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**“LUNAR ZEN GARDEN”  
NATURAL DESIGN AS A KEY FOR RELIABILITY IN EXTREME SPACE ENVIRONMENTS**

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**ABSTRACT**

*KEY WORDS: Space Art, Extreme Design, Natural Design, Human Factors, Long duration Space Mission, Space Tourism, Zen*

Natural Design is a discipline that, utilizing in situ natural elements or evocation of natural structure, creates an environment that improves human reliability in extreme conditions, such as a long duration mission on the Moon. The Zen Garden composition is an application of the Natural Design methodology. It is based on the evocation of fractal natural structure, however it evokes a tree structure with calming and relaxing effects. The materials are stone and sands (*the “regolith”*) that are locally available materials on the Moon. The scope is to create a “Lunar Zen Garden” as symbolic evocation that focuses attention on the value of happiness, meditation, energy, and all the elements that have been part of the human culture for century. The application of Natural Design has the aim of utilizing natural elements present in the environment. It creates, with elementary natural structure, a context of art and design interaction that will increase well-being. The Lunar Zen Garden is “landscape design” involving relaxing art therapy, with applications for space tourism context.



*Fig. 1: Lunar Zen Garden*

## **INTRODUCTION**

### **Art and Design for Astronaut's Reliability**

In Space and on the solar system bodies, the human psycho-physiological system becomes completely upset. The lack or the difference in gravity, absence of natural terrestrial stimuli, isolation in a limited space, radiation, etc modifies psycho-physiological factors such as human biorhythm and sensory perception.

For long duration missions, strong training of astronauts will not be sufficient, for mission success we must consider a "Human Centered Design" methodology in order to guarantee the reliability and to increase the comfort and the productivity of the astronauts.

This approach takes into account human sensibility and emotions, primary factors for extreme environment missions that involve isolation and stress. An astronaut is a person, not just a worker. Arts, design, happiness, and nature are the key words. Also, these factors are at the basis of the new expanding area of space tourism.

### **Function of Natural Design in Outer Space**

Natural Design is an area of aesthetics based on the structures and elements found in nature to create harmony for human wellbeing. It considers design similarities such as the one between the solar system and the atom, the ripples in the sand and those in the clouds, as well as the distribution channels of water tributary and our circulatory and nervous systems.

In extreme outer Space context the Natural Design concept forecasts the variety and the variability of the natural terrestrial stimuli, through human features like the emotions, sensory perception (colors, sound, taste, etc.), circadian cycle, physiological and psychological energy.

### **Harmony and Variety for Needs**

In an extreme context where life is always at risk, the most critical factor is safety. For example, engineers work to protect humans from space radiation. We should never lose sight of the safety factor.

However, anyone working toward sending humans into outer space needs to consider all aspect of the physiological and psychological needs of future space travelers. Artists and designers should be taken into account from the first step of a project, in order to provide the mental stability and well-being of all that interact for the safety of any mission. The Lunar Zen Garden can provide suitable living conditions for astronauts on Earth's Moon.

As human beings and not machines, we need to utilize our natural ingenuity to improve the extreme environment, to positively stimulate the spirit of place in order to provide mental stability and achieve happiness.

Imagine the simulated effects of feeling fresh air under trees, of sunbeams streaming through leaves, and of witnessing a sunset on a beach. And even though in reality there will be no such landscapes and situations, the Lunar Zen Garden will be profoundly beneficial in providing its inhabitants with the sense of beauty and the sense of value. It will also provide a changeable and perennial beauty on the lunar surface.

## **DEFINITIONS**

Lunar Zen Garden is a form of outer space art and natural design application in the extreme context. To clarify the terminology, definitions of the disciplines involved are here presented:

- Natural Design
- Outer Space Art
- Extreme Design
- Outer Space Design

***Natural Design:*** A discipline based on naturally occurring phenomena involving the natural elements. Natural Design aims to create a context of art and design interactions to increase the psycho-physiological well-being of humans. It holds to two primary philosophies: One uses natural elements present in existing environments. (Example: Lunar regolith -- or soil covering bedrock -- in the case of the Moon.) Another involves the evocation of natural terrestrial structures or stimuli in which human beings have been formed (daily variation of light radiations and colors perceptions, seasons, etc.)(See Fig.2)



Fig. 2: Circadian light concept

**(Outer) Space Art:** “Contemporary art which relies on space activity for its implementation” (Malina, R., 2002), is able to interact with the feelings and moods of the habitants, thereby increasing the wellbeing.

