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Diversity

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The following article is a philosophical quest for diversity, and a technological venture into uncharted waters of environmental thought.

Diversity Is Not Merely The Spice Of Life; It Is Its Essence

Why are we so passionate about biodiversity? Are we obsessed with making money on drugs and foods derived from exotic species? Of course not. Does our survival depend on the survival of the endangered species? Maybe. What about natural beauty? Some species are indeed beautiful, but others are not. Parasitic species are essential components of biodiversity, and yet most of them have no economic or aesthetic value.

Apparently, our passion is rooted in an instinct that reveres biodiversity regardless of material gain. This instinct extends to other forms of diversity as well. We would have little appreciation for great works of art, colorful nebulae, or dramatic cloud formations, if they were devoid of diversity. Is our reverence for diversity irrational? Not at all. One might argue that diversity is a virtue in its own right. Such an argument is in the realm of normative ethics, which attempts to define rational principles of ethics. Unfortunately, normative ethics has not made much progress in the past 2000 years. It has produced principles of ethics that are subjective expressions of emotion rather than laws of science. In order to evaluate diversity we must devise a new, rational ethic. This new ethic cannot be universal unless it applies to all forms of life, and it cannot be scientific unless it is based on the laws of nature.

Although nature has a unifying purpose, it does not favor any particular size, shape, relationship, or any other attribute. In fact, the opposite is true. Since the Big Bang, the steady proliferation of diversity has been the only long-term trend. It predominates in natural ecosystems, and in human communities. It sounds radical, but I believe that it is fair to say that: Proliferation of diversity is the sole purpose of the universe.

I refer to the above statement as “the principle of diversity.” Its longevity suggests that it is not going to expire soon. Moreover, if the purpose of the universe does change, and if the change spreads with the speed of light, it will take several billion years before the principle of diversity becomes completely invalid.

Diversity is a matter of survival and prosperity. For example, genetic diversity enhances resistance to disease and adaptability to a changing environment. Human communities behave in a similar manner; diversity benefits science and the economy. In the absence of diversity, the universe would become an infinite

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expanse of uniform space, indiscernible from a perfect vacuum.

We cannot preserve diversity unless we know what it is, and how to measure it. Webster's dictionary defines diversity as "the condition of being different or having differences." The definition seems accurate, but it does not provide a good yardstick with which to measure diversity. It is more convenient to define diversity as a complexity of systems. The volume of data necessary to describe a system can be used as a quantitative measure of complexity and diversity. Diversity does not imply that all components of the system are complex; it only implies that the system itself is complex. Diversity has nothing to do with randomness. Randomness can be described by a simple mathematical formula, and therefore lacks complexity which is the foundation of true diversity.

The Principle Of Diversity Is The Universal Principle Of Ethics

Normative ethics defines ethical actions as those which are good or desirable. We can argue what is good and desirable, but we cannot argue the fact that suppression of diversity reduces our field of options and stifles the breadth of our knowledge. Having few options and little knowledge, we cannot choose the most ethical actions.

The principle of diversity calls for proliferation of diversity in all its forms, including seemingly unwelcome phenomena like parasites and mental disorders. Contrary to popular belief, these phenomena are harmful to us only when they proliferate to the point of weakening diversity. Parasites often evolve into beneficial symbionts, e.g. bacterium Escherichia coli. Mental disorders provide scientists with invaluable information about the human brain. In general, a little bit of horror is a bitter but effective medicine against a cataclysmic horror.

In my opinion, the subjective ideas of justice and compassion belong to ethics for one reason only: they are a glue that holds people together. Without the glue, human communities cannot exist, and cannot produce uniquely human contributions to diversity: science, technology, and art.

Let Us Expand Terrestrial Diversity To The Far Reaches Of The Solar System

Biodiversity is threatened by the environmental crisis and by the human population explosion. The Earth is already too small to provide a protein-rich diet for the present human population. Wars, plagues, and family planning may slow down the population growth, but they are unlikely to reduce it to a sustainable level. We cannot stem the onslaught of starving throngs upon habitats of endangered animal and plant species unless we discover another habitat that can

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accommodate the ever- multiplying human population. The rest of this article describes such a habitat - it is the vacuum of the outer space.

An interesting analogy exists between colonization of land and colonization of outer space. Why did aquatic organisms colonize land? Despite the vagaries of weather, land offered generous rewards to the colonists: it stimulated biological evolution, and made technological evolution possible. Outer space offers even greater challenges and greater rewards; without protective gear we feel like fish out of water, but our technology is very efficient in this environment. The combination of a vacuum, cheap solar energy, and weightlessness makes it exceedingly easy to purify, melt, shape, and move objects of arbitrary size. These technological advantages make it feasible to construct large orbital greenhouses sustaining diverse terrestrial ecosystems, as well as nonterrestrial ecosystems, such as a low-gravity rainforest awash in perpetual sunlight.

Faced with the conflict between our technological civilization and nature, some environmentalists have become misanthropes and Luddites. This attitude is understandable, but irrational. Neither we, nor even the primeval Homo erectus could have survived without technology. Our technological civilization has the appearance of a planetary disease not because it is intrinsically evil, but because it is out of place. When practiced on Earth, technology is inefficient and toxic. When practiced in outer space, it is productive and clean because any material, even waste, can be easily processed into useful products. With the help of space technology we can expand terrestrial diversity to the farthest reaches of the solar system, and thereby protect it from natural and man-made disasters. Last, but not least, we can produce great diversity of extraterrestrial species, ecosystems, and human communities.

Space colonization is an important environmental issue, and it deserves as much attention as the environmental aspects of biology, chemistry, or ethics. There is no reason to be intimidated by the technology of space colonization. Anyone who studied physics in college can comprehend this nascent technology, and can contribute to it.

