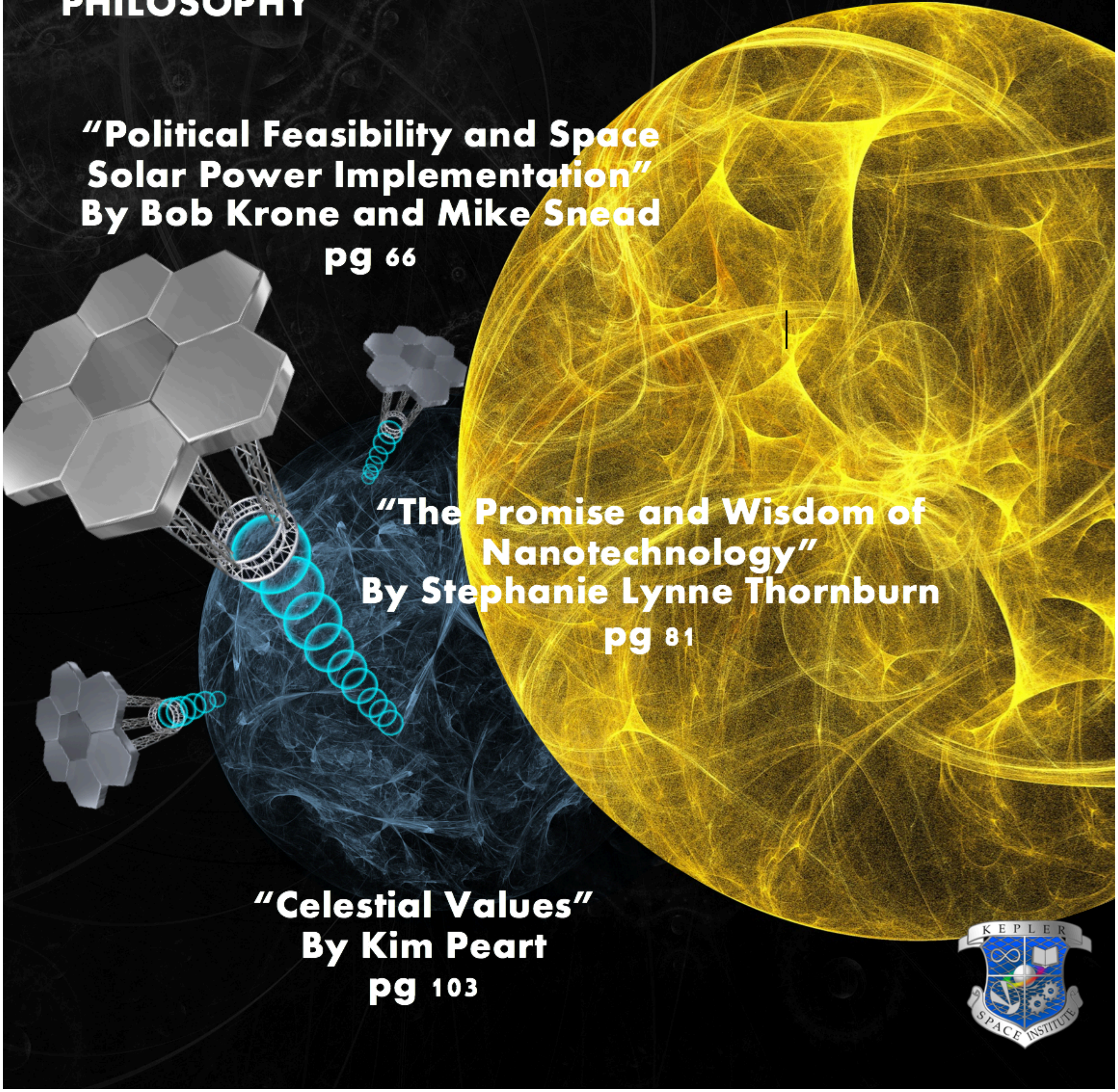
JSP

JOURNAL of SPACE PHILOSOPHY

Volume 3, Number 1
Spring 2014



“Political Feasibility and Space Solar Power Implementation”
By Bob Krone and Mike Snead
pg 66

“The Promise and Wisdom of Nanotechnology”
By Stephanie Lynne Thornburn
pg 81

“Celestial Values”
By Kim Peart
pg 103

KEPLER SPACE INSTITUTE

Kepler Space Institute

Meeting the needs for the future of humans on Earth, and in Space, with dreams and skills of global scholars

Dedicated to the belief that Space holds solutions for the betterment of humankind.

Kepler Space Institute

Meeting the needs for the future of humans on Earth, and in Space, with dreams and skills of global scholars

Preface

This is the fourth issue of the Journal of Space Philosophy. We appreciate the global positive feedback. Our Board of Editors continues to expand with new professional scholars. Articles will continue to represent breakthrough Space science and technology imbedded in philosophical themes.

Readers will find a rich diversity of subjects in this issue from Nanotechnology to how American Vietnam Prisoners of War learned that America had men on the Moon.

This journal is peer-reviewed. Submissions, to BobKrone@aol.com, will be considered for publication from anyone on Earth or in Space. Views contained in articles are those of the authors; not necessarily reflecting policy of Kepler Space Institute. Reproduction and downloading of Journal content for educational purposes is permitted; but authors hold copyrights of their material and professional accreditation is required.

