Space Options for the 21st Century

Overview and Perspective

Arthur R. Woods, Artist *
spaceOp Sàrl, Switzerland
arthur.woods@spaceop.com

Abstract

This is a transcript of my presentation that gives an overview of the conference topic in the context of some of the major issues facing society in the 21st century including global warming and peak oil. I examine a number of resources that I used in my preparation for the conference and cite a number of examples from these that have relevance to the issues being presented and discussed. In conclusion I state that, of the options available to humanity, it is the *"Space Option"* which offers humanity its most optimistic choice for meeting the challenges of the future and for this to be successful the space community should become a partner with the environmental community.

Introduction

Welcome, as one of the organizers of this conference, I have been asked to give an overview of the topics being discussed at the conference.

As the title "*Space Options for the 21st Century"* implies and the conference website indicates, we will be examining how space activities and technologies can be utilized to address and hopefully help solve some of the many problems that are confronting humanity at this critical moment in its history. As this is the second conference on Space & Society co-sponsored by ESA and the International Academy of Astronautics, the issues we will be discussing are very much societal ones and we will be hearing presentations from not only the scientific and technological fields but from the cultural practitioners active within the space community as well.

The increasingly important role of space technologies in identifying and addressing the issues of our time cannot be overstated. Climate and weather monitoring, disaster mitigation, security, global communications are just a few of the essential space technologies that humanity fortunately has at its disposal. Indeed without these we could be unaware of some the changes that are happening on our planet and their implications to the future of our society. How the space community communicates these assets and builds bridges throughout society is crucial to their success and we are here to learn how this aspect is being perceived and implemented by our colleagues in the cultural fields.

In my presentation I would like to add some perspective on this discussion by looking back to history and to some of the other fields of expertise that, too, are dealing with the issues of our time.

Options = Choices

If we have options then it means we can make choices – selecting the best option from those available. For some added historical perspective, if this conference was being held twenty years ago, it may have been called "*Space Options for the 20th Century*" and we may have seen the flowing images being presented.

On the left you see a photo of the Redstone guided ballistic missile as a mobile ICBM and on the right we see the lift-off of the Mercury-Redstone carrying the Alan Shepard, the first American to the edge of space. These two images are also very personal to me because my father was one of those soldiers working with the mobile Redstone as part of the mobile liquid oxygen team and later, at Cape Canaveral where he worked for Air Products, Inc. and helped to supply the liquid propellants for the Mercury, Gemini and Apollo rockets. Consequently, I had the fortunate experience to watch the beginnings of America's space program from my front yard from our house on Merritt Island, Florida.

At that conference we may have heard a presentation by Frank White the author of the just published "*The Overview Effect*" (1) who may have had had this to say about these two very different applications of the same space technology:

"War and space exploration are alternative uses of the assertive, exploratory energies that are so characteristic of human beings. They may also be mutually exclusive because if one occurs on a massive scale, the other probably will not."

This "space option" from the Cold War era is still on the table today and we should not forget Frank White's words in the 21st century and the current justifications for beginning pre-emptive wars.

Whereas the ***Cold War*** was the defining issue of the 20th century, ***Climate Change*** appears to be the defining issue of the 21st century.

As all of us are aware, in the past few years there has been an increasing amount of scientific publications about the apparent certainty of climate change and global warming. Just a few weeks ago the Intergovernmental Panel on Climate Change (IPCC) published its latest and most comprehensive report (2). There is new data in this latest report and the level of consensus among the panel has been raised to a higher level but the information and the warnings are not really new. They basically substantiate the information from the earlier IPCC reports.

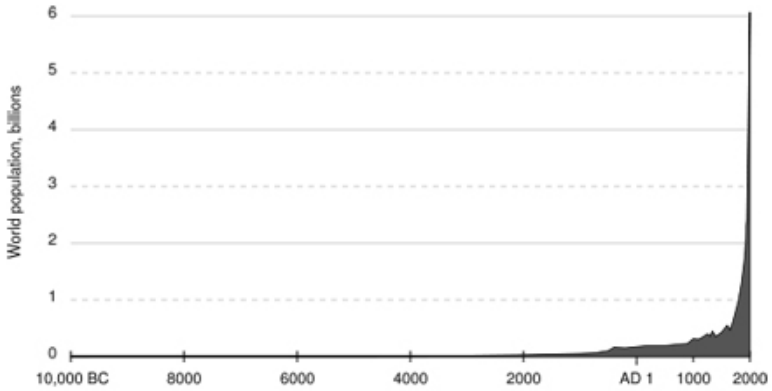
Already in 1995, the IPCC was able to assert that "the balance of evidence suggests" that human activity was increasing the planet's temperature and that this would be a serious problem. The report declared humans had grown so large in numbers and their corresponding demands for energy so high, that they were now damaging the most basic of the earth's systems - the balance between incoming and outgoing solar energy. This was perhaps the most significant warning our species, as a whole, has yet been given.

