

Discovering Greater Earth

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1.0 Introduction

Since the beginning of human history the perception of its home planet Earth has always influenced the way humanity has formulated its beliefs and conducted its affairs. When Earth was perceived of as the entire universe it gave rise to myths and religions that permeate and influence society into the present time. Recently, space exploration has provided humanity a perception of the "Whole Earth" - a blue sphere floating in the vast expanses of the cosmos. This perception has catalyzed the globalization of its cultures and defines many of its present activities.



Figure. 1 . Earth as seen from Apollo 17

Today, most people live with this perception of planet Earth as seen in the famous photograph made by the Apollo 17 astronauts on their way home from the Moon (*Figure 1*). We are comfortable with this image of Earth as defined by the edges of its atmosphere and it has become a powerful symbol of our times representing the environmental movements, the globalization of our diverse cultures and economies, and the understanding the interdependence of our climate and ecology. For most people there is no need to discuss this perception. It is a 20th century view of Earth and most people conduct their affairs accordingly. Not very different than our early ancestors, we are convinced that whatever humanity's fate in the years ahead, that fate will be decided and enacted on this blue sphere.

However, this perception of our home planet is outdated, constraining and unnecessary. This paper introduces the need to formulate a new perception of planet Earth based on its true dimensions - a perception called *Greater Earth* (Wynn & Griffin, 1994). Within the boundaries of *Greater Earth* our species will find the room, resources and opportunities it

will need to survive and prosper in the coming millennium.

2.0 The World is Getting Smaller

Earth has always been the provider of raw materials and the mother of Life. When humans were few Earth itself was the frontier to be discovered and explored. As exploration gave way to exploitation, the human species successfully established its dominance over the rest of Nature and has occupied the planet as no other species before it. It has devised means to extract and utilize resources to feed its populous and to power its development. It has occupied the lands, farmed the vast oceans and traversed the skies in its quest for perpetual progress and development.

The phrase "*The world is getting smaller*" is often used when speaking about faster, safer more efficient modes of transportation. It is also applied to the comprehensive communication technologies that can instantaneously connect anyone with another from almost any point on the globe. For all the positive and exciting benefits that these unprecedented and fantastic aspects of modern life are providing us, we all know that there is an unsettling side to these developments. First and foremost is the uncomfortable realization that the world is not only getting smaller but it is also getting more crowded.

"**The Limits to Growth**" was the controversial book produced by the Club of Rome that appeared in 1972 and which did much to stimulate the discussion about the relationship between resource depletion, the environmental consequences of industrialization and population growth. Its conclusions are still being debated today. Here is a quote from the introduction to the book. (Meadows, Meadows, Randers, Behrens, 1972)

"WILL THIS BE THE WORLD THAT YOUR GRANDCHILDREN - WILL THANK YOU FOR?"

A world where industrial production has sunk to zero. Where population has suffered a catastrophic decline. Where the air, sea, and land are polluted beyond redemption. Where civilization is a distant memory. This is the world that the computer forecasts. What is even more alarming, the collapse will not come gradually, but with awesome suddenness, with no way of stopping it. This is the message and the warning of *The Limits to Growth*, a book that may well offer mankind's last chance for survival. "

Now the university computer that the Club of Rome used was probably not as powerful as the one I use in my office, and their modeling program was not as good as those that have been developed since, but anyone with common sense would agree that there is only enough physical room and resources on our blue sphere for "x" number of people to live with some degree of comfort. The question of course is: "How many people?"

A quick look at history puts human population growth into some perspective. Just 10,000 years ago there were only about 5 million people on the planet living, at that time, mostly in caves. For these people planet Earth was surely the entire cosmos. 8,000 years later, there were 130 million people around when Christianity was born. By 1650 the human population grew to about 500 million. 200 years later, at the beginning of the industrial age, it doubled to 1 billion. Our planet still seemed large enough and resilient enough to support any human purpose. 100 years later, around 1950, the number of humans increased to 2.5 billion. The chart below indicates that this number has more than doubled since then. All of these statistics are alarming but for the purposes of this paper I will refer to just the world population figures and the estimates concerning crude oil.

