

“As long as we’re here...”: Secondary Profit Generators for Moon and Mars Bases

by Bryce Walden¹, Cheryl Lynn York, Thomas L. Billings, and Robert D. McGown²

Abstract

Lunar and Mars base planners concentrate on one or two economic drivers to justify a base. This is like the “killer app” in the computer world, the single indispensable application that justifies the computer purchase. “Secondary profit generators,” numerous economic activities that make a complex lunar or Mars base work, have received less attention.

Trade with Earth is a special case. Due to Earth’s deep gravity well, transportation costs are far from reciprocal. Earth industry produces vital items unavailable elsewhere; however, Earth’s large population represents a huge market for offworld products.

Space commerce among bases on the Moon, Mars, and elsewhere in space brings opportunities in transportation, sales, legal services, and trade in minerals and volatiles, to name a few.

As bases specialize, an interbase economy will develop. Bases can specialize in power production or construction, for example. Precious volatiles could be traded, as long as they remain onworld.

Intrabase economy, or commerce within a single base, opens up a range of small business possibilities including repair shops, laundry, professional services, and others.

The more secondary profit generators a base can develop, the stronger and more resilient the base economy will be. Settlements initiated as “company towns” will transition to diversified economies. Ultimately, the aggregate of secondary profit generators could dominate base balance sheets and do away with the need for a single economic driver to make a base a viable, going concern.

Big Business, Small Business

Many visions of Moon and Mars bases portray small, government-supported outposts conducting pure research. Like an Antarctic base, the outpost is a drain on the economy of its sponsor.

Robert A. Heinlein’s “Future History” stories illustrated vibrant commerce in space. Tour guides and design bureaus had their own small businesses (1967 (contents © 1939 – 1962)). Stanley Kubrick’s 1968 film of Arthur C. Clarke’s *2001: A Space Odyssey* depicted businesses on a space station.

In his 1976 book *The High Frontier*, physicist Gerard O’Neill described orbital colonies building solar power satellites and selling power to Earth. Providing raw material cheaply for this major space industry was the *raison d’être* for a lunar base.

Commercial space development advocates appear to seek one or two “primary profit generators” to justify and pay for a base. This is like the “killer app” early in microcomputer history: the one indispensable application to justify purchase of what

¹ To whom correspondence should be addressed.

² Authors are with the Lunar Base Research Team, The Oregon L5 Society, Inc., P.O. Box 86, Oregon City OR 97045; Email lbrt@OregonL5.org; Website <http://www.OregonL5.org>

is actually a general-purpose computer. In fact, planetary bases will be communities requiring many economic activities to support their industries and workforce. We identify four spheres of economic activity, each with business opportunities.

I. The Earth Trade — A Vital Balance

Trade with Earth is a special case. Shipping from its deep gravity well is very expensive, but Earth will long be the only source for some things space civilization needs. To equalize the balance of trade, space industries must either provide products to Earth at lower prices, or offer unique products at premium prices. Luckily, shipping *to* Earth is far less expensive than shipping *from* Earth, and Earth's population represents a huge market.

Tourism. At any price level, there is a demand for space tourism. Space facilities should include some capacity to host visitors. Tourism support presents business opportunities for travel agents, guides, tour companies, housing and housekeeping, restaurants, gift shops, transportation, and entertainment.

Religion. Religion has associated economic activities. Pilgrimage has tourist-like support needs. Pilgrims buy talismans, artifacts, jewelry, and other religious objects. Religious broad- or narrowcasts from the Moon could also produce revenue. Some well-endowed religious communities may set up their own enclaves on the Moon, ensuring the ultimate in privacy and isolation from outside influences.

Astronomy. Advantages of the Moon for astronomy are well known (Mendell 1985, Section 5). Demand for quality astronomical data in all wavelengths appears consistent and strong. Although even automated telescopes occasionally require costly maintenance, routine costs are low and data transmission to customers on Earth is cheap, suggesting a significant profit margin.

Prospecting. Ore concentrations on the Moon and Mars may require actual prospecting to discover (Gillett and Kuck 1992). Prospectors and mapmakers should be able to sell precise ground-truth data for a high price.

