make fibers.

Iron molds sound like heavy cargos to import to the Moon. Perhaps they could be made on the Moon in large numbers. Magma electrolysis yields ferrosilicon and ceramic as well as oxygen. Ferrosilicon might serve as a low performance rocket fuel after powdering. Ceramic blocks could be cast in molds dug in the ground. It might be possible to perform serial magma electrolysis in which case iron could be derived separately from silicon. This iron could be powdered and fed into 3D printers that use electron beams to fuse metal layer by layer to make all sorts of shapes. If serial magma electrolysis is not possible there is another resource of great value on hand--meteoric iron-nickel fines that are present in regolith all over the Moon at concentrations of a few tenths of a percent by mass. These could be harvested by rovers that have low intensity magnetic separators. The particles are fused with silicates and can be purified by running them through centrifugal grinders followed by another magnetic separation. Dr. William Agosto experimented with regolith and found that he could get a 99% pure iron/nickel feedstock in this way [1]. After sieving and sizing the powder could be placed in 3D printers to make iron molds of various sizes and shapes for casting and sintering basalt.

Basalt could be a very important base material. It is harder than steel and abrasion resistant. It is strong in compression but not so strong in tension and it is rather brittle. Uses for basalt include [2]:

#### Cast basalt

Machine base supports (lathes, milling machines), Furnace lining for resources extraction operations, Large tool beds, Crusher jaws, Pipes and conduits, Conveyor material (pneumatic, hydraulic, sliding), Linings for ball, tube or pug mills, flue ducts, ventilators, cyclers, drains, mixers, tanks, electrolyzers, and mineral dressing equipment, Tiles and bricks, Sidings, Expendable ablative hull material (possibly composited with spun basalt), Track rails, "Railroad" ties, Pylons, Heavy duty containers for "agricultural" use, Radar dish or mirror frames, Thermal rods or heat pipes housings, Supports and backing for solar collectors

#### Sintered basalt

Nozzles, Tubing, Wire-drawing dies, Ball bearings, Wheels, Low torque fasteners, Studs, Furniture and utensils, Low load axles, Scientific equipment, frames and yokes, Light tools, Light duty containers and flasks for laboratory use, Pump housings, Filters/partial plugs

#### Spun basalt (fibers)

Cloth and bedding, Resilient shock absorbing pads, Acoustic insulation, Thermal insulation, Insulator for prevention of cold welding of metals, Filler in sintered "soil" cement, Fine springs, Packing material, Strainers or filters for industrial or agricultural use, Electrical insulation, Ropes for cables (with coatings)

Meteoric iron/nickel fines can be used for more than making molds for casting or sintering basalt. They contain 5 to 10% nickel, 0.2% cobalt and traces of germanium, gallium and platinum group metals (PGMs). Iron, nickel and cobalt can be separated by treating the fines with carbon monoxide gas. High temperature vaporization, ionization and electrostatic separation might also be applied. Nickel and PGMs have catalytic properties. Nickel can make steel harder and stronger without making it more brittle. Cobalt can by used for high speed drill bits and cutting tools. It can also stain glass a deep blue. Germanium and gallium can be used in electronics and photocells.

There are also traces of solar wind implanted volatiles (SWIVs) in regolith. Significant quantities of hydrogen, helium, nitrogen, water, carbon monoxide, carbon dioxide and methane can be obtained by heating regolith up to about 700 C. At higher temperatures sulfur, potassium and sodium will also be liberated. Teleoperated machines that plow through the relatively smooth mare with bucket wheel loaders could roast out these elements in an onboard furnace and store the substances in tanks [3]. The machines would only return to base when their tanks were full and heavy stationary refrigeration equipment could separate the gases and liquids. Hydrogen could be combined with oxygen to make water for life support systems and gardens. Nitrogen would be very important for fertilizer. Carbon could be used to make steel and add CO2 to atmospheres that support plant life.

Steel seems to be an unlikely material on the Moon where only small amounts of carbon exist. In reality, a tiny amount of carbon makes a large quanitity of steel. Mild steel is 0.05% to 0.35% carbon. Alloyed with some nickel very high quality steels can be made. There will be no roaring coke filled blast furnaces or basic oxygen furnaces sending out showers of sparks on the Moon. Steel could be produced by the ancient crucible steel process. Iron powders, rods or plates would be packed with carbon powder and brought up to red heat in a furnace made of basalt or a ceramic made on the Moon such as the spinel rich ceramic produced by magma electrolysis for about a week. The carbon will dissolve into the iron and form steel. The steel and carbon could be magnetically separated and the steel could be homogenized by melting to disperse the carbon evenly throughout the metal. During this melting the steel could be mixed with calcium aluminate flux produced by roasting highland anorthite at 2000 C. to remove impurities.

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Highland regolith contains less iron and magnesium than mare regolith but it is richer in calcium and aluminum. It can make a ceramic that does not melt until 1500 C. unlike basalt that melts at about 1250 C. Roasting highland regolith at up to 2000 C. can drive off silicon dioxide and enrich the calcium and aluminum oxide components to make hydraulic cement. If anorthite is extracted by electrostatic separation and roasted at 2000 C. and hotter calcium aluminate can be obtained [4]. Electrochemical processing of CaAl2O4 can yield aluminum and calcium metals. Calcium is an excellent electrical conductor.

We can see that additional payloads to the Moon should include but not be limited to:

- 1. Solar or electrical furnaces for melting and pouring basalt
- 2. Small digging tool attachments for making crude sand molds in the ground
- 3. Some iron starter molds for basalt
- 4. Platinum-rhodium bushings and whatnot for basalt fiber drawing
- 5. Heaters to sinter basalt packed into iron molds, packing tool for robots
- 6. Heaters, perhaps induction heaters, to melt steel
- 7. Magma electrolysis cells
- 8. Metal powdering equipment (centrifugal electric arc perhaps)
- 9. Rovers with low intensity magnetic separators for havesting meteoric iron fines
- 10. Centrifugal grinders
- 11. 3D printers that can make heavy iron molds
- 12. Carbon monoxide processing equipment
- 13. Rovers for harvesting solar wind implanted volatiles
- 14. Cryonic refrigeration equipment
- 15. Electrostatic separation devices
- 16. Furnaces for roasting anorthite at 2000 C. +
- 17. Electrochemical equipment for aluminum and calcium extraction

With this equipment it should be possible to produce iron molds for basalt and furnaces with basalt, anorthite or spinel rich ceramic linings for steel. Nickel, cobalt, small amounts of germanium, gallium and PGMs, hydrogen, helium, nitrogen, carbon, sulfur, iron, aluminum and calcium also become available. Two more metals can also be had --magnesium and titanium. Ferrosilicon from magma electrolysis can be mixed with magnesium oxide obtained by roasting mare regolith at 1500 C.+. The mixture can be heated to 1200 C. under vacuum conditions and magnesium metal will boil out and can be condensed. Titanium can be obtained by mining in ilmenite rich mare regolith. The ilmenite can be concentrated with electrostatic separators. A fluidized bed can be made of welded steel plates and pipes and possibly some basalt parts in which the ilmenite is treated with hydrogen gas at 1100 C. Water and fused particles of titanium dioxide and iron will form. The water will be electrolyzed to recover hydrogen and gain oxygen. The TiO2 and iron particles must be separated possibly by treatment with CO gas to form iron carbonyls. The titanium dioxide could then be electrolyzed in FFC cells with inconsumable electrodes to obtain sponge titanium metal. This would be melted in a high temperature furnace at over 1800 C. or powdered.