Concerning, population, we are currently adding about 1 million people to the total population every 5 days which means that there will be more than 6 billion people on Earth in just about one year.

This chart and the text below it are from the Millennium Institute's Website.
<http://www.igc.apc.org/millennium/index.html>

These figures called "State of Our World Indicators" were posted on March 9, 1998.

- o **World Population: 5,901,285,756**
- o **Increase Per Day: 217,467**
- o Years Until Insufficient Land - Northern Diet: 7
- o Years Until Insufficient Land - Southern Diet: 38
- o Species Extinctions Per Day: 104
- o Years Until 1/3 Of Species Are Lost: 8
- o **Years Until Half of Crude Oil Is Gone: 2**
- o **Years Until 80% of Crude Oil Is Gone: 22**
- o Percent Antarctic Ozone Depletion: 70+
- o Carbon Dioxide, Years Until Doubling: 59
- o Water Availability (000 cubic meters/person/year): 10 (estimate)

"The rate of world population increase in 1995 was around 88,000,000 per year, or 215,847 per day. The current rate of natural increase is approximately 217,467 per day. If fertility and mortality had remained constant at 1990 levels we would reach 12 billion people in 2028. Current projections say it will take a little longer. The U.S. Census Bureau projects a world population of about 9.4 billion in 2050. Twelve billion is the maximum population that some experts think Earth can sustain. Others, like Gretchen Daily, Paul Ehrlich, and Anne Ehrlich calculate that Earth can only support 1.5 to 2 billion people at a sustainable, decent standard of living. At the very least humanity needs to act to prevent population growth from exceeding 12 billion people. Population growth has momentum, however. Even if we had somehow instantaneously achieved "replacement" fertility in 1990, the population would still ultimately increase to 8.35 billion due to the younger portion of the population reaching childbearing age. We have a very short period of time in which to reduce population growth."

Original Source: United Nations. 1992. Long-Range World Population Projections: Two Centuries of Population Growth, 1950-2150. New York: United Nations

The positive side of having so many people on Earth is that humanity has never experienced so much creativity and progress in such a short time. Humanity itself must be considered as its most valuable resource and its challenge is to find suitable ways to feed, clothe and otherwise nourish this resource in a comfortable and prosperous manner.

The most important resource in this respect is energy and most of modern society is powered by refined crude oil. The first chart below (*Figure 2*) indicates the amount of crude oil still in the ground in the year 1900 and the next chart (*Figure 3*) estimates the amount which will be remaining in the year 2010. The chart above indicates that we have 2 years until half of Earth's crude oil supplies are gone and 22 years until 80% of this resource is used up.

Earth's Petroleum Fuel Tank, by Region 1900

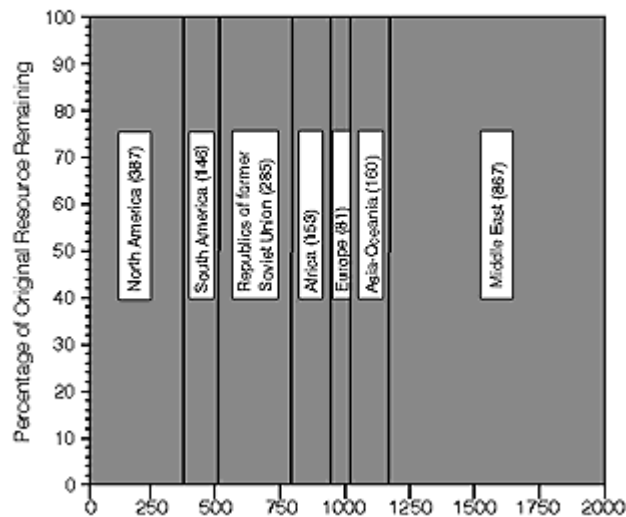


Figure 2. Petroleum Reserves in 1900

Source: Masters, C. D.; Root, D. H.; and Attanasi, E. D. 1991. "Resource Constraints in Petroleum Production Potential." *Science*. vol. 253. 12 July 1991. pp. 146-152.