Moon- and Marsdust. Samples of the Moon or Mars command a steep premium on Earth today. Regular commerce will increase the supply and lower the cost. The potential market is huge, however, so there is still money to be made on raw samples. At the outset, the number of entities dealing in Moon- and Marsdust will be few. Entrepreneurs could form a cartel to keep the price artificially high. Advertising and image-enhancement campaigns can increase demand.

Unique minerals would sell at premium prices. Gasses released in the winning of ^3He (Santarius 1988), particularly hydrogen, could be sold at a profit.

Moon and Mars Jewels. After Mt. St. Helens erupted, entrepreneurs found the volcanic ash could be made into emerald-like "St. Helens Glass" jewels, which sell at high prices. Similar products may be made from regolith fines (Kokh 1989a).

Dot Com. Internet domains ending in .luna, .moon, or .sin (Babylonian name for the Moon) and .mars or .ares could be prestige or provocative web addresses. Servers maintained on the Moon and Mars may be important and profitable small industries. Web-cam relays from fixed and roving cameras might be popular.

Arts and Crafts. Art has the potential to sell at prices far in excess of production cost. Creative colonists may find unusual new ways to produce art: anhydrous minerals may impart interesting colors, textures and strength to glass and ceramics, for example (Blacic 1985). Everyday items, such as a set of ceramic dinner plates, might sell at a high price on Earth.

Entertainment. Local production companies could hire out to terrestrial

filmmakers to provide unique locations and special effects. Production gear may be sent from the Moon at competitive prices even to Low Earth Orbit (LEO).

Sports. The new environments of the Moon or Mars may give rise to unique sports impossible on Earth, generating income from ticket sales, sponsorships, endorsements, broadcast or narrowcast rights, and gambling.

Medicine. Gravity is a major stressor on the human body, but freefall is not without problems. A lunar clinic will reduce gravitational stress without eliminating it entirely. This may aid treatment of chronic conditions exacerbated by gravity, such as foot, knee and hip problems, back problems, and certain circulatory problems. Recovery and healing may be enhanced, making physical therapy easier and reducing risk of bedsores and other problems of immobility.

Retirement. Wealthy retirees will find Moon or Mars retirement attractive. There is still the question of bone loss, but advantages of lower gravity may outweigh the risks. There are already indications of treatments to counteract decalcification (Eli Lilly & Co. 2001). Retirees will demand recreation and support services, and their collective wisdom and wealth will be assets to the community.

Death. It has been demonstrated since ancient Egypt that people will pay dearly to permanently preserve their mortal remains. A mausoleum in a subfreezing lunar lavatube would be almost maintenance-free. Even colder vaults in permanently shaded areas of the lunar poles might hold “corpsicles:” people frozen immediately after death in hopes of eventual resuscitation.

Archives. Peter Kokh of the Lunar Reclamation Society suggests lunar lavatubes could be the best archival storage locations in the Solar System (1989b). Maintained at a constant sub-freezing temperature in vacuum, protected from radiation and space hazards, archived goods can last indefinitely. Lunar archives can provide the ultimate in “off-site storage” to keep valuable corporate records safe from even planetary-scale disasters.

II. The Space Trade — Planetary Bases and Other Space Entities

Transportation. Orbital “mules” delivering packages among various space and planetary centers, passenger transfer “taxis” and mobile space repair/refurbishment facilities could provide valuable services for Earth-based companies. Lunar basing and resupply for these vehicles may cost less than Earth-based services.

Law. Even in early days when most legal affairs will be handled on Earth through Earth courts and lawyers, a need may arise for representatives “on the spot” on the Moon, Mars, asteroids, or in space to collect and examine evidence, track down unwilling correspondents, and other law-related activities. As offworld populations grow, the increase in contracts, relationships, conflicts, insecurity, and new laws provides jobs for lawyers, paralegals, judges, diplomats, arbitrators, clerks, inspectors, guards, police officers, detectives and other legal personnel. As with most professional services, relatively high income and low actual costs aid profitability.