#### This would call for payloads of:

- 1. Rolling mill for making steel plates and welders to produce fluidized bed
- 2. Centrifugal casting machine to make basalt pipes
- 3. Extruder to make metal pipes
- 4. Accessory devices for making magnesium and titanium extraction devices
- 5. FFC cells with calcium chloride electrolyte

#### Manufacturing

The best of terrestrial conventional manufacturing techniques will be applied on the Moon even in the age of 3D printing. Casting is important. There could be times when casting is faster and cheaper than 3D printing; however, casting will require a pressurized foundry so that liquid metals don't evaporate into the vacuum. Small parts made of aluminum and magnesium could be cast in plaster molds inside the foundry. Plaster, calcium sulfate, would be obtained by leaching anorthite with sulfuric acid. While steel and iron might be cast outside in the vacuum without to much loss of metal by evaporation, wetted sand molds will be required to cast these metals and that necessitates a pressurized foundry to recover water vapor from the sand molds that steams off into the air.

Molten metals will emit lots of heat and a powerful cooling system will be required in the foundry in addition to concrete floors and barriers that can stand up to spilled liquid metal. Fortunately, the need to cast anything really huge does not exist. Large metal things like plates and I-beams can all be made outside with rolling mills and extruders. Lunar workers could teleoperate robots that load billets of metals into machines that extrude beams for vehicle frames and weld them up outside with arc welders. Much can be made with flat and curved metal plates produced by feeding ingots of metal into rolling mills. Those plates can be square or workers can laser cut them into various shapes including disks. Beams of various dimensions, rods, bars, rails, pipes, and metal fibers also by extrusion can be produced.

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This is the "Lego set" lunar makers have to work with. Rods can make axles. Beams can make frames. Pipes or tubes can make frames. Flat plates can make buckets and ore bins. Disks can be used for wheels and maybe presses can even stamp out wheels. Rails by extrusion are rails. It shouldn't be to hard to make ore cars, rails and buckets and cables for slushers with rolling mills, extruders, presses and a small foundry with machine shop along with 3D printers. A big engine lathe instead of a giant press could spin metal domes from circular metal plates, disks, outside. Beams and rods can make power cable towers and supports for reflector systems. If one is imaginative enough, it might be possible to extrude basalt. Take a billet of basalt, get it red hot and soft, and squeeze out beams for making things like towers and supports. Drill holes in the beams with lasers and bolt them together with steel bolts and one can come up with all sorts of structures. Solar furnaces will require lots of frame members to support reflectors and crucibles. Trough reflectors can be made by rolling and dishes can be made by spinning. This work can all be done outside with machines mounted on solid basalt pads with parasols to shield everything from the blistering hot lunar Sun.

Forging metals will also be important when this can make parts faster and in larger quantity than 3D printing. Drop forges would have to be very tall and have massive weights in low lunar gravity. Compressed oxygen could drive forging hammers to. All sorts of parts can be made from hot metal blanks. All varieties of steel dies might be made by 3D printing; however, printed parts are sometimes more porous and weaker than cast parts. Casting steel dies in the lunar foundry might be called for. Forgings will be in demand. A jet liner contains thousands of forged parts. Rockets, ground vehicles, robots, rovers, refrigeration devices, machine tools and many other things will contain forged parts.

It is true that 3D printing can make some large parts like an airplane wing, but it is slow. It wouldn't make sense to print an I-beam, which would probably be the biggest single part made of metal on the Moon. There might not be any demand for large I-beams until lava tubes are sealed and pressurized and buildings are constructed within using conventional techniques. Curved plates and domes for "sausage" shaped habitat modules can be cranked out by rolling and spinning. An airlock hatch seems like something that would be cast. It could be possible to stamp or forge hatches outside if there is a big enough press and some disk shaped billets.

Fasteners will be necessary. Bolts and screws are made in a bolt rolling machine that rolls rods (made by extrusion) between two dies. Nuts and rivets are also going to be required.

To continue with the payload list for setting up a bootstrapping lunar industrial base:

- 1. Inflatable module for foundry with powerful cooling system.
- 2. Cement mixer to make concrete for foundry floor and barriers
- 3. 3D printers as needed
- 4. More solar panels and associated hardware, wiring, etc. to power machines
- 5. Rolling mills, flat plate and curved plate
- 6. Very large engine lathe
- 7. Cutting lasers, perhaps a cutting table
- 8. Extruders
- 9. Forging hammers
- 10. Sulfuric acid leaching systems (these might be made of acid resistant basalt on the Moon)
- 11. Machine tools (drill presses, lathes, grinders, boring and milling machines, etc.)
- 12. Bolt rolling machines
- 13. Spare parts for machines--could be printed up on the Moon as needed

#### **Solar Panels**

Lunar industry will have a voracious apetite for electrical energy. It would seem reasonable then that solar panels and related gear should be made on the Moon. Dr. Peter Schubert has designed a device that works in a manner similar to a mass spectrometer. The device can produce oxygen, silicon, silicon doped with phosphorus, aluminum and iron; possibly other elements to [5]. This device does not require imported chemical reagents like chlorine and fluorine. It consists of some exotic materials that would have to be imported like thorium oxide and platinum-rhodium. Much of the machine could be made on the Moon from steel and ceramic materials. Boron for p-type silicon is rare on the Moon. Aluminum could be used instead. Phosphorus for n-type material is available. Aluminum could also be used for backing and wiring. Glass could be produced for anti-reflection coatings.

#### **Hypothetical Materials**

Basalt fibers bound with polymer resins are now being used to reinforce concrete. Resins will not be plentiful on the Moon. There will be some carbon for steel and some for agriculture and some for organic chemicals, but those organics will be pricy. Glass fiber reinforced glass matrix composites have been suggested. Unfortunately very little work has been done with this material. The pure silica fibers would add tensile strength and fracture resistance to a matrix of glass that has been doped with sodium and calcium to lower its melting point.

Why not a basalt fiber reinforced basalt matrix composite? The matrix could have its melting point reduced so as not to melt the fibers by doping with sodium, potassium, calcium and/or magnesium. It seems that this material would be "easier" to produce than glass fiber reinforced glass composites. Basalt is readily mined and melted.

Glass, or silicon dioxide, requires roasting regolith at 1500 C.+ and condensing the SiO2 vapors or sulfuric acid leaching of regolith with all its caveats. Moon miners have to look at lunar basalt compositions to. Lunar basalt has more iron in it than terrestrial basalt. It might be desirable to alter iron contents with magnetic separations. Casting basalt and fiber drawing in the vacuum and low gravity must be studied. On Earth, makers of basalt products cool the fibers with a water spray. In space, a sealed chamber and a spray of recycled cooled helium gas might be called for to cool the fibers.