The 1995 report did stimulate the basis for the Kyoto negotiations and the treaty that was produced and has subsequently led most of the developed world to generate plans for reductions in carbon emissions. However, the world was not yet united behind this issue and, had it immediately heeded the

warnings, the rate of temperature increase this century might be substantially less than the current projections of the latest report. (3)

Al Gore's book and film – "*An Inconvenient Truth*" powerfully and convincingly presents the case for global warming. This film has particular relevance for us gathered here today at ESTEC, as one the animations in the film shows The Netherlands being flooded by the predicted rise in ocean's level. In my own country, Switzerland, the film shows video footage of the melting glaciers and the recent land and mudslides that we have experienced. Indeed, this winter is the warmest winter on record in Switzerland. For those of you who haven't yet seen this film, I suggest you do so at the next opportunity.

The cause of all of this is the burning of fossil fuels and the impact of their emissions on the climate. The flip side of this issue is the topic of *"**Peak Oil**"* (4) which, simply stated, refers to the fact that global oil production has peaked or soon will peak and less oil will be available to meet the growing appetite of the new economies and keep the established industrial economies adequately supplied. The oil that will become available after current production levels drop, will be more difficult and expensive to extract and as a result the price is expected increase substantially. Many believe the current wars in Afghanistan and Iraq are ultimately about Western control of this vital resource. Considering the impact that the burning of fossil fuels is having on the climate and our future, it may be wiser to leave the rest of the oil in the earth.



These two interrelated issues are intimately tied to the increase in world population. The good news is that the rate of global population increase has started to decline in recent years, however, the numbers of new humans has not and under present circumstances even conservative estimates expect world population to reach or exceed 8 billion by 2025 and perhaps 9 billion by mid-century (5). We should be aware that the mothers of the next two billion human beings have already been born.

Perspectives on the Conference Topic

In preparation for this, the second conference on Space & Society, conference chairman David Raitt and I regularly exchanged information about numerous articles available on the Internet and we discussed many recent books and publications. I was particularly interested to understand why and how humanity reached this critical point in its history and what suggestions to deal with the issues and challenges are now being proposed by those working in other areas of society. I was especially interested in what some of the "deep ecologists" and "holistic scientists" had to say and here is a list of just a few of the books and films that I ran across:

On the Topic of Climate and Weather:

"*The Weather Makers – How Man is Changing the Climate and What it Means for Life on Earth*", by Tim Flannery (2005)

"An Inconvenient Truth", by Al Gore, Director Davis Guggenheim, DVD November 21, 2006

On the Topic of Oil Depletion:

"*The Party's Over – Oil, War, and the Fate of Industrial Societies*", by Richard Heinberg (2003)

"*Resource Wars – The New Landscape of Global Conflict*", by Michael T. Klare (2002)

On Society's Prospects for the Future:

"*Collapse – How Societies Choose to Fail or Succeed*", by Jared Diamond (2005)

"Our Final Hour- A Scientist's Warning: How terror, error, and environmental disaster threaten humankind's future in this century – on earth and beyond", by Sir Martin Rees (2003)

"*The Revenge of Gaia – Why the earth is fighting back – and how we can still save humanity*", by James Lovelock (2006)

On Holistic Science and Deep Ecology:

"*The Voice of the Earth – An Exploration of Ecopsychology*", by Theodore Roszak (2001)

"*The Great Work - Our Way Into the Future*", by Thomas Berry (1999)

"*The Spell of the Sensuous*" by David Abram (1996)

"The Web of Life - A New Synthesis of Mind and Matter", by Fritjof Capra, (1997)

"*Animate Earth – Science, Intuition and Gaia*", by Stephan Harding (2006)

On the Role of Space Activities in Meeting the Challenges of the Future:

"*Return to the Moon – Exploration, Enterprise, and Energy in the human Settlement of Space*", by Harrison Schmitt (2006)

"*Return to the Moon*" , edited by Rick Tumlinson with Erin Medlicott (2005)

"*Gaia Selene: Saving the Earth by Colonizing the Moon*" DVD by Charles Proser (2005)

Fiction:
"Running the Line – Stories of the Space Elevator" edited by Bradley Edwards and David Raitt (2006)

"*The Swarm – a Novel of the Deep*" – a 900 page eco-thriller by Frank Schätzing (2004)

Some of these books and the topics they address could become the subject of an entire conference. However I would like to share a few insights of what I learned which may have relevance to theme of the conference.