Sales. Wherever goods are sold, sales representatives are needed. These range from unskilled help at retail counters to well-educated technical representatives from mining or chemical companies. Businesses eager to expand their trade will hire sales associates to present their products in an attractive manner to potential customers. Traveling salespeople could be regular customers for local businesses.

Barter. Some commodities and services may be amenable to direct trade arrangements. Even if barter is not reflected in company accounts, it may still present many business opportunities and generate significant economic activity.

III. The Base Trade — One Base to Another

Roads and Construction. Roads within and between bases need sturdy foundations and pavements. A construction company at one base with the expertise and equipment might build roads at many sites. Another firm could specialize in shelter construction at strategic places along these roads. Equipment brought in to assemble the primary profit generators could continue work on base infrastructure.

Banking. As the lunar, Mars and space economies grow, there will be movements to establish local currencies (Bennett and Other Contributors 2000). Businesses and individuals will want portable money, credit, currency conversion, and other financial services. Bankers experienced in local conditions and economies will be needed.

Commodities. We normally think of a base jealously hoarding its water and organic substances, but this is a planetary problem rather than a base problem. If these stay onworld, they could become economic commodities for interbase trade.

Law. Wherever humans live and work, there will be conflicts. Environmental laws, building codes, and other regulations require inspection and enforcement. Previously described legal services will be needed to handle these concerns as well.

Sales. Opportunities for salespeople working base-to-base will be similar to those described in the space trade.

Office supplies. The “paperless office” has not arrived as promised. The typical space office may well be a market for pens, pencils, staplers and staples, transparent tape, paperclips, and binders, as well as desks, chairs, shelving, file cabinets, copiers, sorting bins, water coolers and coffee makers.

Paper. A factory-farm specializing in paper production has considerable profit potential. Paper or its functional equivalent is expensive to ship from Earth, yet too important to do without. “Paper” includes writing and printing paper, envelopes, cardstock, corrugated board, file folders, photographic paper, and “consumable” or recyclable paper like paper garments, paper towels, tissues, toilet paper, etc.

Dyes, Ink, Paint, and Adhesives. It is difficult to overstate the importance of color on monochromatic worlds such as the gray Moon or rust-colored Mars. A color merchant can almost set his own price. Pigments and dyes can be sold to companies who make ink, paint, clothes, furniture, ceramics, cosmetics, and even food coloring. Applying ink or paint to surfaces brings up adhesion. Suppliers of adhesives suitable for use inside or outside space bases could set a relatively high price.

Fabric & Padding. The high price of Earth imports suggests a ready market for tough-wearing fabric for clothes, curtains, tapestries, bedsheets, upholstery, etc., as well as padding and insulation. Fiberglass may work for some things, but is not satisfactory in contact with people. Some life support plants and animals should be chosen for their ability to provide added value in textiles, padding, or insulation.

Power. Electricity may be a primary profit generator, sold from the Moon to Earth, but it could also be an interbase commodity. A base specializing in solar electricity production or with a nuclear generator may sell surplus power to the grid.

Communications. On the nearside Moon, someone just over the horizon is more difficult to talk to than someone on Earth. A company could set up and charge for a lunar communications service. At first, simple parts could be made locally, such as wires, antennas, waveguides, chassis, and radiators. Later, fiber optics, transmitters, receivers, amplifiers, test equipment, and other complex components could be added.

Medicine. Medicines will initially be imported from Earth. When medicine is

produced locally, perhaps under license, its manufacturer can expect to undercut Earth-sourcing through lower transportation costs. A relatively small facility can supply the needs of all lunar bases for one or another medicine.

IV. The Home Trade — Small Business Within a Base

Repair. Mechanical devices break. Even the first stages of setting up some primary profit generator will require repair capabilities. It might be smart to spin off this activity as a subsidiary accepting work from others on the lunar base, thereby more quickly amortizing its costs. Alternatively, an unaffiliated company may provide repair services.

Professionals. As in any town, professional services will be needed. These include medical professionals such as doctors, dentists, pharmacists, and psychologists as well as mechanical professionals such as plumbers, electricians, and engineers. Itinerant professionals who could not quite make a living at just one base may travel from base to base on schedule or as needed. Some professionals may help the balance of trade by teaching or offering their services by telepresence to Earth.