If basalt fiber reinforced basalt matrix composites are feasible and cheap, then this could be a material for space frames for power satellites, space stations, space shipyards and large telecommunications platforms and space telescopes to. No imported reagents would be needed. Manufacturing this stuff, which would have a density of about 2.95 vs 2.7 for aluminum, in quantities of 2,000,000 tons a year, enough to make 20 powersats at 100,000 tons each, should be far cheaper than producing millions of tons of aluminum. That would require the costly importation of halogens to make electrolyte using various proposed methods for electrowinning aluminum from lunar regolith. If basalt fiber reinforced basalt composites are possible and cheap, this would drastically increase the value of lunar basalt and make the case for a mare/highland coast installation much stronger.

If 20 powersats a year are built and each is rated at 20 GWe then in 50 years there would be 1000 of them and 20 TW of power---enough for the whole world by mid- century. It is predicted that civilization will demand about 60 TW by 2050 A.D., but two-thirds of this is waste heat, thus 20 TW of electrical power could energize the world if everyone switches to electric heat and electric cars. Large trucks, railroad trains, ships and airplanes would probably still use energy dense hydrocarbon fuels. If coal and oil ever disappear then biological sources of diesel fuel and jet fuel could be used.

#### The Dead End

The lunar poles are a dead end. While a polar base might make a nice scientific research outpost, it is not a great place for a bootstrapping industrial settlement. To reap the ice in permanently shadowed craters robots must descend into craters colder than Pluto. There is sunshine 70 to 80% of the time, but 20 to 30% of the time it is un-available and power storage for nightspan--batteries or flywheels or fuel cells, are needed. With merely twice as many power storage devices there can be enough for 40 to 60% of the time so clearly it is possible to overnight anywhere on the Moon especially if small nuclear generators are allowed. Aluminum is usually thought of as the primary construction material on the Moon. It has even been suggested for rocket fuel.

There is plenty of anorthite, CaAl2Si2O8, in highland regolith like that in the polar regions, but a coastal (mare-highlands) base has just as much access to this stuff. Most aluminum production processes rely on imported reagents like lithium fluoride or exotic materials for equipment. Magnesium is actually lighter (spG 1.8 vs 2.7) and is a slightly better reflector than aluminum. Magnesium can be extracted with lunar reagents alone. It might be the choice material for reflectors that concentrate solar energy on to solar panels on the Moon and in outer space. Magnesium can be rolled into sheets for reflectors. It is rather soft and easy to cut. Mare regolith is richer in magnesium than highland regolith.

It could be true that history is governed by economic factors. If so, then lunar development will be governed by costs, especially if the Moon is developed by private entrepreneurs who have to keep an eye on the bottom line instead of governments that seem to have a blank check. It seems logical that products that can be produced on the Moon with lunar available resources alone will be cheaper than products that rely on imports, but reality and the marketplace can defy common sense. Presently, there is no way to predict any of the costs of doing business in outer space. Rocket launches cost tens of millions of dollars just to reach low Earth orbit. Prices for rocket launches will probably come down in the future. That seems to be the trend for so many products be they aluminum, computers or automobiles and microwave ovens. Even if the price for a rocket launch comes down by a factor of ten to one hundred, it will still be expensive to travel in space and the use of on site materials and energy will still be preferred.

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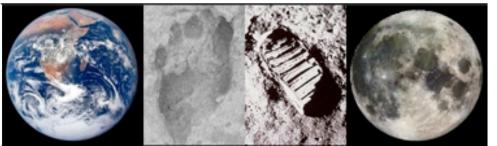
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Dave Dietzler lives in St. Louis, MO and has been a frequent contributor to MMM over the past decade.

Check out Dave's new website: http://mooniner.info/ Note: no "www"

#### THE MOON SOCIETY - LUNAR FRONTIER SETTLEMENT - WWW.MOONSOCIETY.ORG

From Africa to the Moon, the Human Epic, told in footprints, Continues to the Stars!



Our Goal is Communities on the Moon involving large scale industrialization and private enterprise.

### The Moon Society Journal Section (pages 9–12) About the Moon Society Objectives of the Moon Society include, but are not limited to:

- Creation of a spacefaring civilization, which will establish communities on the Moon involving large-scale industrialization and private enterprise.
- **Promotion** of interest in the **exploration**, **research**, **development**, **and habitation of the Moon**, through the media of conferences, the press, library and museum exhibits, and other literary and educational means
- **Support** by funding or otherwise, of scholarships, libraries, museums and other means of encouraging the study of the Moon and related technologies
- Stimulation of the advancement and development of applications of space and related technologies and encouragement their entrepreneurial development
- Bringing together persons from government, industry, educational institutions, the press, and other walks of life for the exchange of information about the Moon
- **Promoting** collaboration between various societies and groups interested in developing and utilizing the Moon.
- Informing the public on matters related to the Moon
- **Provision** of suitable recognition and honor to individuals and organizations that have contributed to the advancement of the exploration, research, development, and habitation of the Moon, as well as scientific and technological developments related thereto.

**Our Vision says it all** – **"Who We Are and What We Do"** – <u>www.moonsociety.org/spreadtheword/whowhat.html</u> We envision a future in which the free enterprise human economy has expanded to include settlements on the Moon and elsewhere, contributing products and services that will foster a better life for all humanity on Earth and beyond, inspiring our youth, and fostering hope in an open-ended positive future for humankind.

Moon Society Mission: to inspire and involve people everywhere, from all walks of life, to create an expanded Earth-Moon economy that contributes solutions to the major problems that challenge our home world.

## From Moon Society President 🐜 Ken Murphy

#### Welcome to 2015, and welcome to all of our new members! The Moon Society is looking forward to a terrific year.

To get things started, we have an exclusive treat for members – we will be reprinting a Moon story that hasn't been seen in some 30 years. "Simon Sidekick" by noted sci-fi author John E. Stith first appeared in issue number 87 of Dragon Magazine in July 1984. We will be serializing the story over the next few months, with the final excerpt in the July issue, concluding 31 years after it was first published. This exciting young adult story tells of Carl, a teen on the Moon who must soon face a rite of passage, and learns a valuable lesson in the process.

After our management pow-wow early in January, we're going to be building out some collaborative workspaces on our new website to tackle a few projects. One example is our power-beaming demo. The Moon Society has a wireless power transmitter unit that we show at conferences and events like Moon Day, although it is showing some wear and tear. We're going to re-visit the design and create a STEM project for schools and others to build their own examples. Our technically minded members should keep an eye out for that one. Another is Aqua Luna, wherein students will break down water into oxygen and hydrogen, and then recombine them in a home-built fuel cell. The point is to create engaging projects that highlight the kinds of technologies we will need on the Moon. We encourage our members to submit their own ideas for projects!

We're also continuing the buildout of our website. We're trying to find the right collaborative tools to update/supersede our MOO, which has a rather Zork-like quality to it. This will allow teams to collaborate better on projects, and allow a better interface between the membership and your leadership.