Bob Krone, PhD, *Editor-in-Chief*
Gordon Arthur, PhD, *Associate Editor*
Kseniya Khovanova-Rubicondo, PhD, *Research Editor*

Kepler Space Institute

Meeting the needs for the future of humans on Earth, and in Space, with dreams and skills of global scholars

Contents

Volume 3, Number 1: Spring 2014

Access to the Journal of Space Philosophy and downloading of its articles is available at www.bobkrone.com/node/120. Anyone on Earth or in Space may submit his or her article to BobKrone@aol.com

Kepler Space Institute

Meeting the needs for the future of humans on Earth, and in Space, with dreams and skills of global scholars

Press Release, March 23, 2014

Wide Array of Ideas in New *Journal of Space Philosophy*

By Walter Putnam

Ideas ranging from space solar power as the energy of the future to the spiritual movement behind extraterrestrial development are contained in the next issue of the *Journal of Space Philosophy.*

The fourth installment of the Journal, a semiannual online collection of thoughts that drive humankind's reach for the stars, also features essays on the political feasibility of space missions, the nature of "Celestial Values," and a tribute to one of the founders of KSI, the late Dr. Richard S. Kirby.

Also in the issue due April 1 is a new feature on Space Art, providing glimpses of the work of artists inspired by the natural works of the universe. The first display will include a memorial to the wife of space art pioneer and longtime KSI associate Lowry Burgess. Janet Burgess died March 8 after a brief illness.

And, there also is a preview of a new book by Professor Yehezkel Dror, a leading scholar of policy sciences. Dror's *Avant-garde Politician: Leaders for a New Epoch,* explores the critical need for new thinking in political leadership, including "looking beyond our current tribalisms to a pan-human commonality."

Former U.S. Air Force civilian engineer James Michael "Mike" Snead begins the spring *Journal* with a provocative argument for ensuring the global energy future through the development of satellites to capture the Sun's radiation.

Comparing the planet to the Titanic sailing into an ice field, Snead uses a wealth of facts and figures to demonstrate that America faces economic and cultural ruin by reliance on fossil fuels through the remainder of this century.

"Consequently, absent the building of substantial sustainable energy sources, in time to transition smoothly from fossil fuels, our American culture will undergo disaster," writes Snead, who argues strongly for U.S. leadership in space development.

“The facts supporting this contention are quantifiable and easily understandable. The conclusion is simple arithmetic showing that the U.S. energy ledger is substantially in the red.”

He then lays out that arithmetic in a compelling argument for SBSP.

William Mook, a past contributor to the *Journal,* the brainchild of KSI President Robert Krone, also adds to the case with an essay titled “Solar Power Satellites for a Sustainable Industrial Future.”

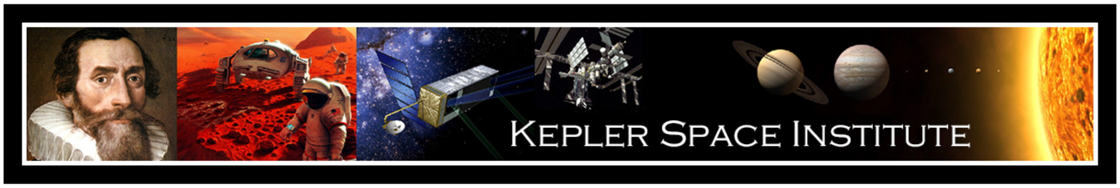
On a different note, Madhu Thangavelu writes of “Human Space Activity: The Spiritual Imperative,” and Walter Putnam has an essay titled “Astro-Humanism: Space as a Spiritual Movement,” in which he suggests that the international political will for extraterrestrial development might come only through a global spiritual thrust.

In a similar vein, Stephen Wolfe explains “The Evolutionary Impulse to Expand Beyond Earth,” Arthur Woods expounds on “The Space Option: Our Cosmic Choice,” and Kim Peart delves into the realm of “Celestial Values.”

Among other essays, Gordon Arthur describes “Richard Kirby’s Inspiration,” Krone and Snead consider “Political Feasibility and Space Missions,” and Stephanie Lynne Thorburn outlines “The Promise and Wisdom of Nanotechnology.”

Readers of the spring *Journal* also will be treated to an account of how American prisoners of war in Vietnam learned of the Apollo landing on the Moon in 1969, “The Happiest 20 Seconds of Our Lives,” by Leo Thorsness.

####



About Kepler Space Institute

By Board of Directors, Kepler Space Institute, Inc.

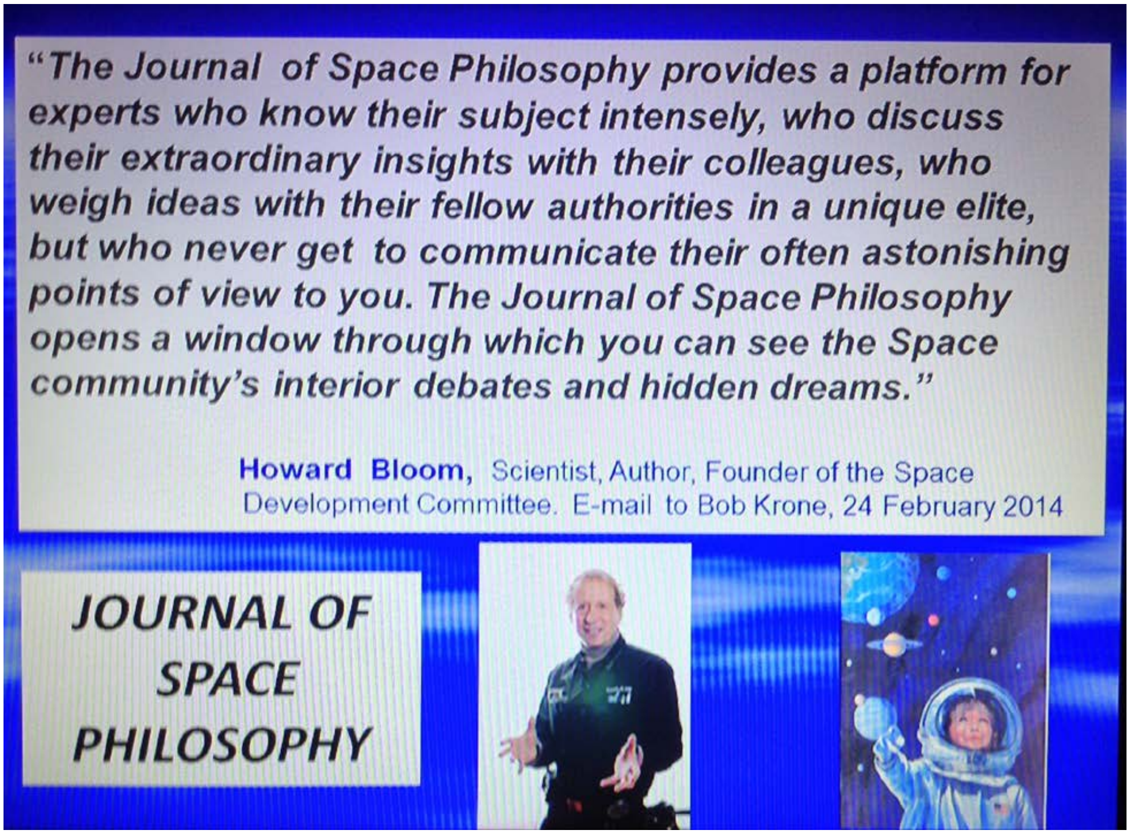
Readers will find the origin and evolution of Kepler Space Institute (KSI) in the front matter of the previous three Journal issues, Fall 2012, Spring 2013, and Fall 2013. As this Spring 2014 Issue is published, KSI is in the process of preparing academic registration in the State of Florida under its for-profit KSI, Inc. Corporation (ID #P12000087928).

