SSLC

Self-Sustaining Lunar Colony

A 100-person Lunar Colony

ORBITEC has designed the architecture of a SSLC, a colony with the ability to survive without any major supplies or resources from Earth for an extended period of time. The establishment of the SSLC is necessary to drive new innovative approaches and developments that would ultimately support a much lower cost and highly-survivable human colonization of the Moon, Mars, and other bodies in the Solar system.

ORBITAL TECHNOLOGIES CORPORATION

Small Business Leader

ORBITEC is a national leader in small business innovations for the space industry, with over $90 million in government and industrial contracts since its founding in 1988.

Mission Statement

To serve government and industry by developing and demonstrating innovative technologies and advanced products that enhance the quality of human life and support mankind's exploration of the Universe.

Main Business Areas

- Advanced concepts and technology development
- Space resource systems
- Space propulsion and propellant systems
- Space flight systems
- Human, animal, and plant habitation systems.

Company Background

Headquartered in Madison, WI, ORBITEC is Wisconsin's leader in space research, technology and product development, working with the federal small business innovation research and other major technology development programs of the nation. ORBITEC was awarded Wisconsin's Professional Service Business of the Year Award (1995) and the Tibbitts Award (1996 and 1999) from the SBA for outstanding work for the US Government.

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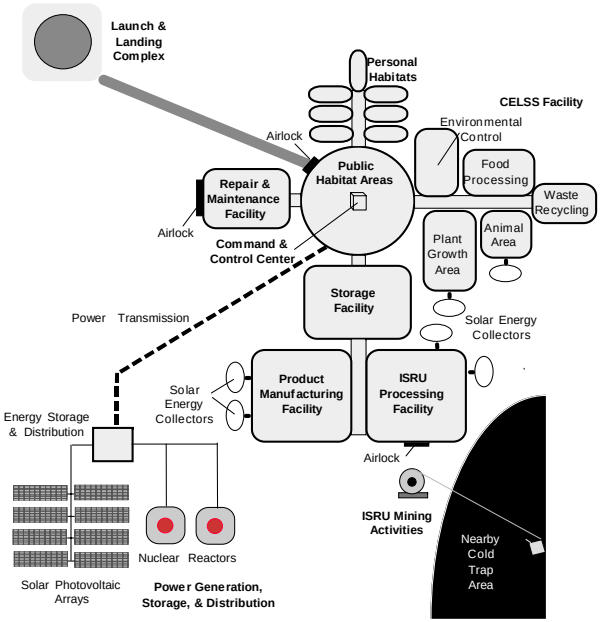
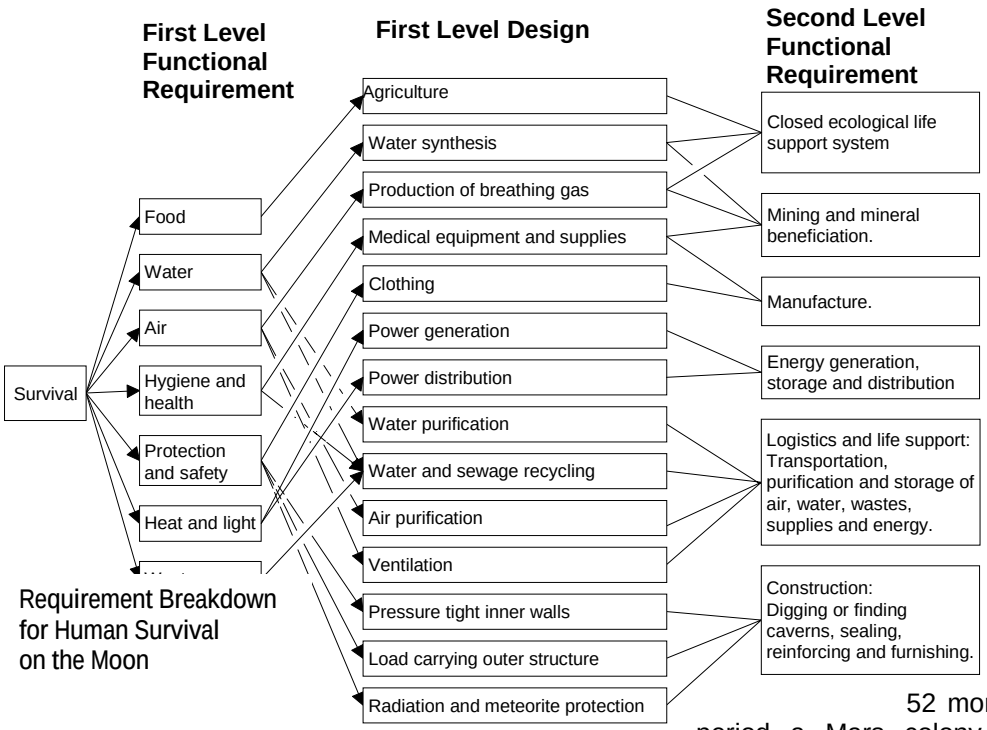
Background