Our most immediate need this year is to form an editorial team for Moon Miners' Manifesto. This is a great opportunity to help grow the legacy of The Moon Society. With over two decades of publication, it is a thorough chronicle of all aspects of future Lunar life. Still, we keep learning new things, and new generations continue to want to know more about the Moon. To join the team, send me an e-mail at president@moonsociety.org.

#### The Moon Society – Lunar Frontier Settlement – <u>www.moonsociety.org</u> p.2 Looking forward into 2015:

**Feb** – Space Exploration Alliance Blitz, February 22–24th. The Moon Society does not generally involve itself in political matters. However, we do not discourage our members from undertaking the sisyphean task of trying to educate congressional staffers on the importance of space development. The SEA Blitz details can be found at: http://www.spaceexplorationalliance.org/blitz/

**Mar** – March Storm, March 15–19th. Also for the politically minded, March Storm is more focused on space development than the Blitz. Details at: <u>http://joshuajenkins.wix.com/marchstorm2015</u>

**Apr** – Yuri's Night, April 12th. Members are encouraged to team up with our space advocates in your community and join the world space celebration of humanity's first step into space in 1961 (and the first Shuttle launch in 1981). The only space party to be celebrated on all seven continents and in space, it goes on for a full 24 hours. You can find local events or create your own at: <u>https://yurisnight.net/</u>

**May** – International Space Development Conference, May 20–24th. We're still working to determine if there will be a Moon-specific track for this year's conference, which is focused on Breakthrough Technologies. Members interested in attending are urged to make sure to have their passports in order, as a driver's license doesn't cut it anymore. Details at: <a href="http://isdc2015.nss.org/wordpress/">http://isdc2015.nss.org/wordpress/</a>

**Jun** – Asteroid Day, June 30th. A new event for this year, Asteroid Day is a global movement to protect Earth from asteroids, starting with awareness building and education. Details at: <a href="http://www.asteroidday.org/">http://www.asteroidday.org/</a>

Jul – Moon Day, July 20th. The anniversary of the first Moon landing is becoming an annual celebration of space and STEM as more and more institutions put together Moon Day events, like at the National Air & Space Museum last year (<u>http://airandspace.si.edu/events/moonday/</u>).; Your Moon Society president is once again organizing the event in the D/FW metroplex, and has a few surprises up his sleeve for this year's event. Details at: <u>http://www.flightmuseum.com/event/moon-day-2015/</u>

**Sep** – International Observe the Moon Night, September 19th. A global celebration for people to stop and take the time to look at the Moon up close. Sidewalk observing is strongly encouraged. A great way to introduce the Moon to your community. Details at: <u>http://observethemoonnight.org/</u>

**Oct** – World Space Week, October 4–10th. Another global celebration, this one tied to the launch of Sputnik in 1957 and affiliated with the UN. This year's theme is Discovery! Find out more at: http://www.worldspaceweek.org/

So all members are encouraged to get active in promoting our Moon and humans living and working thereon! ##

## A Proposed Junior High/Middle School Design Contest: Moon/Mars Outpost/Settlement Exhibits made from Recyclable Items

By Peter Kokh, Milwaukee Lunar Reclamation Society Chapter - NSS/TMS

#### Why Junior High/Middle Schools?

It is much easier to get the attention & spark deep interest in anything with youth not yet dominated by adolescent urges. Through the years, we have judged a number of High School Science Fairs. 70–90% of the entries were from the Junior High School division. The rest from the Senior Division. Not only were there more entries from the younger students, many of these entries showed deeper interest in their chosen topic, and more ingenuity in the way they approached it.

That's a powerful lesson. Times have not changed. If we don't get the interest of the younger students at this stage of their lives, we are most unlikely to get their attention, and time and energy, later on.

The idea is to have students use their own ingenuity – along with some helpful guidelines – to "imagineer" a starter "settlement" on the Moon or Mars, made from recyclable components: e.g.plastic and/ or cardobard jars and bottles, various plastic bottle caps, tubes (toilet paper and paper towel cores) and various other "reusable" commercial waste products to make an outpost display that shows that on worlds where there is no breathable atmosphere (the Moon, Mars, yes even Earth's sea bottoms) it makes sense to have as much of the outpost as possible interconnected by pressurized passageways. It is also important to provide several meters of shielding against radiation and temperature extremes. This shielding can be placed directly on top of the growing modular complex, of over large hangar type structures, the advantage of the later being that rearranging modules or repairing them, would be much easier.

The contest could have divisions by size: smaller sizes can use cork boards or white boards, or even trifold foam display boards (the back serving as the bottom, the sides as upper and lower information panels.) Larger sizes could take up whole display tables: e.g.  $2.5 \times 6-8$  ft.

Judging could be on both ingenuity, and quality. There is so much horrific artwork out there showing outposts that are not properly shielded, and seldom showing actual settlements. An annual competion of this sort would get younger people's interest, and encourage them to get involved in space-related careers. PK

#### The Moon Society – Lunar Frontier Settlement – <u>www.moonsociety.org</u> p. 3

## A Portable Analog Moon Base Design for Middle/High School Gyms

By Peter Kokh, Milwaukee Lunar Reclamation Society

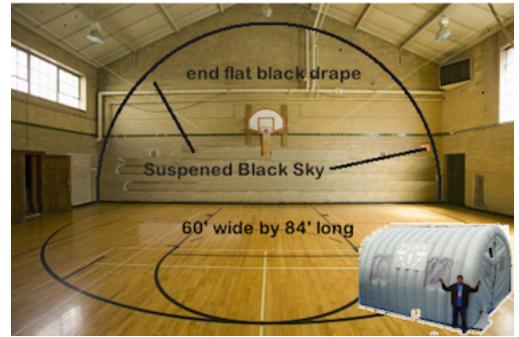


ILLUSTRATION of Quonset Shaped Hung Ceiling (Black Lunar Sky) with possible "stars" & "Earth" overhead

- School Gyms / Basketball Courts provide a standard size 60'x84'
- A a suspended curved flat black canvas inside a high school gym to create the black sky and cut off views of terrestrial horizons, with black end caps it could be attached to a topside colapsable pipe framework.
- With a smaller inflatable quonset or tent for the hab on the "surface"
- Earth and stars moving across the "sky' projected by device in {a) "hill(s)" on the "surface" floor
- Since high school gyms are pretty much the same basketball court size, such a setup could be put up almost anywhere and move around from school to school, district to district.
- We'd need corporate money, but that might be doable, as could be a Kickstarter fundraising effort.
- A movable "lunar surface" (rocks, small hills, etc.) for gym floors and this itself could be the object of a student design contest as could be the interior outfitting of the "hab" and surface vehicles
- With windows blocked, It would be easy to simulate the two week long dayspans and nightspans
- Outfitting the "hab" with inexpensive, movable fixtures should be easy too.
- A google image search for inflatable hangars, inflatable quonsets, etc. <u>http://forum.monolithic.org/viewtopic.php?f=4&t=350&start=45</u> <u>http://www.ffti.com.au/wp-content/gallery/3-1-6-acd-air-shelter/acd-air-shelter-inflatable-hangar.jpg</u>
- This setup could be copied by others.
- This is a crude design, and we'd need help designing a real one that could work in many standard gyms
- Junior High Schools and Middle Schools would be best (most receptive students ready to be enthused, and not yet distracted as they will be in their senior high school years)
- A Mars version with a salmon colored "sky" and ochre surface could be an easy spinoff.
- An electric vehicle that took student astronauts from the "entrance" to the hab and to other "surface" points.
- This would be a summer school thing, so as not to interfere with scheduled gym use.
- Two schools each summer, perhaps one urban, one suburban or rural
- Afrer a few years, start the cycle tour over, from school to school
- Could this work in your city?
- Your input and ideas for improving this concept are most welcome Kokhmmm@aol.com