Kepler Space Institute, a research and education organization, is committed to directing its efforts, resources, qualifications and talents to endeavors that benefit humanity now and in the future. Our KSI leadership formulated the *Law of Space Abundance* in 2009, defined as *"Space offers abundant resources for humanity's needs*." It was a logical law, flowing from research and discoveries over centuries. We seek to guide people, groups, businesses, agencies, and international organizations to achieve new goals and visions facilitated by the material and spiritual resources that await us in Space.

Our Kepler Team, which collectively has spent one thousand work years within the Space Community, is proud to have launched the world's first *Journal of Space Philosophy* with the Fall 2012 issue. We invite global Space professionals and enthusiasts to access, or download free, any article of the first four issues of the Journal on www.bobkrone.com/node/120. We encourage global comments on the streams of knowledge, analysis, and recommendations you will find.

Philosophy has been the study of the meaning of life and of humanity since before Plato. The era of humans living in Space has begun. The *Journal of Space Philosophy* will document ideas and concepts that will enhance the human movement from Earth both for Earth's benefits and for humankind's improvement and eventual survival.

We thank Space colleague, Howard Bloom, for stating our purpose in his typical elegant language.



Kepler Space Institute Board of Directors.

****

Letters to the Editor

****

From Dr. George S. Robinson, III, Esq., January 18, 2014.

Dear Bob,

In my professional career I handled rather bizarre cases and issues all over the world, both for NASA and particularly for twenty-five years for the Smithsonian Institute. Ninety percent of my Space activities involvement involved writing and publishing books and articles, giving speeches, and teaching Space Law and Commerce for many years. It was done on my own time. The Smithsonian Institute Secretary and Chief Justice Warren Berger only encouraged me to use SI time to start the first two *International Conferences on Doing Business in Space: Legal Issues and Practical Problems.* Those conferences brought USSR reps to the United States to learn how to negotiate and run private sector Space businesses; and to initiate my idea of two conferences of expert US engineers, scientists and lawyers together to discuss formulation of the First Constitutional Convention for long duration and permanent Space inhabitants. My "profession" as an attorney was separate and distinct from developing realistic concepts of the empirical bases of Space Law any law.

Thank you, Bob, for your work initiating and very successfully managing of the Journal of Space Philosophy. Very much needed . Very valuable to many folks in many different disciplines.

****

About the Author: Dr. George S. Robinson, III is one of the most distinguished Space Law experts in the world. His book, book chapter, and professional article publications – over 100 – are found throughout the aerospace and Space literature and continue in 2014. He served as International Relations Specialist for NASA and legal counsel to the FAA, the Department of Transportation, and the Smithsonian Institution in Washington, DC. He serves on numerous Boards of Directors for science research.

Editors' Notes: Dr. Robinson was a strong supporter of the Aerospace Technology Working Group (ATWG), which was the forum from which Kepler Space Institute emerged. KSI is proud to have him as an Editor of the *Journal of Space Philosophy*. His long legal service to the Space community puts him in a unique group of professionals building the legal foundations for the Space Age. ***Bob Krone and Gordon Arthur.***

****

On behalf of Edward L, Hancock, Educator, Author, Athlete.

Dear Bob,

We, Ed Hancock's Family, were so pleased to have his special life experiences recorded in the 2010 *Nevada Review*, Vol. 2, Issue 1, 102-126, and to have it include your personal friendship with him starting in Reno in 1943 and continuing to today.

Ed's quote in the Journal about his viewing the stars is relevant to your founding of the *Journal of Space Philosophy.* Here were his thoughts:

> I like sleeping out on the deck, but I have a hard time getting up and down. I like looking at the moon. I like looking at the stars. Every night I go out and look at the stars until 1:30 in the morning and look at the stars and make contact and think about the millions of people who have looked up at the stars. It's like their lives are in there too. And I have to get up and walk around here to look at the North Star and the Big Dipper and the Little Dipper up there. But I do that, and that North Star, it's just a faint light. (126)

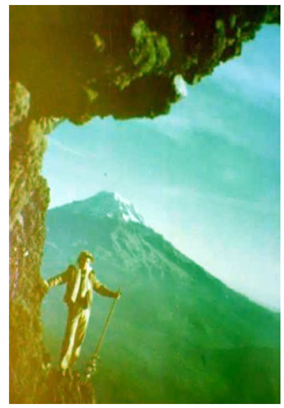
Leslie Donovan, Daughter of Edward L. Hancock

****

Editor's Notes: Lifelong friendship is a rare and satisfying experience. Ed Hancock and I grew up together in Reno, Nevada starting in Junior High School. He talks about our unguided climbing of the 17,802 foot high Popocatepetl Volcano in Mexico in 1949 in his Nevada Review interview.