The roles of space art are:

1. encouraging scientific exploration
2. recording historical evolution and planetary exploration
3. promoting international cooperation
4. synthesizing information to stimulate new ideas about the universe and our relationship to it.

(William K. Hartmann, 1990)

**Extreme Design:** A discipline of Design with a multidisciplinary approach that intends to increase the life quality in extreme environments at the limits of human survival, finding project solutions and supporting cultural expression. (Schlacht et al., June 2007)

Extreme Design creates projects proficient to solve the psycho-physiological stress factors created by:

1. Physical problems: radiation, body adaptation at different gravity)
2. Psychological conditions: distance from mother Earth, feelings of risk (cause: space dust, meteorites...technical breakdown), stress.
3. Confinement problems: dimensional (interior spatial restriction), temporal (mission time not easy be re-scheduled), social (group dimension limitation), biological (abstention from the natural earthly stimuli).

**Outer Space Design:** A branch of Extreme Design applied at the space context. It considers from the first design stage all the human factors that are indispensable for creating a “personnel-friendly” space environment which must be

comfortable, pleasant and efficient. (A. Dominoni, 2002)

## ZEN GARDEN ON THE MOON

Lunar Zen Garden (Fig.1) is a form of landscape design and art therapy that also represents an example of Natural Design applications. It uses the natural elements present in the local environment to increase the well-being.

To improve the environment, we must focus on the mental activities of natural daily life. The environment should consist of balance. Art and design can help to make a tranquil mood. For example mimicking day and night cycling is an important factor to be considered when creating a comfortable environment.

Also, it could be a form of occupational art therapy. It combines recreation and inspiration issues, also it can solve psychological issues connected with extreme habitats.

### Landscape and Spacescape Design

Landscape design is the art of arranging or modifying the features of a landscape, for aesthetic or practical purposes. It attempts to develop techniques by which the social, psychological and aesthetic qualities of the environment will be improved.

Spacescape Design is landscape design in outer space. For universal healing effect, the design should follow the principle of Natural Design.

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### Art Therapy in Space

The International Space Station (ISS), spaceships, and lunar bases are classified as extreme habitats. Psychological issues can be solved with art therapy. Lunar Zen Garden combines recreation and inspiration, and will be an art therapy on the Moon. Art and design would encourage and inspire not only pioneers such as astronauts but also space tourists as well.

## **Zen Gardens**

“There is an increasing interest in Zen Buddhism among psychoanalysts that is becoming trans-cultural.”(A. Ono, 2007)

Zen gardens could be considered relaxing therapy to increase well-being. Following Erich Fromm's (1960) definition's, “well-being is being in accord with the nature of man”. However “Nature” is the keyword of Zen and Japanese gardens attempt harmony with nature.

“Spacescape” designs should also be in harmony with nature. Therefore, Zen could be a technique to increasing the well-being, overcoming mental breakdown of people in isolated long-term missions.

## **Therapeutic Effects**

The aim of a Lunar Zen Garden is not to promote Zen Buddhism but to propose the possibilities of Zen gardens for its therapeutic effects. We can enhance spirituality through creations. This will be “Occupational Therapy” focusing on the composition of the lunar soil with scattered rocks (regolith).

Creating a garden could be both group and individual work. Rather than a passive environment such as only rocks and sand without growing life, an interactive space can enable individual and group exploration of creative design. Such a garden can also provide space tourism.