"Collapse – How Societies Choose to Fail or Succeed"

In *Collapse* **Jared Diamond**, a geologist, examines a number of ancient societies that have died including among others Easter Island, the Mayan culture and the Norse settlements in Greenland. He then turns toward the present and future by examining societal catastrophes such as in Rwanda and looks at modern societies like China and Australia, whose futures may be mortgaged by environmental degradation and/or overpopulation. What particularly struck me about the title was the word ***"choose"*** in the sub title***:*** *– how societies choose to fail of succeed.*

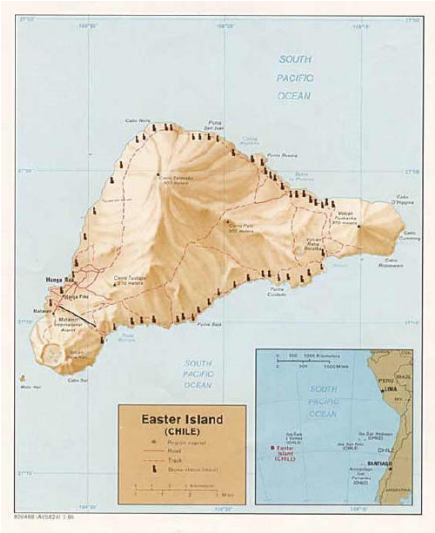
Malcolm Gladwell of the New Yorker Book Review had this to say about *"Collapse"* (6) :

"We live in an era preoccupied with the way that ideology and culture and politics and economics help shape the course of history. But Diamond isn't particularly interested in any of those things—or, at least, he's interested in them only insofar as they bear on what to him is the far more important question, which is a society's relationship to its climate and geography and resources and neighbors.

"Collapse" is a book about the most prosaic elements of the earth's ecosystem—soil, trees, and water—because societies fail, in Diamond's view, when they mismanage those environmental factors. Diamond makes a distinction between social and biological survival because too often we blur the two, or assume that biological survival is contingent on the strength of our civilizational values. The fact is, though, that we can be law-abiding and peace-loving and tolerant and inventive and committed to freedom and true to our own values and still behave in ways that are biologically suicidal."

I believe the mysterious story of Easter Island has particular significance for our conference. Easter Island, an isolated island in the South Pacific, once had an abundant amount of natural resources, it had dozens of species of trees which created and protected an ecosystem fertile enough to support a thriving culture of over 30,000 inhabitants that produced enormous stone statutes. This society was not murdered or wiped-out by invasion, by a pest or another natural catastrophe. Their collapse appears to have been caused primarily by deforestation attributed to political and social causes such as competition among the chiefs to erect larger statues which required a large number of trees. Larger statues gave them a higher rank and over time the Eastern Islanders cut down each and all of their trees one-by-one. They committed suicide.

When Diamond gives this lecture his students ask the obvious question: "How could on earth could such a society make the disastrous decision to cut down all of the trees on which it depended?" Diamond, too, asks himself: "What was the person thinking when he cut down the last tree?" as he points out that the destruction of the trees was made by rational people who must have been aware of the importance of trees to their survival (7, 8).



The fact that Easter Island was also quite isolated in the South Pacific made the possibility of emigration to another locality very difficult. It is located 2000 km from the coast of Chile and 1400 km from the nearest inhabited island to the west. Easter Island was alone in the Pacific Ocean much as the Earth is alone in space.

Today, we have become a global society and our modern societies have developed quite a complex infrastructure to deal with changes in the system - regulate the economy, manage resources, respond to threats to national security, etc. - yet there is also the inherent problem that group dynamics which characterize our decision making processes are not always effective and often fail because of competing interest groups and competing priorities.

The failure of the world community to unite behind the Kyoto protocols when the first warnings were substantiated and, more recently the US government agency FEMA's response to Hurricane Katrina both before and after the storm are recent examples of how such modern systems fail.

Diamond has a lot more to stay about lessons we could learn by examining what happened to these failed societies and says that although we have many more creative people alive today, vast technological resources and stores of information that the ancients didn't have and with these we can possibly invent environmentally friendly technologies as needed to meet our challenges. However, he soberly points out the impact of our powerful technology on the environment – from heavy metal

bulldozers to nuclear power – may actually increase rather than decrease the risks inherent in our global society.