ORBITEC has conducted a Phase I NIAC study (available online at www.niac.usra.edu, see O'Handley) of an overall system architecture with the goal of designing a truly self-sustaining Lunar colony (SSLC). We defined self-sustaining as a colony that would be able to survive without any major supplies or resources from Earth for an extended period of time. We showed that a design of a self-sustaining architecture is feasible and represents an attractive alternative to what would be a regular Earth-supported Lunar colony. The establishment of SSLC is necessary to drive new innovative approaches/developments that would ultimately support a much lower cost and highly-survivable human colonization of the Moon, Mars, and other bodies in the Solar system. Once established, the SSLC will implement many innovative applications for the production of needed structures and commodities from Lunar materials and lead to significant commercial activities.



A Potential SSLC Layout



Requirement Breakdown for Human Survival on the Moon

Role of Space Resources for the SSLC

The key to success will be its smart use of space resources that are available on the Moon. Chemical analyses performed on Lunar samples from Apollo missions indicate O_2, Si, Al, Fe, Ca, Mg, and Ti are the major components of Lunar soil. O_2 comprises approximately 42% of the Lunar soil by mass, while Ti accounts for only 3% (mare soils). All of these elements are chemically bound in various minerals, so the Lunar regolith will require processing to extract the useful components. O_2 could be "mined" by directly heating Lunar regolith to moderately high temperatures and adding methane to reduce the oxides to form water or CO. These gases can be further processed to form O_2, leaving recycled methane gas and Si, Fe, and other metallic and ceramic by-products in the processed regolith which can be processed into useful products.

Advanced SSLC Concept

The first purpose of the SSLC is to establish a permanent human presence on the Moon with a minimum need for supplies from Earth. The second purpose would be to serve as a test-bed for tech-nologies that would be in common between the SSLC and an eventual Mars base.

The SSLC is intended to fully utilize Lunar resources. The colony would be considered "self-sustaining" when it can achieve the goal of surviving without any supplies from Earth for 52 months. This rep-resents the period a Mars colony would need to survive between supply missions from Earth, assuming one missed re-supply mission opportunity. The SSLC would need to produce and recycle all of the consumables required over that time. It must also maintain all of the modules, facilities, and equipment. We have assumed that the SSLC would have a steady-state population of 100. The Lunar colonists are considered to be permanent residents for a minimum period of 52 months. The colony could become self-sustaining without becoming completely isolated from the Earth. For example, scientific and technical equipment needed for further science, exploration, and extension of operations could be supplied. Communications and electronic data transfer with Earth would be extensive.

The SSLC would be located at the southern pole of the Moon. There are several reasons to choose this location. First, data from the Lunar Prospector indicated significant amounts of frozen water ice, or at least bound hydrogen, at both of the Lunar poles in cold traps where the Sunlight is severely limited or non-existent (bottoms of craters and depressions). This resource will provide a valuable feedstock for H_2O, O_2, and fuel to support Lunar surface activities, provide life support consumables, and allow transportation back to the Earth. Second, there are several areas at the South pole that receive near-constant Sunlight. Two locations near the Shackleton crater at the Lunar south pole have been identified that collectively receive sunlight for ~98% of the time, making them excellent sites for the SSLC and the associated Solar power systems. The availability of near continuous power eliminates the need for long-term energy storage. Third, the temperature environment is much more consistent than other non-polar Lunar sites, with few dramatic temperature shifts. Surface temperatures at the south pole remain close to –53 +/- 10 C. Other places on the Moon, outside of the poles, can see temperature swings over 400 C during Lunar day to night cycle. The small changes in temperature will simplify the thermal control system requirements of the SSLC and reduce cyclical thermal stresses. Electrical and thermal energy for the colony is proposed to be initially supplied by a combination of nuclear power plants (two $\geq$ 1 MW plants) and Solar energy. The CELSS, Closed Ecological Life Support System, would provide all the atmospheric requirements for living on the Moon. The food acreage is sized to support 100 people. Dust has been identified as a significant problem during the Apollo missions. All attempts will be made to prevent the entry of dust into the habitat volume. Robotics and automated processes would be extensively used for surface construction and maintenance of the SSLC facilities. Telecommunications, navigation and information management are other important requirements.

For a more complete description, see the NIAC website for the final report.