His diverse active career included hitch-hiking in Europe, boxing, football, University of Nevada basketball, writing books on literature, quoting literature, instructing university composition, earning the University of Chicago Master's Degree in Literature – one of the most difficult programs in the world of literature – and being Dean of the Literature Department at Nevada Truckee Meadows Community College and Fulbright Scholarship teacher in England. As this goes to press on April 1, 2014, Ed's health is failing. His views of the heavens will find resonance with *Journal of Space Philosophy* readers. ***Bob Krone***.

Ed Hancock



Bob Krone

Mexico, Summer 1949, *Dos Pobre Estudiantes.*
Before climbing the Popocatepetl Volcano

Ed Hancock

Varsity Basketball, University of Nevada

Professor

****

From Rob Godwin, Founder, *The Space Library*

Dear Bob,

This is to inform you, and your readers, of *The Space Library*. I began writing the code for it five years ago, about the time we had mentioned the idea to you and Sue at dinner at an ISDC Conference. We have kept it under wraps during a long and difficult design and development period. Your recent question to me about converting your issues of the *Journal of Space Philosophy* to e-books arrived at a time when we had just made the decision to Beta Test the Library.

Our site is a hybrid of the best parts of the most successful websites on the net, hopefully without most of their pitfalls.

Think of Wikipedia/Facebook/Amazon/Kickstarter/Youtube/Ancestry all combined, but just for Space.

Similarities:

- Wikipedia: Multiple contributors, simple internal links, no hard code skills.
- Facebook: Each and every contributor has a personal page.
- Amazon: Contributors can sell e-content, contributors get paid for all referrals.
- Kickstarter: Subscribers can support/pay the contributor of their choice.
- YouTube: Video and Audio enabled.
- Ancestry: Institutional databases can be added and searched, given away, or sold.

Differences:

- Wikipedia: No one can change a page without the creator's express permission; only authorized contributors can add content.
- Facebook: No deluge of unrelated advertising; even people who are long gone have a personal page (e.g., Jules Verne, Wernher von Braun, etc.).
- Amazon: No ISBN needed to sell content. No one telling you how much to charge for content. Sell a single page or a whole book.
- Kickstarter: Subscribers can change their allegiance to a different author when they resubscribe.
- YouTube: Contributors can SELL audio and video or give it away for free.
- Ancestry: Links can go back to the contributing institution if they want to host and sell their own content.

Unlike most content-management systems, it is infinitely scalable because it uses the well-tested open-source Mediawiki engine as its foundation. *Mediawiki is NOT Wikipedia*. It is the engine that Wikipedia uses.

The Wiki concept was first created by Wikiwiki Web as a way to allow multiple users to add content to a website without learning code. Adding internal links is as simple as adding [[square brackets]].

The site also has an Almanac, which provides an invaluable tool for historians: a day-by-day breakdown of events with nothing too small to include. At the moment there are over 25,000 pages, plus more than 5,400 documents and images, over 400 hours of rare audio, and dozens of hours of video. There are already indices to the Journal of the British Interplanetary Society and every issue of the Journal of the VfR.

It is hooked into PayPal and includes the powerful Sphinx search engine as well as a Beta-test PDF search engine. We will be adding huge databases of NASA documents, space patents, video, and personal archives of paperwork and photographs. The whole site will be available for both individual and institutional subscriptions. It will start at $5/month or $50/year: the cost of a single book for a year's access.

There is no single site on the Internet like this and certainly nothing like it just for Aerospace. It is a publishing platform, a news source, an encyclopedia, an almanac, a social network, and a shop.

Initially, contributors will be selected by referrals and committee. Our goal is to allow experts to continue to earn something for their expertise. The site will not be open to general public editing. Some people may call this "gate-keeping." It is. But it is also a statement of us choosing to invest our time, money, and effort in the people we wish to support. If we choose the wrong content and the wrong contributors we live or die by those choices. This is the same basic choice we have had to make over 30 years of publishing.

We will be happy to create your Kepler Space Institute (KSI) account and have you participate in the Beta Test. You, and your Board of Directors, will appreciate that until we are fully operational with the Space Library there can be no guarantees that you may not run into pitfalls or setbacks and you won't be able to hold us liable for any mishaps!

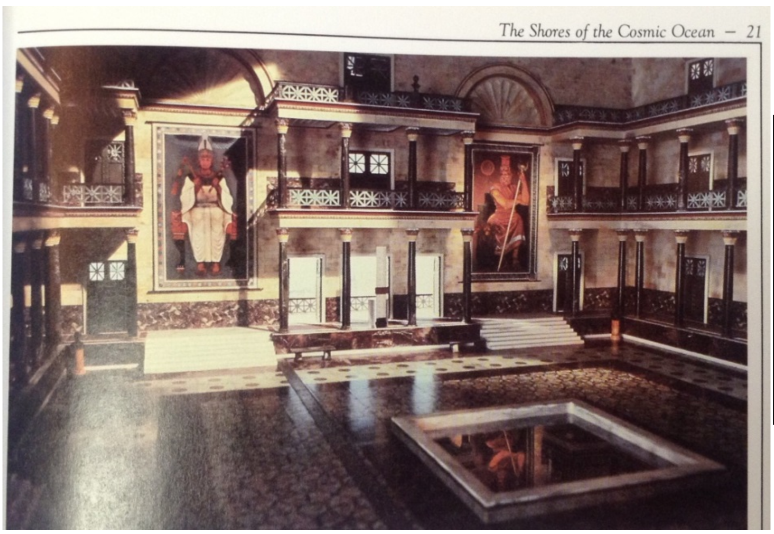
Rob Godwin,
Apogee Space Press
Founder, *The Space Library*

****

Editor's Notes: In Carl Sagan's Cosmos book and Video Series, 1980 (Carl Sagan Productions, 14, 18-20, 50, 62, 188, 281, 333-37) he stated: "It was in Alexandria, during the six hundred years beginning around 300 BC, that human beings, in an important sense, began the intellectual adventure that has led us to the shores of space" (*Cosmos*, 18).

