

MILLENNIUM CHALLENGES FOR LIVING AND WORKING IN SPACE¹

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ABSTRACT

With the approach of a new millennium, activities in outer space should be placed in the service of humanity. Starting in the 21st Century, a space policy regarding off-world development should be valued for their contribution toward improving the quality of life on this planet, as well as in the entire Solar System.

To this end, humankind needs to articulate a new *global vision and ethos* relative to our joint efforts in outer space. As we extend our species into the universe, humanity needs to integrate its visions and philosophies regarding orbital enterprises. Today, the majority of the world's inhabitants are terrestrially oriented, and do not perceive space, its exploration, utilization, and *settlement* as central to our wellbeing and continuing evolution.

For the first time in human history, we have the opportunity to plan the establishment of *space culture*. We can begin to make choices relative to the kind of societies we wish to create as spacefaring civilizations. As human habitations are constructed on this high frontier, from space stations to planetary

bases, enlightened thought should also be directed to matters of *space governance*. United Nations space treaties enshrine space as the *common heritage of humankind*, and that spacefarers are our *envoys*. Before the migration aloft escalates beyond elite astronauts and cosmonauts, their sponsors need to agree on the groundrules, be it strategies, guidelines, laws or understandings to ensure that space exploration and resource utilization will be accomplished for the benefit of the Earth and its peoples. Contributors to Space Policy may clarify such issues, and provide leadership in this *mission* for tomorrow!

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SPACE VISION AND ETHOSⁱⁱ

Since the first time our ancestors climbed down from trees and walked upright, the human species has always explored and probed new frontiers - it is part of our nature. We have migrated around our planet and under its waters, but after three million years as *terrestrial beings*, we have begun to go *offworld* in the last half of the 20th Century! This human enterprise in outer space is manifested both in manned and unmanned spaceflights that extend our minds to the farthest corners of our known universe. For eons, we thought we were earthbound, yet strove through poetry, prose, and film to place the *Man on the Moon*. Finally, on July 21, 1969, we achieved the first human lunar landing.

To paraphrase astronaut Neil Armstrong's words on that occasion, *this second great step for humankind was a giant leap* in our evolution as a species. Now we are forced to strip away our blinders and binders for we are not earthbound and we can fly to the stars! This means we have to change our collective self-image to create a new identity and ethos for humanity - maybe our real home is out there, not just on *Spaceship Earth*! Dictionaries define the term, *vision*, as unusual foresight; using the imagination in creation of a future scenario or mental image. Some of the most stirring visions of our future aloft have come from visuals, thanks to photographs and television produced by astronauts, astronomers, and astronomical artists.¹ In our space context, a visionary is one who moves beyond the here and now to envision humanity's future aloft.

ⁱⁱ This paper is based, in part, upon P. R. Harris' Living and Working in Space published in 1996 by Wiley-Praxis, Chichester, England.

At the end of the 19th Century, one such person was the pioneering Russian space philosopher, Konstantin Tsiolkovsky, who observed about the Earth:

*The planet is the cradle of intelligence, but it is impossible to live forever in the cradle.*²

As we enter a third millennium, the challenge before humanity was well stated by another visionary, the late U.S. Senator from Hawaii when he wrote:³

At a certain point, anything less than international exploration of the cosmos from our tiny planet will cease to make any sense at all...we must develop policies that respond to the unfolding realities of the Space Age, that move us out to meet it on its own uniquely promising terms. Without such policies, earthbound civilization can only wind up recoiling upon itself.

Both before and since the Russians launched the first orbiting satellite, *Sputnik 1* (October 4, 1957), various leaders, space agencies, and organizations have attempted to set forth their visions and goals for the exploration, settlement and industrialization of the high or so-called final frontier. One such significant statement came from the National Commission on Space through its farsighted report, Pioneering the Space Frontier⁴. Established under U.S Presidential authority, The Commission offered a fifty-year forecast for the space program. Although many of its recommendations have yet to be implemented, they centered on this vision to:

- advance understanding of our Earth, its solar system, and the universe....
- explore, prospect, and settle the inner solar system....
- open up the vast resources of space frontier to supplement the limitation of our own planet.