"The Revenge of Gaia –
Why the earth is fighting back – and how we can still save humanity"

I have always been intuitively attracted to **James Lovelock**'s Gaia theory basically because it was stimulated by his work for space –one could say that the Gaia theory is a spin-off of the space program. Lovelock, a scientist and inventor of an apparatus called the **electron capture detector** (ECD) used to detect tiny amounts of chemical compounds in the atmosphere, was invited by NASA in 1960's to help them devise instruments for detecting the presence of life on Mars. Lovelock realized that if life on Mars was bio-chemically or physically different from terrestrial life or, if the probe landed in a region of the planet that happened to be absent of life, such instruments would be ineffective. He then took a holistic approach to the problem and realizing that life on Earth radically alters the atmosphere, he reasoned if we could analyze the atmosphere of Mars it might be a better approach. He was aware that the atmospheres of Mars and Venus are in a state of chemical equilibrium consisting mostly of carbon dioxide and, as such, they were essentially dead, whereas the Earth's atmosphere was far from equilibrium and full of very active chemical processes. To him this was an indication that life existed and we could use approach this to look for life elsewhere.

Even though NASA was quite open to this line of reasoning the funding for his work was cut but Lovelock continued to work on this insight. He discovered that these processes operated in such a way on Earth to regulate the environment by keeping it congenial for life even though the temperature of the Sun had been steadily increasing over millennia. From this he theorized that life on Earth operates like a super-organism that intimately involves a number of coordinated and interconnected processes involving the atmosphere, the earth's crust, the oceans and all of the life forms working together to regulate both the composition of the atmosphere and the temperature in order for Life to exist and thrive on our planet. This integrated self-regulatory feedback system – that he calls ***Gaia*** - has been going on for billions of years as life has evolved.

When his newest book: *"The Revenge of Gaia"* came out last year I was very curious at what he would have to say as the title is very provocative. Lovelock is convinced that the effects of human activities have - *in a very short time* - dramatically upset the regulatory processes in such a way as to be a danger for the viability of life on Earth and now *"Gaia"*, as it always has in the past, is now reacting by taking corrective measures. Like many other scientists he sees the danger of too much CO_2 in the atmosphere and believes humanity must do everything possible to reduce these levels. To the shock of many environmentalists he suggests, in the absence of any other terrestrial alternative, society should immediately turn to a massive deployment of nuclear energy in order to reduce our reliance on fossil fuels in an effort to buy our civilization some needed time to cope with the radically changing climate. He also mentions that the use of sun-shades placed in orbit which could have a positive impact on the situation but he is skeptical that other proposed macro-engineering concepts often referred to as *"Geoengineering"* to regulate the climate with artificial means would ask too much of human capabilities and knowledge. Lovelock says (9):

"….. will humans now be faced with the tedious drudgery of trying to regulate the planet's climate – something that Gaia effectively managed for over three billion of years?"

Could we trust any nation, any international organization or international body to regulate the climate and the atmospheric composition?"

The Environmentalist Perspective

As climate change is impacting all aspects society, in the coming years we can be sure that the environmental groups and their ideas and proposals will have a growing influence on the political and economic policies that will be put into place to deal with this overwhelming issue. For this reason, I think it is important to see what suggestions and prescriptions the prominent thinkers in this field have to say. I would say that every author on the subject of deep ecology would state the following is at the core of our species' current problems:

Humans are out of touch with the rest of nature.

If this is indeed the case, I was curious to find out why, how and when this happened. Like Jared Diamond, a number of the authors representing the deep ecology field looked to the past to try to give us some insight about how we got to this point today. It should be no surprise to state that the human species, which emerged in its modern form several million years ago, has mostly lived in harmony with its environment - with Gaia - like the other terrestrial creatures sharing our planet, for most of its time on the planet. There existed a dialogue with nature encompassing all creatures including humans and all aspects of the environment. Yet, in various locations and at various points of time, even some of these isolated societies mismanaged their local resources and eventually failed. The failure of a localized community, while devastating for the members of that particular community, had very little impact on the larger environment. Today, human activities on a global scale are impacting every aspect of the global environment as no other creature before it has done.

Evolution gave human beings certain traits that enabled us to become what we are today – and we have over time we have developed and refined these traits to exert our dominance and control over the rest of the nature enabling us to use whatever physical resource or other creature for our own benefit and purposes. Most humans believe that this is our right because we are special creatures among all of the rest of life sharing our planet.

As the deep ecologists believe that the human species is no longer in touch with the planet – with the underlying nature which is the source of its own sustenance, it is clear to them that no matter what course of action our species takes in the future, humanity will not be successful unless it appreciates the interconnectedness and interdependence of all life on Earth and somehow get back in synch with the rest of nature. We need to reestablish a dialogue with nature that we seem to have lost over time.

How our species got out of touch with nature in the first place can be traced to a number of developments as described in the following books:

"The Spell of the Sensuous" by David Abram

"Animate Earth – Science, Intuition and Gaia", by Stephan Harding

In their books *"The Spell of the Sensuous" (10)* and *"Animate Earth – Science, Intuition and Gaia"***,** (11) authors Abram and Harding each give us some historical insights into this process. Indeed the first chapter of Harding's book is dedicated to this topic and includes a synopsis of Abram's interest in language.