Alexander the Great constructed the city on a lavish scale to be the world center of commerce, culture, and learning. The knowledge apex of Alexandria was the Library and its associated Museum. It was the brain and glory of the greatest city on the planet 2,000 years ago. There was a community of scholars, exploring physics, literature, medicine, astronomy, geography, philosophy, mathematics, biology, and engineering. For centuries after Alexandria, the Greek Kings of Egypt supported research and maintained the Library as a working environment for the best minds of the age. There could have been half a million books (that summary paraphrases Sagan, *Cosmos*, 20).

By 500 AD, the glory of the Alexandrian Library was completely destroyed and a dim memory. The Dark Ages for civilization and brainpower followed. Today not one physical scroll remains and only a small percentage of the intellectual treasure centered in the Library has survived.



The Great Hall of the ancient Library of Alexandria, Egypt. A reconstruction based on scholarly evidence. Carl Sagan, *Cosmos*, 1980, p. 21.

Computers and the electronic and information sciences have now created a capability unimagined in ancient Alexandria. Space information can be easily accessed by anyone anywhere on Earth, or by the few humans who have been in Space over the past fifty years.

Rob Godwin has made a paradigm shift leap from the Apogee Space Books, C. G. Publishing, that he and Richard Godwin founded in 1984. My short introduction to the Space Library transported me back to Carl Sagan's *Cosmos*. Carl is saying, "Thank you Rob Godwin" and Kepler Space Institute is excited about its potential to capture and advance knowledge of the Space Age*. **Bob Krone and Gordon Arthur***.

****

From Mrs. Bea Parnes, February 19, 2014

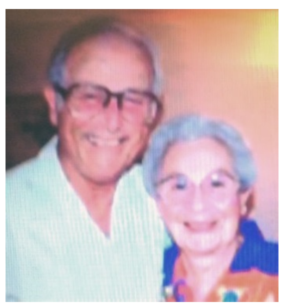
Dear Bob,

Congratulations on the *Journal of Space Philosophy*. I appreciate you inviting me to provide a summary of Sid Parnes's career findings on creative problem solving, creative thinking and breakthrough thinking.

In Sid's last work, "VISIONIZING – INNOVATING Your Opportunities," he emphasizes "Bringing Your Dreams into Reality" – not many dreams come true – but with your guidance the *Journal of Space Philosophy* will become a reality. Although Sid's work was on earth, his writing and thinking could be applied to exploring space and the philosophy behind it. Putting a man on the moon was only the beginning of a beautiful dream.

As Sid said "viewing the future is a journey – not a destination – no fixed goals – but flexible ones that can be changed – never limiting your possibilities." Good luck on your journey into space.

Bea Parnes



Sid and Bea Parnes

****

Editor's Notes: The Creative Education Foundation (CEF) has been teaching adults and children the *Applied Imagination* process since Alex Osborn and Dr. Sidney J. Parnes created the Foundation in 1954. Sid became its Director in 1966 and continued his leadership, with Bea Parnes help, until his death in 2013. Dr. Richard Kirby, the first President of Kepler Space Institute (January to September 2009), negotiated a meeting between Sid, myself, and Walt Putnam in 2007. The essential role of creative thinking for Space-Age development has been known for a century. We thank Bea Parnes for providing us these valuable memories from her long partnership with Sid. ***Bob Krone***.

****

From Richard Godwin

March 17, 2014

Journal of Space Philosophy

Dear Editor,

Being deeply involved with both the publishing industry, through my company Apogee Books, and the space commercialization market as CEO and president of Zero Gravity Solutions (ZGSI), I have witnessed a growing awareness regarding the potential for space technologies to provide solutions among to existential threats to the global population.

Humanity is facing a perfect storm that may potentially wipe out our species. Consider the factors we are now facing:

- Global climate change
- Population growth to 9 billion by 2050
- Disease threats to monoclonal cash crops
- Depletion of nutrition and minerals in the soil
- Need to farm more land to increase yields
- Scarcity of fresh water
- Public concern about genetically modified food (GMO)

Throughout our existence, survival of our global civilization has been and probably always will be based upon our agricultural practices. Technology has allowed us to populate the whole planet in the space of a few thousand years. If we were still hunter-gatherers we would not be sitting here today. Our technology is the only means for us to keep ahead of nature's culling practices. If we don't keep ahead, nature will indeed cull our species.

The development of human spaceflight has always been at the forefront of our advanced technologies. The reason is because human spaceflight brings to bear almost every technological discipline in order to carry people off world or to other worlds. The innovations derived from space-related technologies have been responsible for cutting-edge developments in human medicine, propulsion, materials science, electronics, chemistry, physics, psychology, engineering, life support, and almost every other

190 NW Spanish River Boulevard, Boca Raton, Florida USA

www.zerogsi.com

endeavor involved in human activities, including of course agriculture. More science advancements come out of space flight technologies than ANY other human endeavor; this is why it is so relevant now to agricultural and medicinal advances.

In the past, human spaceflight has been driven by big government and big engineering. Those segments are still prevalent, but a sea change has occurred as focus has shifted beyond the achievement of flying into space and establishing the ISS to the creation of commercial value and groundbreaking innovations. Science is being applied not only to turn a profit, but also to enhance our lives and maybe even to address the serious threats to humanity's very existence.

Now backed by the support and cooperation between private industry, government and NASA, an entirely new space economy is emerging in the United States in which rapid innovation is enabled by frequent and regular access to space and the growing infrastructure to support research. This is a golden opportunity for science to change the world by applying and commercializing its cutting edge technology.