Among individual visionaries, an eloquent, comprehensive expression of our future in a microgravity environment came from Krafft A. Ehrlicke, a German-born rocket pioneer. Unique to this remarkable scientist was his understanding of the philosophical and anthropological underpinnings in human exploration of the solar system - he saw the traveling to other celestial bodies as a reflection of the highest degree of independence and agility of the human mind.⁵ Ehrlicke envisioned man as unique because of our ability to reason and solve problems. He saw space development as an absolute necessity for our species to reach its potential. Naming this the *extraterrestrial imperative*, he believed that space travel was a universal activity for us which transcended nationalities, and went beyond historical or ethnological origins. His three philosophical premises, based on the natural laws of this universe, were:

- nobody and nothing impose any limitations upon Man except ourselves....
- the Earth, as well as the entire solar system and the universe we can reach, are Man's rightful field of activity....
- by expanding through the universe, Man fulfills our destiny as an element of life.

Ehrlicke thought that space development would enable humankind to transform and improve the reality of our existence - it was a means to overcome extreme poverty, mass starvation, as well as disasters which were geopolitical or ecological in origin.

Our rationale for human emergence in outer space requires an *ethos*, as well as *vision*. Ethos is defined as the fundamental character or spirit that defines a culture. It is the underlying sentiment that informs the beliefs, customs, and practices of a society. A *global space ethos* has yet to be

articulated, so as to dominate the citizenry's assumptions, values, and dispositions. For most of the world's inhabitants do not perceive space, its exploration and utilization, as central to our wellbeing. The media has created a certain amount of mass interest in spacefaring, though the majority are still terrestrially oriented. Humanity have not fully grasped the deep significance of migrating aloft, and its importance for this planet and its peoples.

Space Ethos Prototypes

In four regions of this world, peoples unconsciously struggle to formulate and express their space ethos:

- In **North America**, a very proactive people innovate with a space program that is mission-centered, technically sophisticated, underfunded, and controlled by the public sector. Yet private space enterprise and investment are growing and increasingly will dominate these endeavors. After the Apollo missions ended, the National Aeronautics and Space Administration (NASA), as well as other government entities and reports within both the United States and Canada, have come forth with bold initiatives and pragmatic strategies to further space development. However, few have actually been translated into national policy and commitment. At this writing, beyond building an International Space Station, there is still great uncertainty as to which direction to move, whether in manned or unmanned missions, to the Moon or Mars. Were a space vision and ethos to be cultivated in the nations' schools, colleges, universities, businesses and media, then doable strategic plans would be formulated that would gain citizen and investor support. Yet over the last half century, American enterprise has extended human intelligence

throughout the cosmos - to eight planets in the Solar System, to numerous low orbiting flights, and to placing twelve astronauts on the Moon. However, the U.S. space program originally began in response to challenges initially from Nazi Germany, and later from the former Soviet Union.

Perhaps the best expressions of the American space ethos has come from television and film producers, such as Stanley Kubrick, Gene Rodenberry, George Lucas, Stephen Spielberg, and Tom Hanks.

One manifestation of a national ethos is the amount of money invested in space development. Today, America's taxpayers invest more in space undertakings than the rest of the world put together - almost \$15 billion annually, but less than was spent in 1966! Some Presidents have exercised national leadership in space endeavors, while others have cut back space funding. Although a national debate or expression of an American space ethos has yet to be articulated, the National Commission on Space report (1986) came close to stating it for that country:

As we move outward into the Solar System, we must remain true to our American values - to go forward peacefully and to respect the integrity of the planetary bodies and alien life forms, with equality of opportunity for all.

Within Canada a space ethos has risen gradually since the country first launched the *Alouette 1* satellite in 1962. It is most evident in a growing space community with their publications and conferences, as well as in increased allocation of the national budget to space efforts. After success with *Canadarm* and Canadian astronauts on the space shuttle of NASA, as well as joint ventures with the European Space Agency, the country's space

budget is estimated to be \$2.4 billion (Canadian dollars) by year 2000.