Harding states that some theorists such as Paul Shepard, put the time at about 5,000 years ago with the widespread use of agriculture in the *Neolithic period* (new stone age*)*. Humankind was fearful of the uncertainties of nature and devised various means to circumvent these threats. This may have been the beginning of a *dualistic attitude* about nature that grew out of the process of protecting the crops and domesticated animals from the surrounding wilderness with its many pests, floods and droughts and other natural misfortunes. Humans became distrustful and afraid of what they could not control.

In his book *"The Spell of the Sensuous"* cultural ecologist David Abram points to the advent of formal writing systems and especially the spread of the *"phonetic alphabet"* which appeared a bit more than two thousand years ago. He refers specifically to the Hebrew writing and to the later Greek alphabet which was an adaptation of the Semitic *"aleph-beth"* which arrived in Greece several centuries before Plato. Pre-alphabetic Greece had a highly developed oral tradition of communication that was passed on to subsequent generations by the *"bards"* or *"rhaposodes"*. These stories constantly changed to match the circumstances and contained all of their cultural knowledge – the bards were walking encyclopedias in their communities. Thus, the alphabet was resisted for quite some because the elites of society were also the reciters and the performers. The alphabet could only take root once it became allied with the oral tradition. Thus the first large written texts to appear in Greece – the *"Illiad"* and the *"Odyssey"* - were paradoxically oral stories that were written down. Once this happened the writing and reading of the spoken word became acceptable and the status of the bards was replaced by that of the "scribes".

With arrival of the written alphabet humans devised a powerful technology to, not only store and pass on information, but to do so in a purely human-to-human context displacing our previously instinctive perception of an animistic world and the continual dialogue that we had maintained. Stories no longer relied on localized experiences entwined with the forces of nature, but could be frozen and passed on future generations and even shared with other societies. Words began to speak with the same magic and power like that of the stones and trees and rivers which previously spoke to our ancestors. Ideas became entities that existed in another universe.

This technology was used effectively against societies and peoples that did not posses such technology and thus permitted the later spread of Christianity throughout much of the Western world and beyond. In the middle ages, the common folk, which had little or no access to reading and writing, remained very animistic in their beliefs despite the efforts of the church to convince them that there were no spirits in the stones and trees or forests and that the real source of creation was in some distant place in the heavens. The church incorporated many of these animistic beliefs into their religious practices in order to accommodate the common folk and this dualistic approach held sway for about 1600 years until the birth of modern science.

Harding believes this evolution of a gradual sense of separation from nature intensified in the 16th and 17th centuries after the end of the "30 Years War"(1618 – 1648) that decimated Europe and was a result of the break-up of the Catholic Church at the time of the reformation.

Plagues and famines were widespread which, in addition to the effects of the war, killed millions of people living in Europe. The old world order collapsed under the pressure brought by the new Protestantism. Whereas the old church had Christianized the old pagan religions and tolerated the animistic views held by a majority of the congregation - the Protestant revolution denied these and declared that God was detached from his physical creation which was nothing more than a sinful horrible place that could be escaped through virtue and dedication to the teachings of the church.

It was into this context modern science was born and its earliest practitioners – Galileo, Bacon, Descartes and Newton - were convinced that a new basis for certainty must be found based on reason and not on simple faith in established religious dogma and the superstitious beliefs of the common people.

As most people attending this conference have a scientific background, I will not go into detail about all of the contributions these pioneers of modern science made. However, the result was a vision of the world as a giant machine with a clear distinction between matter and mind. The material world around us was devoid of soul – a machine which human beings could master and control through the exercise of their rational intellect.

For Descartes, the only non-mechanical entity in the world was the human psyche and any other entity could be completely understood by studying how its component parts worked in isolation which led to his famous *reductionist methodology*.

The work of Issac Newton which seemed to validate this emerging mechanistic world-view with his mathematical inventions which led to astounding and verifiable predictions about the trajectories of cannon balls and the orbits of the planets.

The new world order that these scientific thinkers ushered in was based on mathematical reason and a detachment – especially an emotional attachment from what it was the scientist was observing or studying. This new confidence in scientific materialism swept through the Western world and in the subsequent centuries transformed the lives of millions of people into the society we find ourselves in today.

Any remaining superstitious beliefs which were quite commonly shared just 400 years ago slowly faded from our consciousness which has since become dazzled by new technologies and theories that are so much a part of the modern scene. Indeed, we have even created a virtual ***"Second Life"*** (www.secondlife.com) for those who are not content with living the life they have in the real physical world.