Zero Gravity Solutions is the first public company focused on commercializing, industrializing, and monetizing a growing pipeline of products resulting from space-developed and derived technology, which can produce recurring and scalable revenue. Our mission is to use space technology to improve life on Earth.

ZGSI's two new breakthrough technologies, designed for and derived from Space, are focused on providing improved nutrition and sustainable agriculture on Earth in order to feed a growing population without GMO.

ZGSI's technologies are:

1. **Directed Selection™** – Production of new varieties of patentable stem cells *en masse* that can only be developed in the weightless environment of long-term microgravity available on the ISS.
2. **BAM-FX™** – a platform technology that provides systemic delivery of ionic minerals and micronutrients to plants at the cellular level.

Directed Selection™ is a proprietary technology designed to use the unique conditions of near-zero gravity in low earth orbit to create plants with beneficial traits of great value to humanity. Zero Gravity Solutions, Inc. is using this proprietary new platform technology to create more robust plant varieties adapted toward desirable characteristics: our IP, derived from six research flights aboard the ISS. Because genes perceive microgravity as a threat, they express differently in space. With the differential gene expression, plant cells can have an improved ability to adapt to a changing environment or disease-causing organism. The plant cells can be driven to adapt toward desirable traits by artificially introducing stress conditions, such as cold, heat, drought, or salinity. These changes in the genome of the plant are done without the need for additive or subtractive genomic engineering; thus, the plant is still natural, only with previously dormant genes now expressed.

BAM-FX ™ is our first revenue-generating space-derived commercial product and it will be introduced into the agricultural marketplace in 2014. BAM, which stands for bioavailable minerals, is an ionic mineral and micronutrient delivery system for plants that was originally developed to ensure fresh food crops for astronauts in space. Our Chief Science Officer and founder, John W. Kennedy, recognized that future NASA space programs were directed at the long-term goals of sending astronauts on extended deep space missions. Cargo volume and weight limitations dictate that a continuous supply of fresh food crops be grown to feed the crew on such journeys. Plants also provide essential minerals with organic carriers, making plants a superior source of nutrition compared to vitamin and mineral supplements. A new way for robust food crops to support astronaut nutrition and immune requirements was needed, and so the BAM-FX concept was born. Although developed with space habitat support in mind, BAM-FX promises substantial agricultural benefits here on Earth. Current field trials are well advanced and performing well in conjunction with several universities. Initial research clearly indicates that the BAM-FX ionic delivery system increases the biomass and enhances the plants immune system.

The ability to impact plant food crops using next-generation technologies – far superior to existing fertilization and nutritional supplementation practices – paves the way for revolutionary advances in world agriculture and methods of global food supply.

Today’s new Space economy is further fueled by the awakening of global consciousness that space-derived innovations are potential solutions to existential problems and the pathway to innovation and commercialization is now paved through the collaboration of government, NASA, and private industry. This is an exciting time for the space industry as a whole and for Zero Gravity Solutions to be one of the game-changing innovators along with some of the world’s most influential and leading-edge companies in sustainable agriculture who are rising to meet the food security challenges of feeding 9 billion people by 2050.

It will take the power of government, the drive of private industry, and the vision and ingenuity of scientific research and innovation to turn the possibility of meeting tomorrow’s challenges into reality, which will create a better future for us all.

Richard Godwin, President Zero Gravity Solutions

About the Author: Richard Godwin is president and CEO of Zero Gravity Solutions, Inc. (ZGSI), a public company committed to becoming the first zero gravity biotechnology company focused on commercializing, industrializing, and monetizing a growing pipeline of products resulting from space developed and derived technology. Mr. Godwin was originally introduced to this technology while working recently as a business consultant for SpaceX on its nascent DragonLab program. He was formerly a Board Director at a large National Space Society and Board Director of the Space Frontier Foundation. He has been a space advocate for over 20 years and is a founder and the president of Apogee Books, a publishing company with an award-winning line of space books.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

The American Energy Security Crisis Solution—Space Solar Power

By James Michael "Mike" Snead

Introduction

It is 11:39 pm, April 14, 1912 and you are comfortably enjoying a transatlantic voyage from England to New York on the world's newest, largest, and safest ocean liner—the *RMS Titanic*. The weather outside has turned clear and brisk due to air and water temperatures having rapidly fallen in the last few hours. Stepping outside, the sky is awash in stars from horizon to horizon on the moonless night. The water is almost flat due to the absence of wind. The unrivaled power of the Titanic can be felt through the decking as it steams at near its maximum speed. Unknown to you, disaster is less than a minute away, your live or die moment at the hands of the heartless Atlantic less than three hours away; the cause yet unseen, however, by the forward observers.

The captain—an experienced mariner of these Transatlantic voyages—has made a fatefully wrong assumption. In 1912, eyes were still the herald of danger ahead. The captain has assumed that, with such clear viewing conditions, his observers in the crow's nest and his bridge crew will have twenty minutes or so of warning should an iceberg or ice pack appear ahead of the ship. With that amount of warning, stopping or turning the ship to avoid the ice can easily be accomplished.