The Moon Society – Lunar Frontier Settlement – <u>www.moonsociety.org</u> p. 4



### **ORGANIZING "OUTPOSTS"**

Bay Area Moon Society, CA Outpost - South San Francisco Bay <u>- http://www.moonsociety.org/chapters/bams/</u> Contact: Henry Cates <u>hcate2@pacbell.net</u> Meeting the 1<sup>st</sup> Tuesday of the Month at Henry's home Moon Society Nashville Outpost - Contact: Chuck Schlemm - <u>cschlemm@comcast.net</u>

#### **ORGANIZED CHAPTERS**

Milwaukee Lunar Reclamation Society - http://www.moonsociety.org/chapters/milwaukee/ http://www.meetup.com/Milwaukee-Space-Exploration-Meetup/ - http://www.space-Mlwaukee.com Contact: Peter Kokh - kokhmmm@aol.com - MEETINGs, 2nd Saturday 1-4 pm monthly except July, August, At Mayfair Mall lower level Community room G150 for all meetings except December, in G110:

FEB 14, MAR 14, APR 11, MAY 9, JUN 29, (JUL AUG)) SEP 12, OCT 10, NOV 14, DEC 12 We are exploring ways to reach Junior/Middle High School Students before adolescence absorbs all their attention

Moon Society St./NSS Louis Chapter - http://www.moonsociety.org/chapters/stlouis/

http://www.meetup.com/Saint-Louis-Space-Frontier-Meetup/

Contact: Robert Perry <u>surfer\_bob@charter.net</u> – Meetings 2nd Wed monthly at Buder Branch Library, 4401 S. Hampton, in the basement conference room. We've been relaxing after a busy productive **Gateway to Space conf**erence Nov. 6-10 – Next meetings **FEB 11 – MAR 11 – MAY 8 – JUN 13 – JUL 8 – AUG 12** 

NSS/Moon Society Phoenix Chapter - <u>http://nssphoenix.wordpress.com</u>/ - c/o Mike Mackowski. http://www.meetup.com/NSSPhoenix/events/161939572/

Meeting 3rd Saturdays monthly at Humanist Community Center, Mesa, 627 W. Rio Salado Parkway.

**On December 17**, the joint NSS-Moon Society chapter in Phoenix held a winter holiday party at the home of chapter president Mike Mackowski and his wife, Maura. We had nine folks show up and plenty of food and merriment was had by all. We also discussed plans for 2015, including officer candidates for our upcoming election.

The January 17 meeting of the Phoenix Chapters of the National Space Society and the Moon Society featured Dr. Sian Proctor, a geology professor at South Mountain Community College. She spent over three months in a simulated Mars habitat in Hawaii (the Hawaii Space Exploration Analog and Simulation (HI–SEAS)) in 2013. Her very excellent presentation was titled "Meals for Mars" as the focus of the sim was food. She spoke about her experience in this four-month experiment and how her team learned to live and cook like future Mars astronauts.

There were fifteen attendees (one new person) and we wrapped up voting for chapter officers for the next two years. It was a fun meeting with a lively exchange.. – Submitted by Mike Mackowski

#### The chapter election results are:

President:	Mike Mackowski (incumbent)	Vice President:	Athena Roberts
Secretary:	Chuck Lesher	Treasurer:	Pat Lonchar (incumbent)

#### Tucson L5 Space Society - http://www.tucsonspacesociety.org/

http://www.meetup.com/NSSPhoenix/events/161939572/ Now serving Moon Society Members Contact: Al Anzaldua – Meets monthly, every 2nd Saturday, 6:30 PM

Clear Lake NSS/Moon Society Chapter (Houston) -http://www.moonsociety.org/chapters/houston/ Contact: Eric Bowen eric@streamlinerschedules.com - Meeting 7 pm 3<sup>rd</sup> Mondays of even # months in the conference room of the Bay Area Community Center at Clear Lake Park: FEB 16 - APR 20 - JUN 15 - AUG 17

#### Greater Fort Worth Space Chapter c/o Patricia Ferguson tricia3718@gmail.com

## DEC 2014 + JAN 2015 SPACE NEWS BROWSING LINKS

#### SPACE STATIONS + ROCKETS + COMMERCIAL SPACE

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#### moon

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# Moonscapes And Fiction

## Simon Sidekick (Installment #1)

By John E. Stith

Carl tumbled as he fell. Embarrassment supplanted his initial surprise and panic.

His arms flailed in a useless effort to stop the tumbling. As though Carl's mind had decided that his coordination skills were inadequate to keep him from landing awkwardly, it started rattling off useless bits of information. He would be traveling at almost fifteen meters per second by the time of impact with the water almost sixty meters below.

The domed ceiling spun by his view again, followed by the blue circle of the pool far below. There was no hope of controlling the fall, but maybe he could at least avoid a bellyflop.

The simple jump from the high board had been going smoothly until the pellet hit his neck. The sting startled him enough that he whipped his hands to the back of his head. That started the tumbling. Since then, his efforts to stop the rotation had made it worse.

Carl felt foolish mainly because of the time it took to reach the water: over eight long seconds. On Earth, at six times normal lunar gravity, the trip would have taken less than four seconds. But then he'd have hit the water well over twice as fast.

Carl hated recess.

During one of the toomany instants on the way down, he recalled seeing Peter Tahale's black hair and white trunks shortly before he jumped. Was this another of his little jokes?

Carl still hadn't gained control of the fall, so he did the next best thing: he tucked into a cannon ball.

Predictably, his rotation rate increased. The scenery whipped by in front of his eyes. Water followed light, water, light. And then came the pain.

The impact stung his back from the base all the way up to his neck. Carl hit with almost enough force to knock his breath away, but he knew right then that he was OK. The water quickly buoyed him back to the surface. His form had kept him from going very deep. The spray was still falling when he surfaced and shook the water out of his eyes and hair.

As he swam toward the ladder, he heard at least one giggle, but apparently most of the other kids weren't paying attention. Carl still had halfway to go when a splash sounded behind him. Shortly, a familiar face surfaced directly in his path.

"Real good, Carl," said Peter "Alligator" Tahale. He ran one hand through his skyblack hair, squeezing out the water.