However in the past few decades there has also been the appearance of new perception of science referred to as *"Holistic Science"* which is attempting to understand the deep working of nature and consequently, to re-connect us with the rest of nature. Some the areas of exploration include the following:

1. Synthesis of Mind and Matter
2. Complexity Theory & Cybernetics
3. Theory of Living Systems
4. Earth Systems Science
5. Ecopsychology

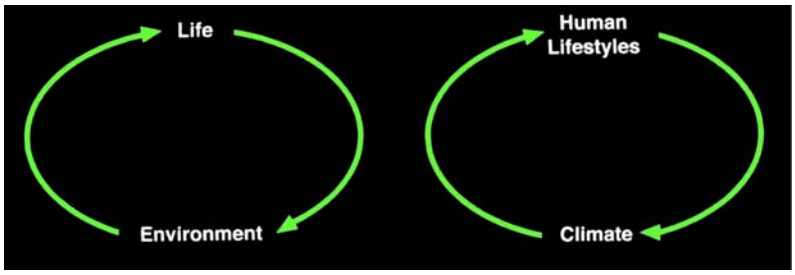
So there is some optimism that through modern day holistic science humanity will better understand the workings of nature on a systems level and be able get back into touch and in-synch with the rest of life on our planet.

However, it is clear that no other earthly creature has had such a direct impact on the environment in entire the history of our planet – especially in such a short amount of time. The question we are asking ourselves is have we gone too far – past the point of no return? Due to impact that our species is having on the underlying systems that keep our planet suitable for life, will Gaia now make the necessary adjustments that may signal the end of our civilization in order to correct what has been set into motion? Or perhaps more importantly - does Gaia need our help? Does she need us to survive?

Like Lovelock, Harding is skeptical of any *"Geoengineering"* plans such as adding a layer of sulphates in the stratosphere as suggested by Nobel laureate Paul Crutzen of the Max Planck Institute for Chemistry, seeding the oceans with iron or placing mirrors in orbit to deflect sunlight as other have suggested, as these ideas may be beyond the capabilities and responsibilities of our species (12).

Even with such measures as the sequestration of CO_2 – the goal of the prize that Richard Branson has just announced, gets humanity into a unenviable situation of managing the planet's atmospheric composition and temperature as mentioned above by Lovelock – something that Gaia effectively managed for over three billion of years.

Do the deep ecologists have the answer?



Harding offers the above diagrams to explain the inter-relationships of Gaia – *Life* and the *Environment* and *Human Lifestyles* and *Climate*.

This diagram indicates that each person is ultimately and individually responsible for their own relationship with the rest of the planet. Thus this responsibility needs to be taught and embraced by everyone on the planet.

Below are some common sense suggestions about learning to live energy efficient and carbon neutral lifestyles. The Al Gore film lists a number of these suggestions as the film's credits are scrolled onto the screen.

Suggestions for a Carbon Neutral Lifestyle for Individuals:

- Turning down the thermostat.
- Better insulate your home.
- Switch to fluorescent or energy efficient light bulbs.
- Buy a hybrid car and drive less and more slowly.
- Use public transportation and avoid flying when possible.
- Walk, use a bicycle instead of driving.
- Eat local produce and compost your organic waste.
- Consider becoming a vegetarian.
- Choose green energy when given the opportunity.
- Reduce your consumption, reuse and recycle.

We will be hearing more of such suggestions in the future and rightfully so as most are effective and easily implemented. Governments will also be placing mandatory restrictions on energy efficiency and on products and industry. Indeed, recently the Australian government has announced plans to ban the use of incandescent light bulbs by 2010 a move which could cut the country's greenhouse emissions by 4 million tones by 2012 (13). Other countries, including Switzerland will most likely follow with similar measures.

What about "The Carbon Neutral Lifestyle for Corporations" which will be impacting all of our society's ideological, political, economical and technological structures?

In his book "*The Weather Makers – How Man is Changing the Climate and What it Means for Life on Earth*", Tim Flannery states that it will be necessary for us to decarbonize the electric grid by 2030 and decarbonize transport by 2050 in order to have any chance in avoiding catastrophic climate change. If we are successful then perhaps around 2150 Gaia would once again be able to take over the control of the Earth's thermostat (14).

Stephan Harding states that the idea of ***"sustainable development"*** is not feasible if *development* means continuously increasing the extraction rates of raw materials from the wild nature. If so, "sustainability" and "development" are contradictory concepts.