The Ryoanji Temple in Kyoto is one of the most famous Zen gardens. To discover why it has a calming effect on the hundreds of thousands of visitors who come every year, Kyoto University researchers found that the seemingly random collection of rocks formed the outline of a tree's branches. The researchers found that the unconscious perception of the tree's pattern have relaxing propriety (AA.VV. Kyoto University researchers, 2002). A further example: Zen gardens use rounded forms, and this makes us remember our mother's body unconsciously (Iwai, 1986).

Also these studies underline the connection between natural design and Zen garden, however it uses natural patterns present on the Earth.

From another point of view, the landscape gardener Yasuo Kitayama told that stone arrangements don't need a technique and love is everything (Kitayama, 2007).

## **Karesansui as a Form of Zen Garden**

The Zen garden style called “karesansui” literally means “dry landscape.”

As a Natural Design application the main elements of karesansui are rocks and sand that engender calmness by symbolizing the sea and the water stream. Sand is raked in patterns that suggest rippling water (a dry stream) with minimal composition.

”Aesthetic ideals displayed by karesansui gardens are asymmetry, tranquility, simplicity, and naturalness.” (Suzuki, 2002)

A karesansui garden's emphasis is placed on the beauty of empty space. By utilizing karesansui technique we may be able to blend harmoniously with the lunar landscape's natural beauty by way of Natural Design.

## **LUNAR HABITAT**

### **For the Realization of the Lunar Zen Garden**

To establish the feasibility of the Lunar Zen Garden multiple elements must be taken into consideration:

- The integration of human-made structures to the lunar landscape via the natural concepts of Natural Design.
- The extreme environment.
- Economic and environmental effects.
- Maintenance

On the lunar surface there is no weathering, so although the static conditions, minute soil particles and low gravity make the lunar surface powdery the garden may last forever if not impacted by meteorites or by harmful human actions.

The Lunar Zen Garden will benefit people both physically and mentally. But astronauts, cosmonauts, Taikonauts, or space tourists will not need to work the soil. However, all these may work together to plan the garden.

A remote-controlled rover can create and maintain the Zen Garden. The rover would be pre-programmed (like a robotic vacuum cleaner) to maintain the garden automatically. Programming the rover is creative work that can be done with a Zen garden table model or PC inside the lunar habitat. Co-creative works will be needed in this process and it will be work as an Occupational Therapy.

What the rover will do:

1. Guided by remote control make a good foundation for the garden.
2. Separate different sizes of grains. Remove middle-sized grains.
3. Keep bigger rocks. Use separated grains to make the foundation of the spacescape.
4. Put smaller sand particles on the top layer of the place to make lines.
5. To make lines, move on small sand particles to around the large rocks.

What humans will do:

1. Integrate the basic design into the lunar landscape following Natural Design concepts.
2. Make the plan for the spacescape.
3. Plan the remote control and creative work that can be done on a Zen Garden table version or PC inside the lunar habitat or on the Earth.
4. Maintenance for the rover.

Assumed problems:

- Minute soil (microscopic) and low gravity makes objects' surface powdery due to static.
- Elements take into account both economic and environmental effects because of the difficulties of the extreme environment.

Astronauts, cosmonauts, Taikonauts, or space tourists can make the plan for the gardening. By doing this type of garden people will benefit psychologically through both seeing and making. Maintenance could be another project to create new Zen Garden.

A Zen Garden is very nature NATURAL and in sync with Natural Design. So, there will be no need for multi-cultural expressions.

### **The Lunar Habitat in the Garden**

Connected with the Zen Garden, the Lunar Habitat facility will be infused throughout with functionality and harmony (harmony of color, configuration and structural function).

Elements of Natural Design in the lunar base can be applied to the shape and composition of solar panels and habitat modules. The entire lunar base can be designed geometrically to coordinate these elements with natural fractal structure (Fractal Geometry is nature's method of creating new things – whether those things be animate or inanimate objects).

Currently, the Gifu University in Japan is developing colorful solar panels. They will be able to become geometric solar panels such as flower-shaped ones mounted on rotating systems to point toward the sun. These beautiful panels will not only provide energy to the entire lunar base, they will improve the habitat and garden as artistic elements.