- In **Russia** and the former states of the Soviet Union, a turning point in their advanced space program took place with the implosion and collapse of the U.S.S.R. as a political entity in International Space Year (1992).⁶ Formerly, their space ethos replaced religion in the life of the people - their cosmonauts, such as Gagarin the first human in space and Leonov the first person to walk in space, were revered like demigods. The public adulation of Soviet spacefarers can be seen in the giant paintings and busts, parks and museums, cosmodromes and space city. But in the chaotic, crises-ridden Russian Federation of today their space program is underfunded (1.17 trillion rubles, approximately \$270 million), barely enough to keep the *Mir* station aloft. The cosmonauts are no longer of mythical proportions as people struggle to survive. The Russians have always favored international participation in their space ventures, and currently are key partners in the International Space Station. One of their media reports emphasized that their country is and will be a space power, for *breath-taking ambitions are necessary to reach the spiritual heights of the Russian spirit.*

Despite the setbacks and the present social transitions, the Russians still are leaders in excellent space science and engineering, as well as philosophical understanding of *cosmonautics* and its implications for humanity's future. Russians have been articulating an inspirational space ethos for over a 140 years! One of the earliest expression came from Nicholai Federov, a 19th Century philosopher-librarian.. In his thinking everything in the universe was alive with some degree of consciousness.⁷

- Since human beings had the highest state of *consciousness*, their special role is to give design and purpose into the chaotic workings of the natural world.
- Mankind needs *space* for material and spiritual development - we have a moral obligation to immortalize life and to settle on other planets in the solar system. Federov was the mentor who influenced the thinking of Tsiolkovsky, the father of space travel, particularly with reference space colonization. Tsiolkovsky, gave cosmic meaning to human space endeavors, including the *why* of inhabiting the solar system, as well as the *how* in terms of space science and engineering. In 1935, just before his death, he remarked: *The biggest step in the history of mankind will be to leave the atmosphere of Earth to join the other planets!*

In such a tradition, deeply rooted in the country's culture, *Russian cosmism* has emerged as a space philosophy. A combination of natural philosophy, religion, and ethics, it has been described by Vladimir Lytkin, Scientific Director of the State Tsiolkovsky Museum of the History of Cosmonautics in Kaluga, Russia:

Russian cosmism deals with the history and philosophy of the origin, evolution, and future existence of the universe and humankind .

Konstantin Tsiolkovsky envisioned the universe as a single substance with the same structure, governed by the same laws. He wrote that by studying our solar system, we study the entire universe! He speculated that a cosmic force governs the universe which we may think of as God or an extremely high level of an extraterrestrial space civilization.

For him, higher levels of human civilizations possess the technology for interplanetary and

interstellar travel. Human evolution is advanced by living in free space to the point when a new species will emerge, *Homo Cosmicus*, that is spacefaring man described by others as *Homo Spatiales* or spacekind. This philosopher-aeronautical engineer saw spaceflight and spacecrafts as the first steps in human history toward creation of a *Star Culture* era.

- In western **Europe**, a space ethos has been developing within the multicultural, multinational European Space Agency (ESA). But the first dreamers of space travel came from that continent - from inventive artists like Michelangelo and Chesley Bonestell, to farsighted writers like Jules Verne and Arthur Clarke, to scientists and engineers like Herman Oberth, Werner von Braun, and Krafft Ehrlicke. Under French and German leadership, ESA has developed complex launch systems, satellites, and research programs in long-duration mission isolation, as well as plans for lunar science studies. Within the growing European Union, ESA coordinates the space efforts of some sixteen nations on an annual budget of \$3.4 billion, while cooperating on joint ventures with both NASA and the Russian Space Agency (RKA).

Some indications of the emerging European ethos is evident in a recent ESA report on The European Moon Programme (ESA/SPC 94-43, Annex 1): *At the turn of the second millennium, our planet is at a major turning point....The need for large and global [space] programmes is necessary for global economic development...serving mankind, offering a mirror with which to survey the home planet, while exploring further the limits of habitability and its visibility of the Universe.*

- in **Asia**, there has been an interest in

space travel and communication satellites in many countries of the Middle and Far East. The leadership in space technology and ethos has come from Japan, China, and India, followed by Pakistan, Korea, Taiwan, and Indonesia, and Australia. Their ethos is manifested in the amount of money invested in space programs, the emphasis on international and Pacific Rim cooperation. The major effort comes from Japan which is developing both manned and unmanned systems, sending astronauts to the American shuttle and Russian *Mir* station, and partnering in the International Space Station. While government-sponsored space technology in China has economic and military purposes, Japan is more scientifically and commercially oriented, especially toward lunar settlement and tourism. Through their National Space Development Agency (NASDA) and the Institute of Space and Astronautical Science (ISAS), this country invests annually over \$2 billion in space, the largest such budget in Asia. But their space research involves both the public and private sectors. The degree of regional cooperation is evident in *Arabsat*, a telecommunications satellite financed by 22 countries in West Asia.