Carl ignored him and tried to swim around him.

"You should be more careful. How are you going to handle the search when you can't even jump off the high board?" Peter continued. Alligator was Carl's name for him all mouth and no ears.

What makes you think I even care, Carl almost asked. Peter had gone on the search almost a year early. Since then he had been even more overbearing. Why couldn't he just let Carl alone? And, why should he be concerned about Carl's future? Peter's usual idea of planning ahead seemed to be making sure he didn't walk into anyone.

Carl kept going. His back still smarted and it had to be Peter's fault.

Peter called after him. "What I'm trying to show you is that you can't do the search alone. I can help you if you let me."

Carl shut out the words. The advice didn't interest him, and he didn't want to be reminded of the search. Peter could find someone else to make dependent on him. He reached the side of the pool and climbed the ladder. There was no more sound from Peter. He brushed past a bunch of kids who were between him and the locker room. There was chubby Alice Kogomo. Carl was now sure he knew the derivation of the word "pigtail".

Recess was supposed to last another hour, but Carl couldn't take any more. He needed to get back to the privacy of his room. He'd had more than enough of people for one day.

His clothes were in the locker. He unwadded jeans and a Tshirt, and put them on. They covered up most of his freckles. It was bad enough at recess, playing games that depended on reaction times rather than intelligence. It was even worse to have to be half naked.

Carl started down Row A, a plain, threemeterwide steel tunnel. It was typical for Jane Doe Station, the largest moon colony. He passed the park, leaving the recreational section behind. Column G, where his mother worked in life-support, was on the way, but he didn't stop. A right turn on Column H led toward home, a twobedroom compartment on Row D. Below the "Column H" sign was stuck one of the kids' labels, saying "Easy Street". Nearby were "Memory Lane" and "Kangaroo Court".

Carl's wristcomp said it was only 1400. Fortunately, his mother would still be at work. There would be trouble if she found out he had skipped most of recess. It provided almost all of the social conditioning time that school required.

The metal corridors were smaller as he neared home. Row D was only wide enough for three people to walk sidebyside. Compartment doors lined the hall. He reached the door and tapped in his ID.

"Carl? You're early. I thought recess didn't get out until 1500." Oh no. May, his mother, was home early.

"I'm fine. I just--" It was then that he saw Uncle Pel sitting in the good chair. Pel's broad grin creased an ample number of laugh lines.

"When did <u>you</u> get here?" Carl hurried in to greet him, surprised and happy to see him, and hoping that May would forget her question. Pel got off Earth only every few months. He came to Jane Doe Station even less often.

"Just an hour ago. We wanted to surprise you." Pel stood and picked him up, proceeding to touch his head to the ceiling. It wasn't difficult since, in the moon's gravity, Carl weighed only onesixth of what he would on Earth. Pel was one of the few adults he felt comfortable with, so he let him have his fun.

Carl could see that his black hair and bushy eyebrows had a few gray lines. Mom had the same black hair but hers was still all dark. Pel was Mom's brother but he reminded Carl of his father. It had been almost eight years ago, but the images still wouldn't fade away.

"What?" Carl realized that someone had been talking to him.

"I asked, are you learning a lot in school?" Pel repeated. "How's your interest in math? May tells me you're making excellent progress."

"Oh, sure. School's great--except recess."

Carl saw the look Pel gave May. It didn't last long but it was there. The boy didn't add anything but they both hesitated.

May fidgeted with her slender fingers her "frank discussion" fidget. "Carl, I've been talking with Pel about you and--well, I'm concerned that you're not making a lot of friends."

"It's not my fault that none of the kids are friendly."

"I've got something you might be interested in." Pel broke in suddenly, looking embarrassed.

Carl forgot about school. Pel was better than a magician, always trying out some new prototype or gadget. He was a computer engineer and was lucky enough, or good enough, to almost consistently work on exciting projects.

"I've got a new wristcomp for you, if you want it," he said.

Carl still had the one Pel had given him. It worked fine, but the new one had to be even more powerful.

"Try to stop me." He started removing the strap on his wrist.

"Wait a minute. It's not quite that easy." Pel grabbed a travel bag and pulled out a gray box. "If you want this, it's not just a matter of trading them. It's more complicated than that."

Carl kept waiting for him to open the box.

"This model does a lot more than your last one. It receives sensory input. It also has so many new functions that I'm not going to tell you all of them right now. And you'll need a checkup before you start wearing it--to get it calibrated."

Carl saw that glance again, but he still didn't know what it meant.

There wasn't anything Pel could have said to make him want to keep his old wristcomp. The new one was beautiful. The brushed surface looked like a diamond could scrape against it without harming it. And it didn't even have a model designation.

The next morning they went up to Row B to see Dr. Frankle. The doctor was a short, tolerant man, a little older than May and Pel. He always seemed to Carl to be as careful as his father had been. Mom and Pel talked to him for almost twenty minutes before Carl was finally admitted.

Dr. Frankle had Carl lie down on a table while he watched a display on his screen. After the doctor manipulated controls and read instruments for what seemed like a halfhour, he said, "All right, Carl. You're going to sleep for a few minutes, but you'll be fine." That's all he remembered. (Continued next issue)

NSS Chapters that share Moon Miners' Manifesto



Space Chapter HUB Webiste: <u>http://nsschapters.org/hub/</u> Feature Page: Project Menus Unlimited <u>http://nsschapters.org/hub/projects.htm</u>

WISCONSIN



MLRS - Milwaukee Lunar Reclamation Society

PO Box 2101, Milwaukee, WI 53201 - <u>www.moonsociety.org/chapters/milwaukee/</u> <u>www.Space-Milwaukee.com</u> - <u>http://www.meetup.com/Milwaukee-Space-Exploration-Meetup/</u>

Ad Astra per Ardua Nostra = To the Stars through our own hard work!

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 372-9613 – bobriverwest@yahoo.com (• Current Members of the MLRS Board of Directors)

Our 2015 Meeting Schedule: We switch to room G150 for all meetings except December, in G110:

**Feb 14, MAR 14, APR 11, MAY 9, JUN 29, (SUMMER BREAK) SEP 12, OCT 10, NOV 14, DEC 12 Our December 6<sup>th</sup> 28<sup>th</sup> Anniversary Celebration** was memorable; Three people from the Twin Cities who had been responsible for helping Milwaukee's put together their chapter in the fall of 1986 – ye, 28 years ago!) were present: Ben and Becky Huset and Scott Sjhefte, as well as visitors from the Sheboygan chapter and former Madison chapter. We showed the very very different hybrid Western–Science Fiction film "Cowboys and Aliens" with great pot–luck food.