*Fig. 3: Flower shaped solar panels*

Following material might be suitable for use keeping those colorful flower-shaped solar panels facing the sun.

NOTE: Research "Solar Muscle" – a discovery from back in the 70's of a material that acts like a living plant and follows the path of sunlight.

- Made from commonly available, low cost materials.
- Harnesses the ability of certain polymers (such as black plastic bags) to shrink when exposed to heat, and relax back to their original length when cooled.
- Normally, this shrinkage occurs in all directions within the material.
- However, the material can be stretched, causing its polymer strands to line-up, and directional zing the shrinkage.

**Fractal Habitat Configuration**

Snowflake-shapes are examples of fractal configurations that can be used for the design of the lunar habitat modules. Snowflakes are natural applications of Fractal Geometry i.e. Natural Design. Fractal Geometry's elements of self-similarity would make adding new modules relatively easy assuming that local natural construction materials will be used.

The snowflakes structure is an example of fractal configuration that can be used for the lunar habitation module. However it is an application of fractal geometries and natural design. The function of self-similarity is to make it easy to add new modules. This concept considering the possibility of habitat expansion and is assumed to use local materials for the buildings.

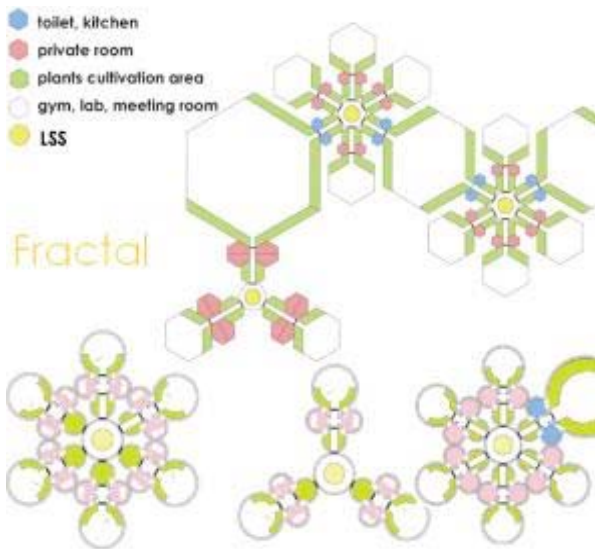


Fig. 4: Proposal fractal habitat settlement structure

Fig. 4 (A. Ono, et al. 2006) depicts the lunar settlement comprised of private rooms and public rooms. Public rooms consist of kitchens, gyms, laboratories and meeting rooms. Each private room would consist of a sleeping area where the next to each small plants cultivation area. Piping should be minimized to connect each room and life support system (LSS) and the "snowflake-shapes compositions" are helpful for it. The yellow parts on the figure are central core regenerative life-support systems. The depicted small black parts are airlocks that would prevent air leakage and heavy damage.

**Lunar Zen Garden Habitat Mountain**

The Zen Garden itself would be a habitable structure. The garden has a mountain comprised of habitat modules within it.

As a part of Zen Garden, the habitation mountain could be called Tsukiyama. Tsukiyama literally means constructed mountain. Historically, the older term was kasan (artificial mountain). The Tsukiyama, which is modeled on Mt. Fuji, is a kind of borrowed-landscape (Schumacher, 1995-2007).

There is another similar design, a white sand Mt. Fuji model called Kougetsudai at Ginkakuji Temple. The Ginkakuji Temple is a Zen temple that was established in the 15th century. The cone-shaped trapezoid Kougetusdai was a geometrically designed mountain and a kind of installation. The creation date and purpose of this mountain is not certainly known, but it is considered to be an innovative design to enjoy the reflection of moonlight and to feel the pretty view with the moon placed above the mountain.