It takes a village to feed an engineer. Central kitchens can efficiently provide meals for restaurants and home delivery, such as done in resorts like Disney World. Each restaurant can feature a unique ambience with cuisine prepared by its specialty chef in the central kitchen. Food may be branded by chef rather than manufacturer.

Children. Effects of planetary environments on fertility, gestation, childbirth, and developmental growth are vital concerns for space colonists. Nevertheless, it seems inevitable that as populations grow by immigration, reproduction will also occur. Businesses will respond to the need for medical care, diapers, childcare, clothes and shoes, education, toys, entertainment, and playgrounds. Childcare may be enhanced by telepresence conferences with terrestrial experts and relatives.

Laundry. A laundry in every domicile is inefficient. A commercial laundry can clean clothes professionally. Special abilities to handle water, cleaning fluids and other chemicals will reduce base recycling loads.

Domestic Capital Goods and Supplies. Some domestic goods with low stress/mass ratios can be made locally with minimal processing. Cast or foamed basalt could become plumbing pipes and fixtures, air ducts, room dividers, furniture, dishes, washbasins, and cabinetry (Capps and Wise 1990; Jakes 1998). Later, less massive, more colorful and more workable glass, ceramics and metals will be available. Life-support plantings can be planned for multiple use: as they grow, mature, and age, they can be harvested to make products like medicines, furniture, baskets, fabric, dyes, brooms, and paper. Carbon-rich products should incur a high “resource tax” if they leave the planet, and so will not be as economically exportable as basalt, ceramic, or glass. There is always demand for artistic product designs.

“Consumables.” Many things we on Earth consider “consumables” must be rethought in austere space environments. Cleanable and reusable alternatives to “disposable” paper towels, menstrual absorbents, diapers, etc. may look back to earlier times for solutions. Entrepreneurs who devise reusable or recyclable alternatives to soap, cosmetics, packaging and other common products will create profitable niches in the base economy.

“Junk” and Recycling. Even with a conscientious attempt to reduce “waste,” there will always be some discards. The “junk recycler” will serve the community, keeping a detailed inventory index against the odd request. A dealers network can effectively expand this inventory. Earth may be a market for some “collectibles.”

Politicians, Lawyers and Judges. In addition to legal work already mentioned, we can expect bases to need local governance, creating political offices that need people to fill them.

Bread and Circuses. Entertainment is more important in remote and deadly planetary environments than on Earth. Local cable companies will provide the same programming that people on Earth enjoy. Local production studios may rent out to corporate customers for teleconferencing and demonstrations. An Earth-based production that comes to a base for filming can lease local studio space, equipment and properties, thereby contributing to the local economy and balance of trade.

Residents may also form their own theater and musical groups. Ticket sales and broadcast rights would help defray production and overhead costs. Some local productions may be exported to Earth audiences or go on Solar System Tour.

Art comes in many forms and media, including painting, sculpture, fabric, glass and ceramics. The work of creative artists will brighten and enliven austere lunar homes and offices, and may be sold offworld to help the balance of trade.

Sports old and new provide entertainment, excitement, and exercise. Ticket sales, advertising, endorsements, and broadcast rights generate income. Formal or informal betting will likely be an economic activity. Exercise itself is an industry, and a fitness center could sell memberships or have hourly rates for walk-in clients.

Sex. Snickering abounds about sex in zero-g, but in 1/6 or 1/3 g it may be easier and more enjoyable. Rooms fixed up nicely for romantic trysts may be popular with local couples, and the Moon could become the new prestige “honeymoon” or romantic destination for wealthy clients from Earth. Related businesses include caterers, florists, photographers, lingerie, jewelry, fragrances, and so on.

Sex for hire will no doubt exist, legal or not. A legal framework for “sex workers” would allow for taxing this economic activity, and monitoring the health of its vendors. In a relatively small and closed community, the latter is most important.