The pessimists will say that our civilization's oil tank is already half empty, the optimists will counter that the tank is still half full. In any case, the amount of crude oil in the ground is finite and given the increase in population and in the overall standard of living, we will be using the remaining amounts of oil rather faster than slower. Knowing these figures, one must surely question multi-billion dollar investments in new airports. Solar powered airplanes that can carry hundreds of passengers around the world has yet to be invented.

Earth's Petroleum Fuel Tank, by Region 2010

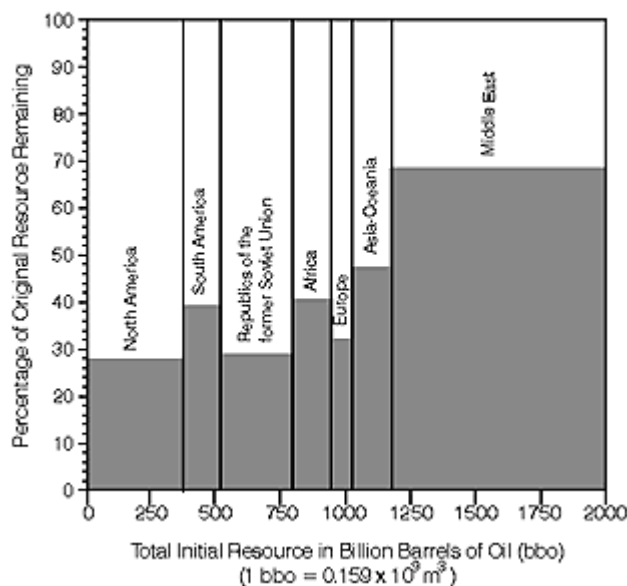


Figure 3. Remaining Petroleum Reserves Year 2010

Source: Masters, C. D.; Root, D. H.; and Attanasi, E. D. 1991. "Resource Constraints in Petroleum Production Potential." *Science*. vol. 253. 12 July 1991. pp. 146-152.

Total Energy Input for U.S. Corn Production from 1700 to 1983

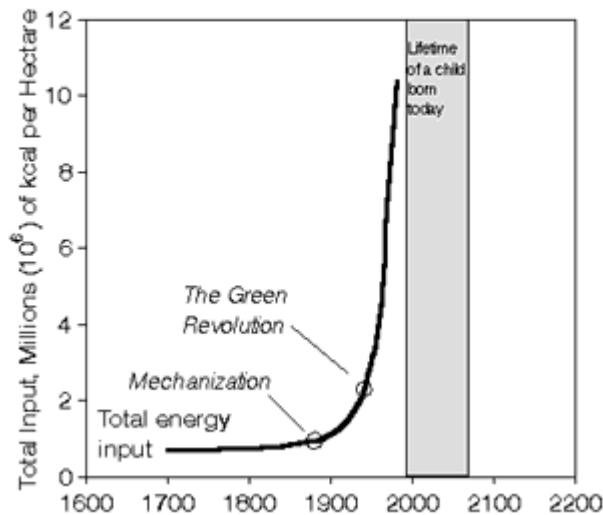


Figure 4. Energy Input for farming corn.

Source: Pimentel, D. and Wen, D. *Technological Changes in Energy Use in U.S. Agricultural Production*. In: Carrol, C. R.; Vandermeer, J. H.; and Rosset, P. M. 1990. *Agroecology*. New York: McGraw-Hill Publishing Company. p. 152.

While we may be able to convince ourselves to give up our cars, jet airplanes and a vast number of consumer goods, (Figure 4) indicates that we also need to use more and more energy just to feed all those new hungry human beings. In any case energy is the essential resource driving humanity's economy, its society and its future development. Our major source of energy today is oil and it is no longer a question of "if" we will run out of oil, but "when". So in order to avoid the prognosis and the consequences of the Club of Rome forecasts, terrestrial solutions to the above situation can be generalized in the following three options:

1. Reduce world population to 1.5 - 2 billion people. The ethical question is "how".
2. Turn off our economy, reduce our standard of living and let nature take its course.
3. Discover a new source of energy and invent new technologies that will solve the problem.