Global Space Ethos Conclusions

Humanity, whether in the West or the East senses that our species is in an epochal transitions to space-based living, creating in the process an entirely new space *culture*! A growing microculture of space professionals and activists around the world is beginning to define a *space ethos* for the masses of unaware peoples. The vision of this subculture is exchanged globally through the Internet, books, professional associations and conferences, as well as

through joint space ventures. The collective consciousness of these futurists is well summed up in the following quotation: *Thus we stand in the late 20th Century, on the threshold of extending old civilizations into space, perhaps even creating new ones in which our own sons and daughters may be extra-terrestrials from every point of view.*⁸

SPACE CULTURE AND SETTLEMENT

As *earthkind* expands beyond its gravity well into outer space through automation or in person, our species is formulating a *space culture*, as well as a new person called *spacekind*. Both kinds will be interdependent, so this author maintains that *space is a place for synergy*! Cooperation and collaboration are the watchwords of space development, especially because of the cost and complexity of macroprojects there. The world's space agencies have finally realized this as they undertake the largest and most sophisticated technological enterprise - orbiting and maintaining an International Space Station. Unfortunately, our sociopolitical institutions worldwide have yet to create a global entity for promoting and managing earthkind's endeavors on the high frontier.

Astroculture

Culture is a unique human capacity - a coping ability of *Homo Sapiens* to the environment which facilitates daily living. In this way, we are learning to cope with the challenges of microgravity and surviving offworld. Through this means, we will transmit to future generations, consciously or unconsciously, a space culture. Information and insights of this unique

social environment is created in the form of customs, norms, practices, traditions, and taboos for living and working safely in space.

Culture, whether on this planet or aloft, is communicable knowledge that is both learned and unlearned, overt and covert in practice, which influences all systems, including social and technological. The organizational cultures of ground-based aerospace agencies and corporations influence behavior and actions on the high ground. On Earth, human culture is remarkable for its diversity; now we see the same phenomenon happening aloft in the multinational sponsorship of space missions, and the multicultural composition of spacefaring crews.

For fifty years behavioral scientists have engaged in pre-planning for *astroculture* in their Earth-based studies of human factors in extreme environments, such as Antarctica, underseas, offshore rigs, and other areas of isolated confined environments (ICE).⁹ For over four decades as Space Age began, physicians, psychologists, anthropologists, and sociologists have been studying humans who travel for short durations 100 km or more into orbit.¹⁰ The latter research has confirmed that humans can perform well in a zero or microgravity environment.¹¹ However, certain precautions and training are necessary if risks are to be manageable. The space environment does affect both the physiological and psychological aspects of a person.

The real challenge in creating space culture will occur with long-duration spaceflights and settlement on planets like our Moon and Mars. To prepare for such, one may take a systems approach to analyzing space culture. Exhibit 1 illustrates another way of studying

astroculture. It offers a paradigm based on ten categories of culture. In other words, space *changes* or alters our sense of self, ways of communicating, dress/appearance, food/ feeding habits, time consciousness, interpersonal relationships, values/ norms, beliefs/customs/traditions, mental processes/ learning, work habits/process, and other dimensions of human behavior. We can use this model to prepare spacefarers to study their culture aloft, and be amenable to creating one that is appropriate for spacekind. We can also use it to analyze the cultures of sponsoring organizations on Earth - their cultures can aid or abet the success of their fellow humans in orbit. Culture is a powerful concept that influences the future of space programs and development. We should be doing advance planning now on 21st Century space communities and their desired cultures.

More than a decade ago the National Academy recommended:¹²

The overall goal for the study of human behavior in space is the development of empirically based scientific principles that can identify environmental, individual, group and organizational requirements for long-term occupancy of space by humans.

Fortunately, many scholars, whether in universities, space agencies, or corporations have inaugurated such investigations. Not only is there a Universities Space Research Association, but institutions of higher education are now offering courses in many aspects of space living. Dr. Edward Cheston pointed up a new arena of study in the social sciences called *spaceology*:¹³

Spaceology is that branch of knowledge that treats the origin, development and varieties of interaction between human culture and the extraterrestrial environment. Spaceology would draw upon the humanities, social

sciences, and natural sciences with equal facility.

It is already evident that the exploration and colonization of space requires interdisciplinary efforts. Most careers and professions will have a place in orbit, but are likely to be altered in practice. We already see this in the field of *astrophysics*, but expect the emergence of *astrolaw*, *astrobusiness*, *astroeducation*, *astroengineering*, *astroanthropologists*, et al.