**Our January 10<sup>th</sup> meeting:** Three new members joined the regulars for a lively conversation about future projects and event opportunities (Rockets for Schools in Sheboygan (2<sup>nd</sup> Sat May) and rocket launching (July\_

SSS – Sheboygan Space Society 728 Center St. Kiel, WI 54042-1034

www.sheboyganspacesociety.org c/o Will Foerster 920-894-1344 (h) astrowill@frontier.com SSS Sec./Tres. c/o B.Pat Knier <u>dcnpatknier@gmail.org</u> DUES: "SSS" c/o B. P. Knier, 22608 County Line Rd, Elkhart Lake WI 53020

Meetings are at The Stoelting House, 309 Indian Hill, Kiel WI 53042 – **3rd Thurs even # months** 2015 MEETINGS: APR 16 – JUN 18 – AUG 20 – OCT 15 – DEC 12 (2<sup>nd</sup> SAT in Milwaukee)

CALIFORNIA



OASIS: Organization for the Advancement of Space Industrialization & Settlement Greater Los Angeles Chapter of the National Space Society PO Box 1231, Redondo Beach, CA 90278

Events Hotline/Answering Machine: 310-364-2290 - Odyssey Ed: Kat Tanaka <u>odyssey\_editor@yahoo.com</u> <u>oasis@oasis-nss.org</u> - Odyssey Newsletter <u>www.oasis-nss.org/articles.html</u>

**Regular Meeting 3 pm 3<sup>rd</sup> SAT monthly – 2015 SCHEDULE; FEB 21, MAR 21, APR 19, MAY 16, JUN 20** Fri, Feb 6, 7:30 to 9:30 pm. "**All Space Considered**" Griffith Observatory holds this FREE public program 1st Fri monthly, Leonard Nimoy Event Horizon theater. Griffith Observatory, 2800 East Observatory Rd. www.griffithobs.org/asc/all\_space.html

Thurs & Fri Feb 12 and 13, 7:00 pm. **No Way Back**: Charting Irreversible Climate Change with Jason-3. Speaker: Dr. Joshua Willis – Jason 3 Project Scientist.

Thurs Feb 12: The von K.rm.n Auditorium at JPL. 4800 Oak Grove Drive, Pasadena, CA Fri Feb 13: The Vosloh Forum at Pasadena City College. 1570 East Colorado Blvd. Pasadena, CA

(Lecture webcast — http://www.jpl.nasa.gov/events/lectures\_archive.php?year=2015&month=2) Info (818) 354-0112 or www.jpl.nasa.gov/events/lectures\_archive.php?year=2015&month=2

Sat, Feb 21, 3:00 pm. OASIS Board Meeting @Craig & Karin Ward. 1914 Condon Ave. Redondo Beach



DSS: Denver Space Society fka Front Range L5 1 Cherry Hills Farm Drive, Englewood, CO 80133

Eric Boethin 303-781-0800 <u>eric@boethin.com</u> – Monthly Meetings 6:00 PM on 3rd Thursdays, 7 pm Englewood Public Library, Englewood, CO 80110 – 1000 Englewood Parkway, First Floor Civic Center 2015 MEETINGS: FEB 19, MAR 19, APR 16. MAY 21, JUN 18

ILLINOIS



LDAhean@aol.com

CSFL5: Chicago Space Frontier L5 - 610 West 47th Place, Chicago, IL 60609



MSFS: Minnesota Space Frontier Society – <u>http://www.mnsfs.org</u> c/o Dave Buth, 433 South 7th St. #1808, Minneapolis, MN 55415

**MNSFS Holiday Party and Movie Tech Night** – On **Saturday, Januarly 24**<sup>th</sup>, 5pm–late, Scott Sjjeftoe hosted MN SFS's Holiday Party at his home, 8625 W River Rd, Brooklin Park, MN 55444–1312 (763)–560–7200. We celebrated the holidays and the good efforts of Orion, Rosetta/Philae GSLV MK. 3/Care, Venus Express, Curiosity and Space X.



Oregon L5 Society – <u>http://www.OregonL5.org</u> PO Box 86, Oregon City, OR 97045

(LBRT - Oregon Moonbase) moonbase@comcast.net - Charles Radley: cfrjlr@gmail.com

We meet the 3rd Saturday of the Month at 2:00 PM - 2015 Meeting Schedule: FEB 21, MAR 21, APR 19, MAY 16 The National Park Service and Oregon L5 Soc. Announce an Aviation Themed Lecture Series at Pearson Air Museum at the Pearson Air Museum, Fort Vancouver. 1115 East 5th Street, Vancouver, WA (ph: (360) 816-6232)

- Feb 5: Robert Cromwell, Ph.D., National Park Service, "The Spruce Production Division's Vancouver Cut Up Mill and the Contribution to the Air War in World War I"
- Feb 12: Dick Pugh, Cascadia Meteorite Laboratory, Portland State University, "The Meteorite Petting Zoo" (Mr. Pugh will bring meteorites for up close viewing, and encourages attendees to bring suspected meteor-ites for verification)
- Feb 19: Charles Radley, Oregon L5 Society, "Mining the Moon With a Lunar Elevator"
- Feb 26: Diana Deluca, Ph.D. "NA 337, The Commonwealth Air Crews and the Evolution of the Handley Page Halifax Bomber"
- Mar 5: Dan Dolan, Moon Base Builders, "Back to the Moon with the Lunar Rover Mission"
- Mar 19: Dr. Cameron Smith, Portland State U., "Designs on Personal Space Exploration" (Dr. Smith is designing and building his own space craft and space suit, which he will bring for show and tell)
- Mar 19: Matthew Simek, M.A. "Lincoln Beachey: The Man Who Owned the Sky"
   For past articles, Visit <u>http://www.moonsociety.org/publications/mmm\_classics/</u> or /mmm\_themes/



#### NSS-PASA: NSS Philadelphia Area Space Alliance 928 Clinton Street, Philadephia, PA, 19107

c/o Earl Bennett, Earlisat@verizon.net - 856/261-8032 (h), 215/698-2600 (w)

http://pasa01.tripod.com/ - http://phillypasa.blogspot.com

#### The December and January NSSPASA Report for 2014/15

Greetings for 2015! We had a good meeting in December with the reelection of officers for another year. Our February meeting will be on Saturday, the seventh (snow date the fifteenth, a Sunday). Our location has not changed: The Liberty One location on the second floor of the building, between 1 and 3 p.m.. I am altering the report arrangement somewhat as this is a combined report.

**Meeting notes:** We had a guest visiting at the December meeting, Diane, who is a friend of Janice , who enjoyed our meeting format and plans to attend future meetings and events.

Larry gave the first report on our internet and connection to the NASAs' site for "This Day in History" material to be linked from our site. He discussed apps, for Smart phones and Tablets, from NASA (but not for Android yet) and pointed us to nasa.gov for more about this, and, for the NASAtv.com link (lots of good "shows"). He also brought the Sunspot report and pictures ! Coronal Mass Ejections where also discussed and speculated on.

Dorothy brought reports on events on the Intrepid; 25 Years of Hubble: Lectures on How to Improve our Greatest Telescope. At the Rose Center (part of the Museum of Natural History) : the film "Dark Universe", and at The Queens Hall of science: "Hidden Universe". Contact the respective New York museums for more on these and other events.