The first two options are not very optimistic scenarios for the 8-12 billion people that we will see in the next twenty to fifty years. The last option is what most people are hoping for - our faith is always in ourselves and in our resourcefulness. Yet, every form of terrestrial energy production known to us today is either hopelessly inefficient or poses a serious danger to the environment. None can sustain a population of 8 billion or more humans with a standard of living that most people in the industrialized nations are used to - and those who are not - aspire to.

As the twenty-first century begins, humanity finds that it needs more room and more resources to sustain its numbers and to maintain its thirst for development. The resources that contributed to its present state are being irrevocably exhausted to unsustainable levels and their uncontrolled use within the biosphere is resulting in severe ecological consequences. What is needed is a bigger, richer planet, one with more room and more resources for all those creative and busy brothers and sisters we will be meeting in the years ahead. While this idea may sound a bit far-fetched and unrealistic, it is indeed what I want to offer you in the remainder of this presentation. As it has done

throughout its history, to meet the needs and the challenges of the future in a humane way, it is time for humanity to change its perception of its planet once again.

3.0 Welcome to *Greater Earth*

In the mid twentieth century humans began to investigate ways to penetrate the atmosphere. Today a communications apparatus installed beyond the atmosphere permits us to remain in constant touch with each other from any place on the planet. Orbital outposts are providing the information to enable human beings to adapt to this new environment. Scientific instruments placed in this area are exploring the depths of the cosmos and investigating the state of the environment below. In a short time these activities have effectively expanded the territory of planet Earth from its solid dimensions of 12,756 kilometers to a diameter of more than 85,000 kilometers. This distance represents the orbital ring of geosynchronous satellites.

All celestial bodies of significant concentrated mass exert a field of gravity around their cores which extends to a point where the competing forces of gravity are neutralized. Earth's gravitational field extends 1,495,000 kilometers from its center where it meets the gravitational influence of the Sun. This sphere has 13 million times the volume of the physical Earth and through it, passes some 30,000 times the amount of solar power which is available on the surface. Within this sphere of 3 million kilometers are enormous amounts of other resources, including the Moon and occasional passing asteroids. Like the territorial waters surrounding nations - these resources belong to our planet and should be used for the ultimate benefit of all Life which has originated there. (Woods & Bernasconi, 1995)

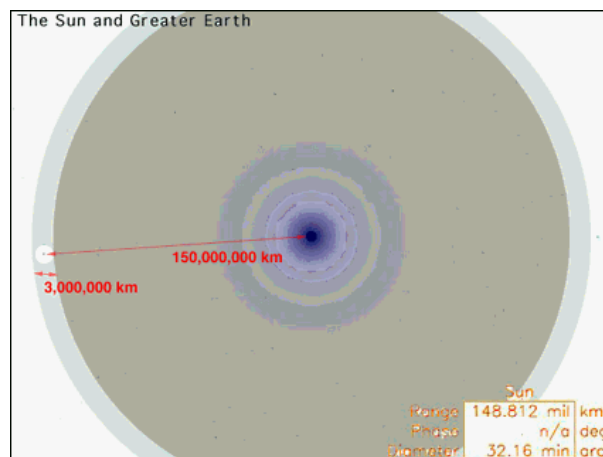


Figure 5. *Gravitational Influence of the Sun and Earth*

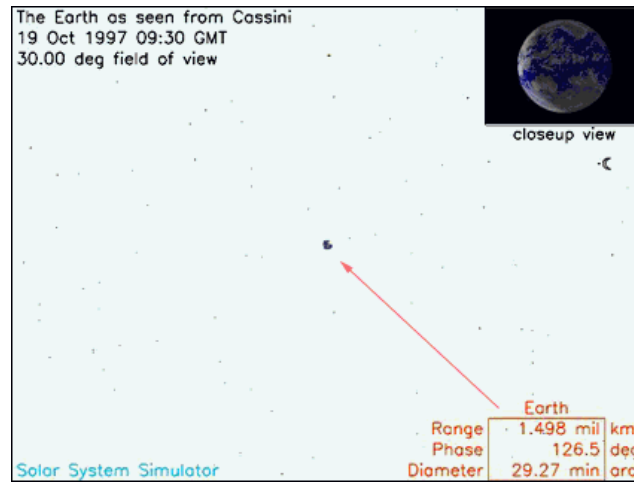


Figure 6. View of Greater Earth from its Perimeter.