Instead he refers to ***"Steady State Economics"*** an idea promoted by economist Herman Daly, which implies: *that the amount of matter flowing through the economy would either shrink or be at a steady state*. This approach appears to have had some influence on the recent EU plans for trading emission credits. (11)

The problem for the world's corporation with the above approach is that of "growth". On this issue Harding mentions another concept put forth by the Swedish ecologist Karl-Heinrich Robért - who has proposed a simple set of system conditions called ***"The Natural Step"*** that a truly sustainable society would have to follow and it is interesting as it avoids the issue of "growth" which would be problem for our industries. (11, 15):

"The Natural Step"
Four conditions for a Sustainable Society

That nature won't be subject to systematically increasing:

1. Concentrations of substances extracted from the earth's crust;

2. Concentrations of substances produced by society;

3. Degradation by physical means;

   and;

4. That human needs are met worldwide.

The first condition tells us that we cannot extract resources such as fossil fuels and minerals faster than our planet can replenish them.

The second condition states that we cannot introduce man-made substances such as DDT, CFC's etc. faster than they can be broken-down and recycled by nature into harmless compounds.

The third condition tells us we cannot continuously degrade nature without dire consequences because this "natural capital" is the source of our well being.

The last condition recognizes that equity is essential to sustainability and that material wealth needs to be fairly distributed in a given society and between all the nations on earth.

As we are at a "Space and Society" conference, I have taken the liberty to integrate some "space concepts" into Robért's schematic.

1. Unlimited amounts of clean energy from space and other extraterrestrial resources could be used to meet Condition 1.

2. If we could move some our nasty industrial processes that are having a poisonous impact on the environment into space instead of doing these in within the atmosphere of our planet many of the goals of Condition 2 could be met.

3. If we enact Conditions 1 & 2 with the addition of space resources and use these to avoid further destruction of the natural environment our "natural capital" could be restored and preserved.

4. As we would essentially be importing new "wealth" from outer space instead of extracting it from the earth's crust as we do today, global prosperity should be within our reach.

This brings me to the two books about space with the same title *"Return to the Moon"* by Harrison Schmitt and Rick Tumlinson and the DVD *"Gaia Selene"* by Charles Proser . These books and the DVD outline many of the visions and plans that have been circulating in the space community for a number of years and include references to many of the progenitors of these concepts. Astronaut Harrison Schmitt's book is a business plan leading us back to the Moon and its stores of ***Helium 3*** which could eventually be used to power fusion reactors. An idea he developed in collaboration with Gerald Kulcinski at the University of Wisconsin. Had Schmitt been a professor at the University of Houston, he might have collaborated with David Criswell and this book could as well have been a business plan for ***Lunar Solar Power*** (16)**.** The last book on my space reading list: *"Running the Line – Stories of the Space Elevator"* edited by Bradley Edwards and David Raitt is a collection of fictional short stories that refer to a potential breakthrough space technology that could make any of these scenarios for using the resources of the Moon to meet the needs of humanity on Earth economically viable.

Options for Humanity in the 21st Century

Considering the theme of this conference humanity may have the following options this century**:**

1. **The End of Cornucopia -** when the current business-as-usual approach to human affairs meets the carrying capacity of the planet. This approach is founded on the blind faith that "Life has never been better - so where is the problem?" and, that science and technology will find the appropriate fix when it is forced to do so.

2. **Unsustainable Development -** when the real concern and reflexive drive to preserve nature results in measures to husband and eventually, to ration Earth's dwindling resources and consequently turns off the economic motor that is now creating the promise of global prosperity. This approach relies on a zero-growth philosophy that demands a fundamental change in human nature - a change which will miraculously occur when humanity wakes up to the fallacy of its exploitative ways.

3. **The Space Option –** to significantly meet the basic and anticipated needs of human societies on Earth through the utilization of extraterrestrial resources - an option that appeals strongly to the human spirit by offering a creative and realistic approach to meeting and solving many of our civilization's impending problems.

I believe options 1 & 2 will ultimately prove to be futile and ineffectual attempts at survival and both are sure prescriptions for much human misery, despotism and eventually - for the end of civilization. Considering the number of human beings that are expected to be around in the year 2025 - 8 billion or so - the beginning of the end of our civilization may be only a generation away.

However *"The Space Option"* (17) takes into account human nature and still offers an optimistic approach to meeting humanity's ever increasing needs. It is an option that appeals strongly to the human spirit by offering a creative and realistic approach to meeting and solving many of our civilization's impending problems. As such, it should be given serious consideration.

The *Space Option* is an evolutionary plan to significantly meet the basic and anticipated needs of human societies on Earth through the utilization of extraterrestrial resources - *not for the in-situ support of science or exploration* - but rather to apply these resources and/or their products for use on Earth at a conspicuous level.