Mitch brought a lot of material including: on Orions successful launch! And the material Larry Ahearn ha sent us for future events, such as his upcoming outreach event. There where images of the Bernal Sphere, which Mitch is talking about having us build (possibly with a 3D printer ( who would have such files??) and the new, 2015, ISDC posters. He also brought the September/October issue of Discover Magazine with "100 Top Science Articles" that included "Plate Tectonics on Europa" and why the Moon has a thinner crust on one side than the other. The result of a large impact on the early Earth, by a Mars size object, resulted in the breaking off of a large amount of material that formed the Moon. The side facing the Earth picked up radiated energy from the molten Earth and consequently stayed molten on "our" side longer than the other causing the difference we detect.

Earl brought a number of articles, but, the most popular material was on the movie "Interstellar". The factthat the movie and its creation was featured in Wired magazine and included assistance from Kip Thorne, a renowned physicist who works on astronomical questions, and included lots of talk on the scientifically accurate special effects and the interesting portrayal of various effects of time dilation and higher dimensions (this last a bit more speculative). Find the publication! Steven also saw a special magazine that talked of Kip Thorne's contribution to this project. Wormholes and Singularities, oh My!

Earl also brought Nuts and Volts for December with L. Paul Verhages' most recent "Near Space" report. He has begun reporting on the new push in the Cubesat area: there is now a vigorous area of expansion for scientific experiments that NASA and a number of other government and private institutions. One example of NASAs' support for such programs is the Elna program (Educational Launch of Nanosatellites) and there are quite a number of others. For more on this subject see the Amsat Journal, Dr. Verhages' bi-monthly column in Nuts and Volts, Q.S.T. (Eclectic Radio column etc.,) and NASA Tech Briefs. From Earth Tech to top stories in Space News: Rosetta and Philae at 67P/ Churyumov- Gerasimenko. This was story number 4 of 25. There was a number of space related stories in this group including the Kepler spacecraft (story #6) and its' new mission: continuing to scan for exoplanets, and, asteroids and comets. This is due to a clever use of sunlight's pressure on the solar array for stabilizing the craft. See the December 27, 2014 issue of Science News or the NASA website on Kepler.

This concludes the December report.

For January: we had a good turnout including Dennis Pearson, regional coordinator and volunteer for several of our outreach activities. Our meeting ran a little long but this was due to a varied number of space and non related topics (like the Hanging Towers of Babylon!) and expansion of some of last month's discussions.

Larry brought information on our new calendar and how to add material for Mitch We can post to this new calendar on upcoming events ourselves (or Larry can do it for us initially). The previously used location was closed but Larry found a solution to our need. We had a question that may interest other exploration advocates: If we are worried about the impact of a Coronal Mass Ejection striking Earth, then, has any of our spacecraft or rovers been affected by such events that came nowhere near "us". Larry had not seen anything on this and I do not remember reading comments on this possibility (except in some science fiction stories and speculation on future manned flights in the solar system). Continued discussion on this was tabled.

Dorothy noted that The Franklin Institute will be holding several three hour classes on 3D printing. At this writing the January class was sold out within a day or two. The February and March class will probably go just as fast. Dorothy also brought material onfilms at the Institute: "Interstellar" is being shown on the I-Max screen."Wildest Weather in the Solar System" is also showing (and is ongoing). Check out Dotty's Dimensions via Googling, or, check on Facebook.

Mitch brought lots of material from a well packed Ad Astra: there is a Mars on a budget article that talks of a price tag near \$6 Billion dollars. This would be a "One Gates Financeable" mission. It's a little out of the range of Kick Starter ,but, a consortium of financiers could do this. Mitrch also talked of his desire to have "a professionally built Bernal Sphere Display". As this is something I actually tried about five years ago (and failed through lack of Willingness to share the work load) I thing the general idea is good, but, there is more than desire needed to get this done. Mitch suggested we do a public event to raise funds for this project. I pointed out that Dennis , sitting with us, could get us, a chapter in good standing, funding for a worthwhile project. This would require a proposal and a well structured plan and time scheduled goals to be achieved. Dennis pointed out that there wasn't as much funding as previously from NSS ,but, it was a possibility. As previously mentioned: who would have the C.A.D. Files to print such an object? They would have to be reformatted (unless recently created) to be used by smaller machines, but, it might be possible. I have seen two physical models of the Bernal Sphere colony: One was used in the 1970s during a presentation to Congress on what we might do with our space program or a private group could do with sufficient resources. This looked to be turned from a large, long, piece of wood. The other model was smaller and made of metal. It was an award for achievement in a space related activity. The recipient held it in both hands. Go, Mitch!

Hank discussed the information he is trying to get about the slow fall in membership of P.S.F.S and Philcon. The officers from last year where re-elected. Hank is trying to get documentation on hotel negotiations but has not been able to do so. On a happier note: Hank is doing better and may go to either Balticon ( a really good science fiction conference in Maryland) or The I.S.D.C. in Canada! They happen to be near each other in time, so, one and not the other.

Wallace, an associate member, will become a dues paying member this year. Renewals are in March.

Earl brought the January Nuts and Volts which had the article "Flight Computers for Sounding Rockets". This describes a group of instruments that can be used for relatively small thrust module (solid rocket propellant) designs for BT-20, BT-50, and, BT-60 tubing sizes. Equipment includes the addition of a tiny 3 axis accelerometer and data transmitter (ham radio assistance for this). By Dan Gravatt. Check out the website:

www.nutsvolts.com/index.php?/magazine/article/january2015\_Gravatt to post comments and see the associated files and/or downloads. There is also an article (first in a series) called The Hams Wireless Workbench by Ward Silver, NOAX, who also appears in Q.S.T.. The first article is on antennas. All of those great images that we see have come down from space with various types of antennas on both ends of the system. The flight computer article above could use antennas described here. The final space craft note is on material from The Amsat Journal. There are two articles, among several, on spacecraft design. The first is a call for members to submit ideas, up to and including spacecraft designs There is two pages of description and questions for those who would like the society to do a particular project. The questionnaire is from Jerry Buxton, N0JY, who is V.P. Engineering for Amsat. The piece s title is "A Checklist to Design The Next Amsat Satellite". The other is the Apogee View report/ editorial from the president Barry Baines, WD4ASW. There are several interesting points in this report including the need for money for replentishing funding for future launches as "we" have just put up money for the launch of the FOX 1C satellite. We plan to put up several satellites this year, both Cubesats, and need money for launches. Among other items in this report is the possibility of new Cubesats with up to a 6U package size. This would be for a high Earth orbit design.

I should mention several upcoming and recent events: The comet Siding Springs Flew within 140,000 K.M. of Mars in October. There where pictures of the comets nucleus from one of the craft near Mars (see SN Online for 10/22/14). We have just witnessed (in January) the successful launch (but not recovery) of a SpaceX rocket. The cargo was delivered to the I.S.S.. Coming this summer! New Horizons will fly through the Pluto system! Finally!

Submitted by Earl Bennett, President, NSSPASA.



Moon Miners' MANIFESTO Milwaukee Lunar Reclamation Society, Inc. PO Box 2102, Milwaukee, WI 53201-2102





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