The chart (Figure 5) describes the relation of the gravitational spheres of influence between the Earth and the Sun. The one below it, (Figure 6) is a view of the planet as seen from the edge of *Greater Earth*. Here, Earth would appear to one's field of vision to be about as large as the Moon appears in our night sky.

4.0 The Resources of *Greater Earth*

Here is a brief overview of some of the resources that we can expect to find in *Greater Earth*. First and foremost, is an inexhaustible supply of clean solar energy. Basically stated, this energy can be captured by photovoltaics, converted into electricity and beamed via microwaves to the receiving antennas located in unpopulated areas on the surface of Earth. A Solar Power Station could be located in orbit like this Japanese concept called SPS 2000 (Figure 7).

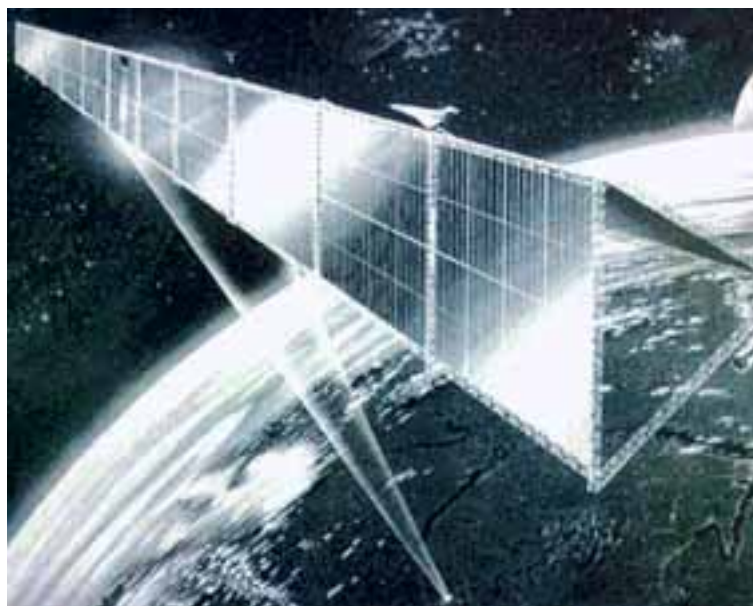


Figure 7. SPS 2000

More practical and economical may be to build them on the Moon itself as pictured in the illustration of David Criswell's Lunar Power System seen below (Figure 8).

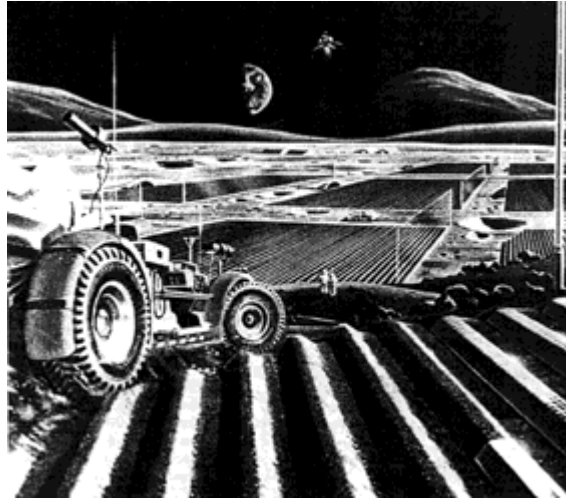


Figure 8. Lunar Power System

In either case, an unlimited supply of clean solar energy could meet humanity's growing energy requirements in the years ahead. Not only would we have enough electricity to power our industries, but we would have the necessary energy to break water down into its hydrogen and oxygen components and to use the hydrogen as fuel for our cars, trucks and tractors insuring personal mobility and farming.

