COMMERCIAL DEVELOPMENT OF THE MOON: INFORMATION CENTER AND THE GREAT LUNAR DEPOSITORY.
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Introduction: Most discussions of the commercial development of the moon have centered on the production and use of lunar resources. These resources range from oxygen and hydrogen for propellant to support space operations to helium-3, a potential source of fusion energy for the earth. In the case of rocket propellant, the proposed customer has generally been the government and its space program, the use of propellants has generally been for earth-moon space operations, support of a lunar base, or possible future support for Mars expeditions. The use of the moon as a collection site for solar power to be beamed to earth is another concept that has been much discussed.

Alternative Activities: Other proposed potential commercial uses of the moon have included robotic rock and soil sample return for sale to collectors, the collection of scientific data for sale to NASA, the production of virtual reality data from robotic rovers for use in entertainment theme parks and schools, and the development of a tourism and hotel industry on the moon, possibly in connection with health rehabilitation activities.

How do you make money developing the moon? The key to long term sustainability of a lunar outpost is to have the participation of commercial activities that share the government infrastructure and pay for their share. What are some examples of possible lunar uses?

Information and Data Storage; information as a commodity. The use of communication satellites, particularly geosynchronous ones, is currently a multi-billion dollar business. If an infrastructure existed, the moon could be used as collection site, relay node, and value-added location for digital information. *In contrast to materials and consumables, the cost of transporting information to the moon and back again to earth is extremely low.* If an infrastructure existed, such collection, transport, processing, and value-added activities could be a source of revenue in the same way that geosynchronous satellites are. An advantage over geosynchronous satellites is that data could not only be relayed, it could be processed, stored, and recalled, and hardware could be periodically repaired or replaced. The decreasing number of empty orbital slots would not apply to lunar systems. Geosynchronous satellites are subject to collisions with orbital debris. They are also subject to radiation damage, and they eventually go dead and cannot be repaired. Of course, the moon does not stay over the same spot on the earth all of the time. This disadvantage might be compensated for by small data-relay satellites. The big advantage of lunar-based information systems is that they can be placed in very safe and protected locations. The systems can be buried in regolith, placed in the bottom of craters, or even put into lava tubes. These locations can be made safe from radiation damage or small impacts. Here, the data can be considered secure for literally millions of years when proper storage media are used, particularly if stored in more than one redundant but widely separated location. Such data would likely survive anything other than a moon-destroying asteroid impact. Data would be secure against nearly all kinds of earth natural disasters (floods, earthquakes, tidal waves, fires, volcanic eruptions, global warming, and glaciers) and most human-caused disasters including wars, terrorist attacks, or deliberate destruction.

Store valuable records. If the cost were reasonable, the moon might be suitable as a depository for both government and industrial records. With appropriate storage media, the lunar storage environment could be ideal: high vacuum, no oxygen or other reactive gases to alter storage media, constant sub-freezing temperature (when buried or in a lava tube). . The initial system consisting of communication packages, servers, and data storage could be all robotic, implanted by soft landers or even penetrators, but as it expanded it would likely require the periodic or permanent presence of humans for maintenance, upgrading, and operations. Storage media could be periodically upgraded as new systems are developed, and several different media types could be used for redundancy. At this stage, a human maintenance staff would likely be needed, but, large staffs would probably not be necessary for many years. Customers might be divided into those with simple data storage requirements, and those with processing, value-added requirements. Examples include banking conglomerates , transportation reservation systems, DOD and national security data managers, Non-DOD records and processing nodes such as Social Security, and any number of financial records, general business records, and even genealogical records. NASA is accumulating huge amounts of data from space missions, and recent examples show that some of these records may be misplaced or lost. The moon could also serve as a major node and data repository for internet-accessible data bases available directly to individuals for a fee. Commercial data storage in secure locations on earth is already a thriving business, and locations include caves, buildings made of thick reinforced concrete, and secret rural locations. However, any terrestrial location is subject to the hazards listed above plus longer term geologic weathering, decay, and erosion; only a buried lunar location can be guaranteed safe for hundreds, thousands, or even millions of years. One approach is to have the astronauts set up and leave behind a data communication/storage system on each lunar Sorte mission. The added cost over the basic cost of the exploration mission would be minimal. Redundancy of many locations would add to the reliability of the overall system.