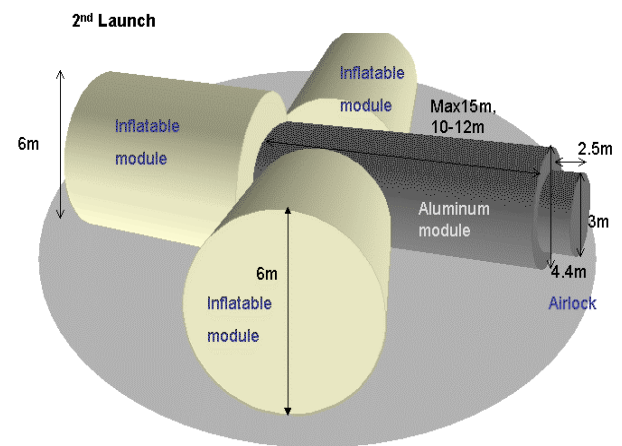
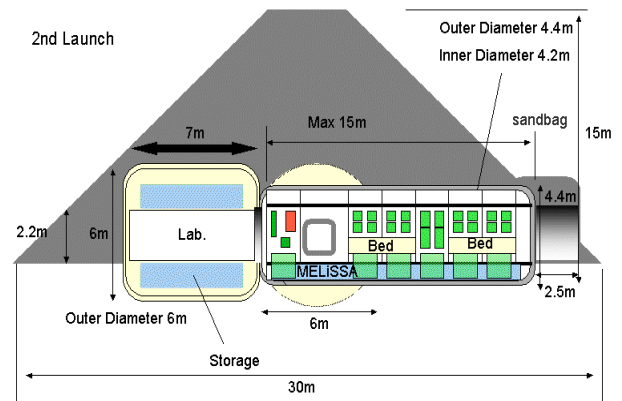


Fig. 5: Modules of the Lunar Zen Garden Mountain

The Lunar Zen Garden Mountain containing one aluminum module and three inflatable modules will shield against intense radiation. It will also be an aesthetic “spacescape” design from which to enjoy the beauty of both the Earth and the Moon. Inhabitants of the Lunar Zen Garden will enjoy the beauty of the Earth (like a blue & green Moon) just as inhabitants of the Earth enjoy the beauty of the Moon. This will be able to use the same method to enjoy the Earth's beauty. An important exemplification of these physiological principles is found in the charm of symmetry (A. Ono, *et al.* 2006).

The garden will be shown via cameras and monitors to everywhere and this spacescape will become a tourist attraction. The tourists in the spaceship to be put into orbit around the Moon will be able to see the garden from the orbit via binoculars. Perhaps the spacescape will be seen from Earth via telescopes as well.

### **CONCLUSION**

How will daily life for human beings be on the Moon? It will be very different. It will be missing most of the positive visual and emotional stimuli human beings are accustomed to here on Earth. The moon is a totally alien environment and human beings will be living within an artificial habitation system.

Natural Design will be introduced to help create a use of ‘natural environment’ that should enable people going to the Moon to achieve their normal sensations of beauty and joy, etc.

The Lunar Zen Garden will be an ingenuity of outer space life settlements. The garden will be a strong expression of Natural Design achievement and also a cultural expression of Humanity on the Moon. The Lunar Zen Garden will also hold strong implications for the newly emerging field of space tourism.

Relative to Space Art and Natural Design, Malina (1989) stated that, "The creation of contemporary art is inextricably tied to the process of creating human civilization."

Art and design will occur as a part of space exploration to make human use of space complete and successful. It would encourage and inspire, not only pioneers such as astronauts, but also space tourists as well.

We need to feel our sense of self-worth, that is the basis for the ability of doing good work -- from technical and scientific activity to space tourism projects.

As if alterations of the lunar surface can be rationally allowed, the Lunar Zen Garden achievement would last forever as will Astronaut Neil Armstrong's “footprint.” It will be another “giant leap for mankind.”

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## **IMAGES**

Fig. 1: Lunar Zen Garden, A.Ono, 2007.

Fig. 2: Circadian light concept, Sivra I-guzzini, 1999.

Fig. 3: Flower shaped solar panels, A.Ono, 2007.

Fig. 4: Fractal habitat structure for the settlement, C. Nakagawa and A.Ono, 2006.

Fig. 5: Modules of the Lunar Zen Garden, N. Hatanaka and A.Ono, 2006.

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