With a plentiful source of energy located outside of the atmosphere we may then consider placing our most polluting terrestrial industries outside of the biosphere making our terrestrial home a more pleasant place to live and raise our children. For this to happen we would need a good source of raw materials. The next chart (Figure 9) shows the composition of lunar soil and the materials located there. The recent discovery of water on the Moon adds to these significantly as this could supply a colony of 2000 people with enough water to last through the next century - a considerable savings if we had to transport this water from the Earth to Moon.

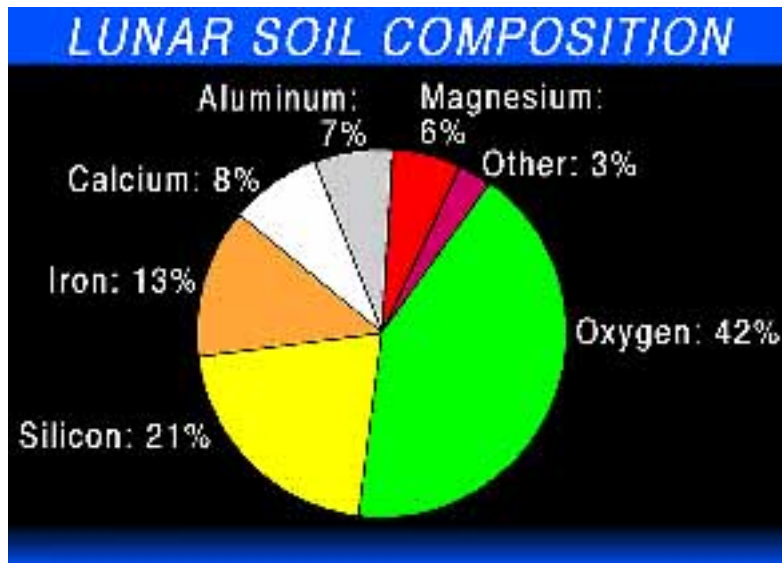


Figure 9. Composition of Lunar Soil

We would expect new industries to flourish as the economies of *Greater Earth* catch on. The idea of harvesting Helium 3, which is plentiful in lunar soil to be used in nuclear fusion reactors back on Earth has been proposed. Tourism would be another economic

development of an expanded human presence beyond the atmosphere of the home planet. For this to happen we will have to have reliable reusable launchers and spacecraft, which will permit travel throughout the new territories of *Greater Earth* with the regularity of today's airline traffic. (Figure 10) shows a Lunar Oxygen factory also necessary to support human and industrial operations on the Moon as well as rocket fuel for other activities. As the economy develops further humanity may be attracted to inhabiting the new territory of *Greater Earth* by building gravitationally stabilized orbiting hotels or communities. The one pictured in (Figure 11) is self-supporting with vegetable gardens and fish farms. As these new industries and economies mature, the products, technologies, resources, skills and knowledge obtained would be used to keep our terrestrial Earth a pleasant and healthy place to live and play.