The Great Lunar Depository. At one point in history, much of the recorded knowledge of the ancient world was stored in the great library of Alexandria, Egypt. In 500BC, that library was destroyed by a great fire and priceless documents were lost forever from human culture. If we make a secure archive on the moon for not only digital data but also for precious artifacts, we increase the chances that records and examples of human culture will be safe for many millennia. *The moon has a priceless asset which has not been fully appreciated: physical security.* The probability that a given site on the moon will remain undisturbed by the impact of asteroid chunks can be calculated rather precisely using meteorite impact data already in hand. The probability is highly dependent on depth of burial, but even material at modest depths—a few meters, will likely survive undisturbed for millions of years. This Great Lunar Depository might be stocked with important artifacts including (simply as examples) a Gutenberg bible, relics from various religions, original scores by composers ranging from Bach to the Beatles, original manuscripts by such authors as Faulkner, Hemingway, and Joyce, copies of the 100 all-time best films, original photo archives dating back to the Civil War, and even important state papers and historic documents. What are the chances that a shiny, rust-free, working 2007 television , PC, wrist watch, DVD, magnetic tape, or newspaper can be preserved on the Earth for a few hundred years, let alone a few thousand years? Will there be a photograph of you and your family around in a thousand years? Perhaps, but only if these items were carefully preserved in a Lunar Depository. Would you pay $100 to ensure that a photograph , history of your family, or your wedding ring will exist for a thousand years? If enough families paid $100, would this be enough to support a basic lunar depository? A related use for a lunar depository is to store burial or cremated human remains. The launching of such remains into space is already a viable revenue-producing business. Storage on the moon would nearly guarantee that these remains are preserved for millions of years.

The moon as a bank vault for our genetic treasures. Going a step beyond data, documents, and artifacts, the moon could also serve as a depository for our genetic treasure and diversity. A collection of seeds, spores, eggs, cells, and DNA samples can be assembled from plants, animals, insects, bacteria, and even viruses. Recent progress in genetic technology and microbial preservation suggests that we may be able revive frozen microbial organisms at any future time, as well as grow the original plants or animals from frozen seeds, spores, eggs, and cells. DNA deteriorates over time, but may last as long as a million years. Human genetic material could be preserved as sperm and eggs, or as stem cells. For endangered species, this might provide a means of preserving their genetic material long into the future. While this could also be done on Earth, a lunar depository provides insurance against nearly all natural disasters, wars, terrorist attacks, unstable governments, and even large asteroid impacts. In the (hopefully) unlikely event that the Earth is destroyed or sterilized by natural disasters or extreme human activity, the genetic material stored on the moon could be used by survivors located on the moon, Space Station, Mars, or elsewhere, to start a new biosphere.

Who will pay? Multiple and diverse customers are envisioned. The government may be interested in data storage and processing in such areas as social security records, tax records, and national security applications. Industries involved in major data processing and storage such as banks, airlines, and health providers may be interested in a system that uses the moon as a data node and archive. More than a million people signed up to have their name carried into space on the Stardust mission to a comet. While this opportunity was free, it does indicate the immense public interest in having a personal stake in a mission and in sending your name and the names of your family members into space. The opportunity to deposit records of your families existence to be preserved for millions of years might become a real attraction It is not clear who would pay for a cultural and genetic depository on the moon. One possibility is that a privately funded non-profit foundation could be established for this .purpose.

Summary While exploration and science may be the early focus and lunar resources will eventually be important, we need to visualize using the moon in a broader context. In particular, we must go beyond the traditional ideas that the moon can only be useful for propellant, consumables, or energy production. Multiple other uses are possible, or perhaps required for sustainability. In the long term, the moon may become both a communication center and a safe deposit box for ecological treasures and civilization from Earth.