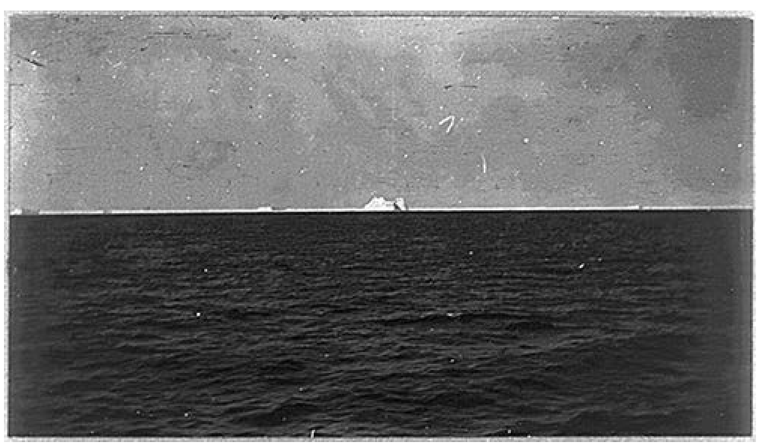


Fig. 1. View from S.S. CARPATHIA of the iceberg which sank the Titanic. Note the other ice and sea condition. http://www.loc.gov/pictures/item/2002721381/

What the captain did not understand was that nature was playing a trick on him that evening. A mirage had formed, due to the difference in air and water temperatures ahead of the ship, which hid the iceberg from view. The mirage brought the image of stars down to the horizon ahead, masking the iceberg from sight. Only too late did the observers in the crow's nest spot the iceberg. No matter what could then have been done by even the most experienced crew, the 40 seconds or so available to respond from first sighting was simply insufficient. The ship and well over a thousand souls were lost. In this small bubble of human civilization crossing an ocean in the leading edge of human technology, its leader judged poorly by ignoring radioed warning messages of ice ahead. He thought he had plenty of time to respond. In reality, he did not understand the dire circumstances his ship faced. Entirely within his control, he let his ship steam into disaster.

Just as the Titanic had blindly entered an ice field that fateful night, its captain confident that he controlled his ship's future, American civilization has entered a new energy security crisis as it blindly pushes forward in the 21st century. Simply put, the United States lacks sufficient technically recoverable, affordable fossil fuels to sustain its increasingly energy-hungry culture through the end of this century. Consequently, absent the building of substantial new sustainable energy sources, in time to transition smoothly from fossil fuels, American culture will undergo disaster. Only the foolish will shrug off this disaster-in-the-making.

The facts supporting this contention are quantifiable and easily understandable. The conclusion is simple arithmetic showing that the U.S. energy security ledger is substantially in the red. While our leaders—our politicians, our government officials, our leading businessmen—probably know this information, it is very clear that they do not understand the severity of the very real threat and the "ice" ahead into which they are steaming. Because of this, American culture—and civilization—is at very serious risk.

The purpose of this paper is to provide the quantitative information needed to understand the seriousness of this crisis, to examine the technological alternatives available to resolve this crisis, and to make clear why space-based solar power is, at this time, the only alternative to pursue. With this information, a new generation of American leadership can arise to lead America out of this crisis.

Section I – The Importance of Energy to our American Culture

Cultural anthropology provides the needed framework for understanding the energy security challenge now squarely facing Americans—specifically, the anthropological study of the relationship of culture to energy undertaken by American anthropologist Leslie White.

White's Law Provides the Framework for Understanding our Energy Security Challenge

White establishes these two key thought anchors:

- **Culture**, as White defines it, "consists of tools, implements, utensils, clothing, ornaments, customs, institutions, police, rituals, games, works of art, language, etc."[1] In other words, culture is what separates modern man from living in a cave, gnawing at uncooked food, and living a short and brutish existence. Culture can be defined as standard of living. Almost everything Americans do is done within the physical expression of culture.

[1] Leslie A. White, *The Evolution of Culture* (New York: McGraw-Hill, 1959), 3.

- **Energy**, as White uses this term, is "the capacity for performing work."[2] Work (whether by humans, animals, or machines) is what produces the products and supplies the services that constitute culture and enable us to live prosperously.

Bringing culture and energy together, White defines his law of cultural evolution as "Other factors remaining constant, culture evolves as the amount of energy harnessed per capita per year is increased, or as the efficiency of the instrumental means of putting the energy to work is increased."[3] "Instrumental means" is a fancy way of describing the technology embodied in the products and services forming our standard of living and the industry producing these products and services.

His arguments are summarized on Wikipedia as:

1. Technology is an attempt to solve the problems of survival.
2. This attempt ultimately means capturing enough energy and diverting it for human needs.
3. Societies that capture more energy and use it more efficiently have an advantage over other societies.
4. Therefore, these different societies are more advanced in an evolutionary sense.

While this line of thinking is exceptional, White expressed his law with a simple symbolic expression that is very understandable:

$$E \bullet T \Rightarrow C$$

Where:

- **E** is the energy used to produce the goods and services consumed. E can be expressed either as the energy used per person (per capita) or the total energy used by the political unit (e.g., the United States).
- **T** are the technologies, using modern energy forms, used to produce the goods, services, and energy at a particular point in time, as well as the technologies embedded in the products. Technology is the application of science through engineering and manufacturing.
- **C** is the standard of living achievable, at a point in time, using available design, manufacturing, and product/service technologies when supplied with sufficient energy of the correct type.

The symbol "•" is used to express the ***interaction*** of energy with technology. It is not a symbol indicating multiplication. Likewise, the symbol "⇒" is not an "=" expressing equality; it is better understood as indicating ***yields***.

---

[2] Leslie A. White, "Energy and the Evolution of Culture," *American Anthropologist* 45, no. 3 (July-September, 1943): 335.
[3] Leslie A. White, *Energy and the Evolution of Culture* (New York: Grove Press, 1949), 111.

America's Energy Security Challenge is to meet our Children's Energy Needs

White's Law, with just five common symbols, captures the fundamental essence of the challenge America (and the world) has this century to REMAIN civilized. America's energy security challenge this century is: *Will America have enough energy of the right type, combined with sufficiently capable technology, to yield an acceptable standard of living for our children and grandchildren?*

With the life expectancy of Americans now commonly stretching into the 80s, many of today's newborns will easily live to see the opening of the 22nd century. Thus, as a society of responsible adults/parents/grandparents understanding the clear implications of White's Law, our national energy security planning horizon now stretches at least to 2100. In terms of White's Law, we are, therefore, responsible to see that the following relationship holds true:

$$E_{\text{America in 2100}} \bullet T_{2100} \Rightarrow C_{\text{America in 2100}}$$

where:

$$C_{\text{America in 2100}} \geq C_{\text{America today}}$$

Expressing this in terms of per capita energy consumption (e) and the U.S. population:

$$(e_{\text{American in 2100}} \times \text{Population}_{\text{United States in 2100}}) \bullet T_{2100} \Rightarrow C_{\text{America in 2100}}$$

The philosophical beauty of this formulation of America's energy security dilemma/challenge is that it allows us to dissect this dilemma/challenge into its pieces, study them, understand them, and use this information to formulate an implementable engineering solution that will make the above expression valid. The starting point is to understand America's population growth through 2100. Population size is the primary consideration in assessing U.S. energy security.