The major hurdle on the path to space colonization is the lack of a safe and economical means of transportation from the Earth to a low Earth orbit. One does not have to be a rocket scientist to realize that chemical rockets are too dangerous and too expensive for the task. Air-breathing scramjet engines may reduce the cost, but they are not economical at high velocities.

The Way To Heavens For The Rest Of Us

I have conceived an invention that may solve the transportation problem. I call it the orbital loop. The invention is illustrated in Figure 1. It consists of a supersonic plane, and an endless, steel pipe that has been launched into an

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elliptic orbit around the Earth. The plane carries cargo from the Earth to a low Earth orbit. A turboramjet engine propels the plane during flight through the atmosphere and accelerates it to about 2 kilometers per second. After leaving the atmosphere, the plane rides on the pipe. The plane is fitted with a long sleeve that envelops a short segment of the pipe. Inert gas is continuously released into the clearance between the pipe and the sleeve. The gas prevents collision between the pipe and the sleeve, and generates drag that transfers momentum from the pipe to the plane. When the plane attains orbital velocity, it drops off, and is carried to its final destination by a variety of economical, low-thrust propulsion techniques.

As the pipe follows its elliptic orbit, its velocity and tension undergo periodic changes, not unlike those of a pendulum or a swing. These periodic changes make it possible to restore the pipe's momentum without the use of propellants. The pipe is filled with an inert gas and periodically heated with sunlight. The periodic changes of gas temperature are synchronized with the orbital movement of the pipe. When the gas heats up, it expands, and exerts a periodic force on the pipe, much like a child riding in a swing.

The steel loop described above is inexpensive and reliable, but it has a limited ability to restore lost momentum: it can carry its own mass into space in about a year. A loop consisting of carbon fiber tethers and solar-powered winches is more attractive in this respect; it can carry its own mass into space in a month. A combination of exceptional strength and high speed of sound enables the carbon loop to transport heavier payloads than the steel loop of the same mass. The first orbital loop will be an extremely light- weight carbon loop. It will carry tethers, winches, and other loop components into space. The new components will then be integrated into the existing loop thereby increasing its capacity to carry cargo into space. Finally, for the sake of reliability and economy, the carbon loop will be replaced by the steel loop.

How To Prosper In Outer Space

Raw materials are plentiful in outer space. They can be easily mined from comets, asteroids, and small satellites. Trojan asteroids are particularly attractive as a source of raw materials, because they are relatively close to the Earth, and yet, as far as we know, have enough volatiles (mostly ices of water, ammonia, and carbon dioxide) to satisfy the needs of space colonies. Some asteroids abound with heavy metals, including gold, and so may trigger an "asteroid gold rush."

The asteroids are broken into smaller pieces which are carried by large cargo vehicles to distant space colonies. The most economical method of propulsion is a combination of solar-thermal propulsion, gravity assist, and aerobreaking. The solar- thermal propulsion is a fancy name for a boiler heated with sunlight.

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Thrust is produced by a steam spewing from the boiler. When the cargo vehicle flies near a planet, its course is altered by gravity, and by drag against the atmosphere. These phenomena are respectively known as gravity assist and aerobreaking. Both phenomena can save the valuable volatiles which are consumed by the solar-thermal propulsion. With the help of the enormous gravity of Jupiter, it is fairly easy to accelerate the cargo vehicles to 10 kilometers per second or so, which corresponds to a one-way trip to the Earth lasting about 1 decade.

What shall we do with the cargo vehicle when it arrives close to the Earth? One possibility is to slow it down, park it in an Earth orbit, and build human colonies from its cargo. This idea makes sense as long as the colonies are limited to a small human population. Unfortunately, there is not enough room in the vicinity of the Earth to house its present population; the colonies would shade both each other and the Earth from sunlight. Another problem is that it is difficult to slow down the massive cargo vehicles. Aerobraking in the Earth's atmosphere is out of the question; one miscalculation could result in a disaster comparable to that of the Tunguska meteor. Aerobraking in the dense atmosphere of Venus is feasible, but requires time-consuming maneuvers. And slowing down the cargo vehicles by drag against a long rail constructed on the Moon is quick, but expensive.

It seems that the best location for the space colonies are the eccentric orbits of the cargo vehicles. The orbits provide easy, though infrequent (once every 12 years) access to the Earth and to the Trojan asteroids. When a cargo vehicle flies by the Earth, it drops off tourists and picks up colonists. The colonists convert the cargo vehicle into a permanent, greenhouse-like settlement, an example of which is depicted in Figure 2. If the greenhouse is large enough, and if it has significant thermal gradients, natural patterns of wind and rain will develop, thus eliminating the need for fans and sprinklers to mimic terrestrial weather. In my opinion, it is feasible to move the entire human population into the orbital greenhouses within 50 years.

The raw materials have to be separated into simple chemical components before they can be converted into the greenhouses. A device depicted in Figure 3 can accomplish most of the separation. The device comprises a solar-heated furnace that vaporizes the raw materials. The vapors are carried by gaseous helium to cool collector bins where they precipitate into powder. During processing, the temperature of the furnace is raised gradually. Because different elements vaporize at different temperatures, they can be collected in different bins.

Iron, a common component of the asteroids, can be processed into steel, which is well suited for structural design. Large walls (e.g. greenhouse shells) can be fabricated from the steel by an economical, continuous process depicted in Figure 4 .

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Space Manifesto

Defenders of nature, and defenders of industry, unite in outer space. Become cosmic nomads, the hunters of comets and gatherers of asteroids. Spin cocoons of steel for your new forests and seas. And when you visit the Earth, step lightly, lest you destroy its fragile beauty.

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