Obviously energy from space is central to the implementation of the *Space Option*. Unlimited amounts of clean energy imported to Earth from space – either in the form of solar energy and/or, later, in the form of Helium 3 - would significantly contribute to the restoration of the environment while avoiding the environmental and political consequences associated with the steady depletion of our fossil fuel reserves and the increasing use of brown coal and/or nuclear power. Having a plentiful supply of clean energy would not only perpetuate the lifestyle of the developed nations, but would continue to provide the basic means for further stimulating the economies of the developing countries. As such, future generations would be guaranteed a sufficient supply of energy and other material resources for their development and today's less fortunate societies would be provided with hope that they, too, could aspire to improve their living standard beyond their present situation.

Greater Earth

If one considers the true boundary of Earth as defined by its gravitational influence and not by its atmosphere, then Earth actually has a diameter of 3 million km. 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 of Earth. Enormous amounts of other resources, including the Moon, are located within the borders of this larger and richer planet. Like the territorial waters surrounding nations - these resources belong to our planet and could and should be used for its ultimate benefit.

Thus, going into space this century may only mean extending our civilization to the limits of a larger redefined Planet Earth and consequently utilizing the bountiful resources to be found within. Some have referred to this area as *"Greater Earth"* (18). Astronautics, space technology and the knowledge that humanity has accumulated over the past 50 years are here today and available to open up this potentially huge new territory for human activities at a time when it seeking effective solutions to the problems it has created.

For the environmentalists, the *Space Option* is the ultimate environmental solution. For the Cornucopians, it is the technological fix that they are relying on and hoping for. For the hard core space community, the obvious by-product would be the eventual exploration and settlement of the solar system. For most of humanity however, the ultimate benefit is having a realistic hope in a future with possibilities. Indeed, the *Space Option* is humanity's most optimistic approach to its future.

While the *Space Option* does suggest importing conspicuous amounts extraterrestrial resources to meet the needs of humanity, it is not specifically about geoengineering the Earth's environment. However, as Lovelock, too, believes, some space technologies such as orbital sun-shades could be effective if they could be easily controlled – i.e. turned on and turned-off as needed.

Actually the *Space Option* is not a new concept. Some early space pioneers have said similar things in other ways:

Krafft Ehricke (1970) (17, 19):

"While civilization is more than a high material living standard, it is nevertheless based on material abundance. It does not thrive on abject poverty nor in an atmosphere of resignation and hopelessness. It needs vigour as well as vision. Therefore the end objectives of solar system exploration are social objectives in the sense that they relate to, or are dictated by, present and future human needs."

Arthur C. Clarke (1968) (20):

" The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race will be drawing to its close. Humanity will have turned its back on the still untrodden heights and will be descending again the long slope that stretches, across a thousand million years of time, down to the shoes of the primeval sea."

And we should not forget the earlier comments from Frank White about the choices we had to make in the last century:

"…because if one occurs on a massive scale, the other probably will not."

Conclusions

Good planets are hard to find

Our civilization is at its peak - we have the means today to implement the *Space Option*. However, if our species does not soon embrace this unique opportunity with sufficient commitment, it may miss its one and only chance to do so. Humanity could soon be overwhelmed by one or more of the many challenges it now faces. This is perhaps the real danger we face as the window of opportunity is closing as fast as the population is increasing. As the 21st century has just begun, the main challenge to the space community will be informing and then convincing the public of the viability of its various space options as optimistic alternatives to the other current approaches to the environmental and economic challenges that are beginning to dominate our society today.

If I have given any message in this presentation, perhaps this is the most important one: I truly believe it would be necessary for the space community to begin speaking with the environmental and ecological communities to find synergies and common goals. There needs to be a *"greening"* of the human space endeavour if the *Space Option* has any chance of being considered, accepted and implemented.

I thank you for your attention and for the opportunity to give this presentation.

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(*) Arthur R. Woods, is currently a free-lance naturalist artist living in Switzerland. He initiated a number of art-in-space projects including the realization of his *Cosmic Dancer Sculpture* on the Mir space station in 1993 and *Ars Ad Astra – The 1st Art Exhibition in Earth Orbit* in 1995 also on the Mir in collaboration with ESA during their EuroMir95 mission. He is co-founder and co-owner of spaceOp sàrl, Switzerland and owner and founder of Swissart GmbH an Internet company serving the Swiss art community. He was also founder and president of the O.U.R.S. Foundation a cultural and astronautical non-profit organization (1990-2006). He is a Fellow of the International Association of Astronomical Artists (IAAA). As a member of the International Academy of Astronautics (IAA) he has been involved in the organization of numerous workshops and symposia dealing with the cultural dimensions of space including participation on the organizing committees for the 1st and 2nd IAA conferences on Space & Society.

Websites:

www.spaceop.com

www.cosmicdancer.com

www.arthurwoods.ch
www.ours.ch