Space Colonization

Although the human species required over three and a half billion years to evolve, only in the past half century have we begun to explore and penetrate the planetary system. Psychologists and anthropologists have mused on our *exploratory nature* which propels us to beyond our *homeworld*.¹⁴ Professor Jordan Peterson suggests that humanity has an *exploration consciousness* that mediates between the unknown or chaotic, and the known or ordered. Professor Ben Finney believes that while interstellar migration may be a revolutionary step for our species, it represents a continuity with our past. He counsels that before establishing bases on the Moon or Mars, serious social prototype studies should focus on groups living effectively together within space stations in lower Earth orbit. Dr. Finney also proposes more ground-based research as analogs and simulations for designing future space communities.

Princeton physicist, Gerard K. O'Neil, wrote that the opening of the high frontier will challenge the best in us, while giving us the opportunity to search for better governments, social systems and ways of life. He projected large-scale, self-sustaining orbiting space colonies with populations in

the thousands.¹⁵ Although O'Neil's research and forecasts were made 20 years ago before his death, it is unlikely his vision will be implemented for another century. In the 20th Century, we have only precursor endeavors to space colonization - *Skylab*, *Mir*, and the *International Space Station* now under construction provide their limited inhabitants with relatively short term orbital experiences (from days to over a year). It will be the 21st Century that will bring the first real space settlements, whether initially on the Moon or Mars. Apart from the technical aspects, Exhibit 2 provides ten arenas in which space policy and planning should now be underway.

A case for investment can be made first for a lunar base. The utilization of the Moon's resources to conceive a two-planet economy would more than justify the building of a lunar base.¹⁶ These resources extend from the mining of Helium 3 to the beaming of solar energy from the Moon or its orbit for the benefit of humanity.¹⁷ The International Academy of Astronautics has had an on-going futures study of the Moon and its potential.¹⁸ Their infrastructure plans for joint ventures in such extraterrestrial enterprises include an Earth-based spaceport, launch and facility services; a lunar spaceport, lunar base authority, lunar support services company; lunar mining and manufacturing company, and lunar laboratories; plus a space utilities group which includes a space solar power system and/or lunar power company.

The most imaginative scenario for lunar development was produced in 1984 by rocket scientist, Krafft Ehrlichke, before his death in LaJolla, California.¹⁹ He envisioned a city on the Moon called *Selenopolis*, named after the Greek goddess, *Selene*.

Ehrlicke then provided a detailed plan in various evolutionary phases for

- *space industrialization* (the capability of productive existence in a new environment);
- *space urbanization* (the capability for establishing large-scale settlements and extraterrestrial civilizations);
- *extraterrestrialization* (a prolonged process of socio-psychological development and anthropological divergence to create a new type of civilization in outer space).

He viewed the Earth-Moon system as interconnected, only 2-3 flight days away from each other. He was convinced that a viable exo-industrial economy could be developed on the Moon utilizing advanced nuclear, cybernetic, and materials processing technologies that eventually would make it possible to export food and other resources to the people of Earth. Ehrlicke maintained that no other celestial body and no orbiting space station can more effectively permit development of habitats, materials extraction, and processing methods. His pragmatic strategy emphasized the need for manageable, maximum investment returns that would attract both venture capital and private funds. Since this was to be a prototype for other planetary settlements, he precisely outlined five stages for gradual, long-term development of a lunar world, capable of housing millions.

There have been many other schemes put forth for space colonization, some by scientists and others by science fiction authors.²⁰ There is growing global consensus that space settlement is to be:

- the principal activity of the New Millennium; a process that will begin in the 21st Century with lunar development and Mars exploration, but extend over centuries....
- international in scope, involving both

the private and public sectors cooperating in the sponsorship of macroprojects....

- market driven so that private enterprise and entrepreneurs will be encouraged to participate....²¹
- technology driven in terms of both lowering the cost of access to space, and in the wide use of both automation and robotics....
- a process of consciousness-raising on the part of both global politicians and the masses of the public as to why and how we must settle and industrialize the space frontier - mass media and space activists have a critical role in this public information effort to create a global space ethos.

Conclusions

As humanity enters the third millennium, those interested in space policy and development should give consideration to the formulation of both a *space vision* and a *space ethos*. In other words, we *toolmakers* have to comprehend *why* we are rocketing into the high frontier and creating a *spacefaring civilization*!

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