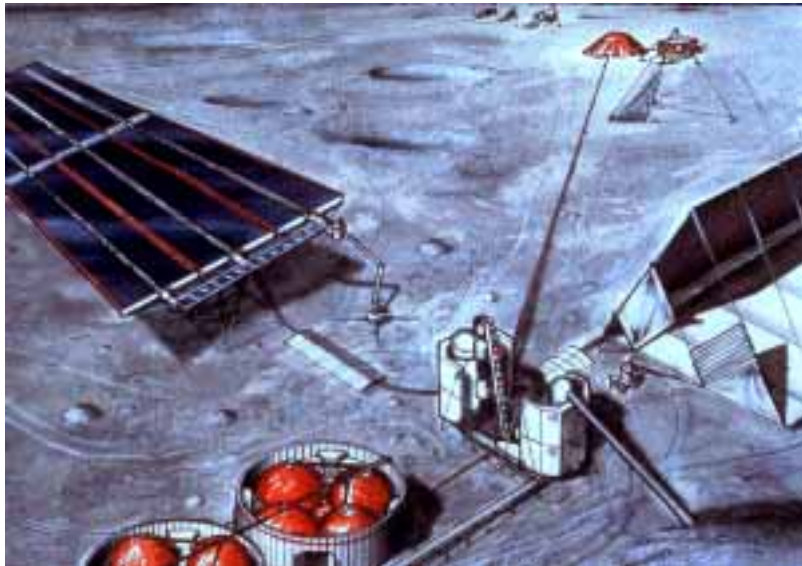


Figure 10. Lunar Oxygen Plant

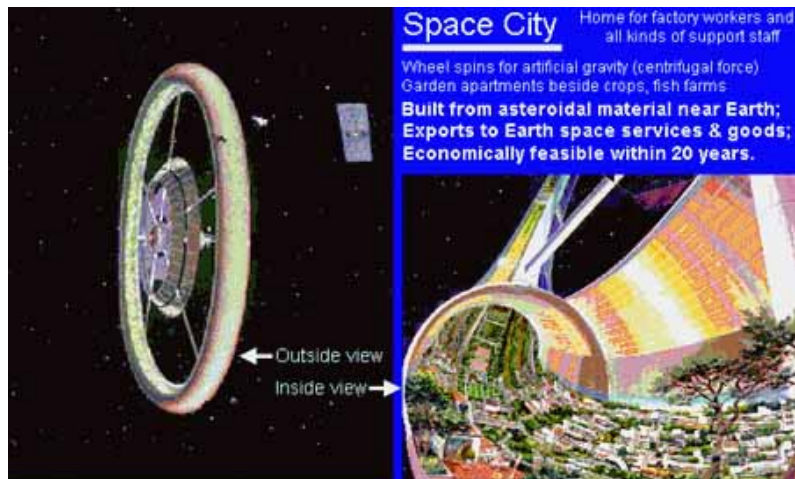


Figure 11. Orbital City

Recently, astronomer Jim Scotti was in the news with his discovery of asteroid 1997 XF11 that is headed for the vicinity of Earth in the year 2028. His first calculations indicated that this 1.6 kilometer wide rock would pass the Earth somewhat less than the distance of the Moon. Although more data and a recalculation show that this distance will now be more than 600,000 miles, this scare has made humanity more sensitive to the vulnerability of its planet to the ecology of the cosmos. Not long ago we witnessed the comet Shoemaker -Levy leave scars on Jupiter that were larger than the Earth itself. By

developing an infrastructure in the territory of *Greater Earth* we can turn a cosmic catastrophe as portrayed by artist Don Davis (*Figure 12*) into a commercial opportunity as illustrated by the painting by David Hardy (*Figure 13*).



Figure 12. Comet Impact - Painting by Don Davis



Figure 13. Asteroid Habitat. Painting by David Hardy

6.0 Conclusions

This has been just a brief introduction to *Greater Earth*. The advantages of adopting this new perspective of our planet are substantial. They include:

1. Access to vital resources necessary to meet the growing needs of humanity, especially a source of unlimited clean solar energy.
2. A heat and pollution sink for moving industries outside of the biosphere.

3. Creating an infrastructure beyond the atmosphere may help provide a defense from possible impacts by asteroids and comets
4. A new territory for human endeavors leading to new knowledge, skills and technology.
5. The possibility to create an optimistic and prosperous future for future generations.
6. Developing *Greater Earth* opens the door to the Solar System exploration and development.

As human creativity and diversity multiply new ideas and even new cultures may emerge as they did in other older, frontiers. To survive and to prosper in the new millennium the next step for our species is to exercise its fullest capabilities to occupy and enjoy this new territory that is part of its cosmic home. By doing so wisely, it may survive and thrive and go on to other places and adventures. *Greater Earth* is the gateway to the Solar System.

7.0 References and Figures

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