Intoxication. Another income generator is intoxication. Intoxicants can demonstrably be sold for high prices, making them economically attractive. We suggest an enlightened approach recognizes that seeking intoxication is part of human nature. It can still be illegal to harm others or put them at risk, without criminalizing drugs. Intoxicant taxes can support treatment for chronic abusers or addicts. Some intoxicants have other valuable uses: alcohol for antiseptic, fuel, solvent, perfumes, flavors, etc., and cannabis for oil paint base, fine linen, birdseed, canvas, rope, and paper (Brecher and The Editors of Consumer Reports 1972).

Summary and Conclusions

Sustainable planetary bases will be more than research outposts or company towns. Allowing entrepreneurs the freedom to set up their own small businesses is a system that has worked very well to tap local resources and human creativity. Those who seek the “killer app” business that will justify investment in lunar or Mars bases may be missing the boat. Many small businesses, each contributing in their own way to the economy, will be more robust, more sustainable, and more enriching than any single target business. Planners should consider a community’s need for small business locations and support infrastructure. Extra space should be allowed for unforeseen purposes, and for expanding families, small businesses and tourist needs. If planners do not provide avenues for growth, they may make it impossible for communities to thrive.

Nota bene: In preparation of this paper we appreciated anew the quantity and quality of Peter Kokh's insights and suggestions to fulfill the needs of planetary settlers. Interested readers are directed to his articles in *Moon Miners' Manifesto* being transcribed onto the World Wide Web at <http://www.asi.org/adb/06/09/03/02/>.

Bibliography

- Bennett G, and Other Contributors (2000). Currency for Lunar Settlements (Artemis-List Discussion, edited by Peter Kokh). *Moon Miners' Manifesto*, n.135, pp. 3-6.
- Blacic J D (1985). Mechanical Properties of Lunar Materials Under Anhydrous, Hard Vacuum Conditions: Applications of Lunar Glass Structural Components. *Lunar Bases and Space Activities of the 21st Century*, Mendell W W, ed., Houston TX, pp. 487-495.
- Brecher E M, and The Editors of Consumer Reports (1972). 53. Marijuana in the Old World. *Licit and Illicit Drugs*, Consumers Union, Mount Vernon NY USA, pp. 397-402.
- Capps S, and Wise T (1990). Lunar Basalt Construction Materials. *Engineering, Construction, and Operations in Space II: Proceedings of Space 90*, Johnson S W and Wetzel J P, eds., New York, pp. 123-132.
- Eli Lilly & Co. (2001). Straight Talk: 2000 Annual Report. Eli Lilly & Co., Indianapolis IN USA.
- Gillett S L, and Kuck D L (1992). Extraterrestrial Resources: A Perspective from Terrestrial Economic Geography. *Engineering, Construction, and Operations in Space III, Space '92, Proceedings of the Third International Conference*, Sadeh W Z, Sture S, and Miller R J, eds., New York, pp. 1048-1057.
- Heinlein R A (1967 (contents © 1939 – 1962)). *Robert A. Heinlein's The Past Through Tomorrow: Future History Stories*. G.P. Putnam's Sons, New York.
- Jakes P (1998). Cast Basalt, Mineral Wool, and Oxygen Production: Early Industries for Planetary (Lunar) Outposts. *Workshop on Using In Situ Resources for Construction of Planetary Outposts*, Duke M B, ed., Houston TX, pp. 9-10.
- Kokh P (1989a). 1st Souvenirs. *Moon Miners' Manifesto*, n.22, p. 4.
- Kokh P (1989b). Lava Tubes. *Moon Miners' Manifesto*, n.25, p. 4.
- Kubrick S (1968). *Arthur C. Clarke's 2001: A Space Odyssey*. MGM/UA Home Video, Motion Picture / Video.
- Mendell W W, ed. (1985). *Lunar Bases and Space Activities of the 21st Century*, Lunar and Planetary Institute, Houston TX.
- O'Neill G K (1976). *The High Frontier*. William Morrow and Company, New York.
- Santarius J F (1988). Lunar ³He, Fusion Propulsion, and Space Development (Abstract). *Papers Presented to the Second Symposium on Lunar Bases and Space Activities of the 21st Century*, Houston TX, p. 212.