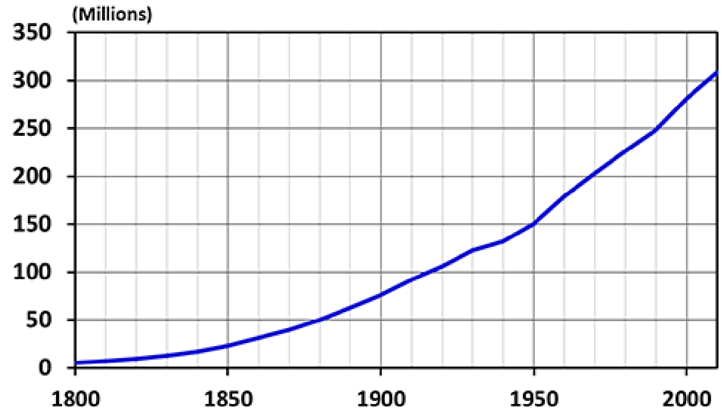
Section II – Forecasting America's Energy Needs in 2100

While politicians may wish to speak in generalities, engineers prefer to express our thinking quantitatively. Fortunately, the critical issue of planning for America's energy needs in 2100 easily lends itself to being defined quantitatively. In fact, it is a matter of simple arithmetic. The two important pieces of information needed to forecast America's energy needs in 2100 are the size of the population and the expected energy supply needed per person (per capita) each year to maintain a prosperous standard of living.

America's Population Will Likely More Than Double By 2100

America's demand for natural resources is driven by its population size. Over the last two centuries, America's population has climbed steadily from around 5-8 million in 1800 to around 307 million in the last census in 2010 (Fig. 2).

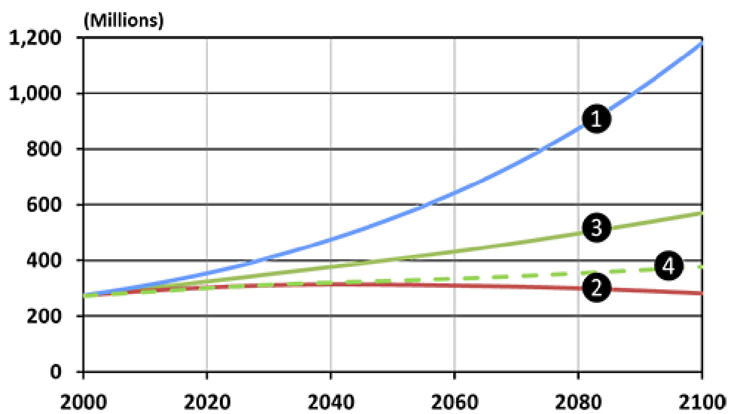
Fig. 2 - U.S. population (1800-2010)



(Original data source: U.S. Government)

In 1999, the U.S. Census Bureau made several forecasts of the U.S. population through 2100.[4] Figure 3 shows three of these forecasts establishing an upper ❶, a lower ❷, and a middle ❸ series projection based on assumptions of fertility and death rate, along with continued immigration.[5] Of these three forecasts, the middle series is used in this paper as the basis for projecting American population size in 2100.

Fig. 3 - U.S. population projection (2000-2100)



(Original data source: U.S. Census Bureau, 1999)

In 2008, the Census Bureau updated the 1999 projection through 2050. This is shown in Fig. 4. <u>Using this update, a linear extrapolation is then used to establish a ballpark</u>

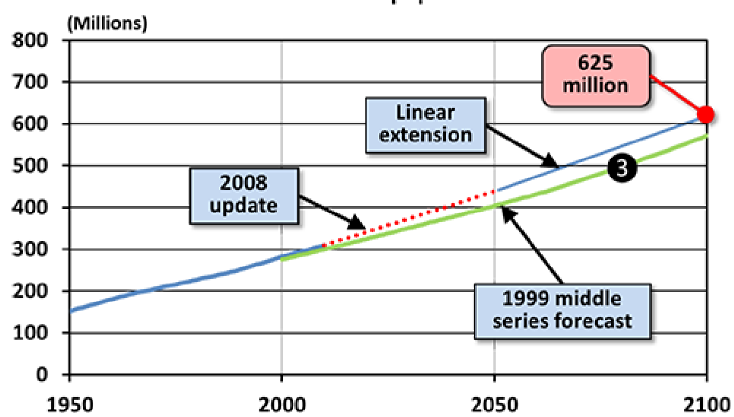
---

[4] http://www.census.gov/population/projections/files/natproj/summary/np-t.txt; http://www.census.gov/population/projections/files/natproj/summary/np-t1.txt.

[5] For comparison, the dashed line ❹ represents the middle series forecast but with zero immigration. Used as a point of reference, it shows that about two thirds of the U.S. population growth through 2100 will be due to immigration.

estimate of the 2100 U.S. population size of 625 million used in this paper. As seen in Fig. 3, this is about 60 million greater than the 1999 forecasted 2100 population, indicating that, as the century unfolds, even this 625 million forecast may prove conservative—a point to keep in mind![6]

Fig. 4 - U.S. population projection to 2100 used in this paper



(Original data source: U.S. Government)

With a planning estimate of 625 million Americans in 2100 as the starting point, the next step in assessing White's Law is to examine U.S. per capita energy use.

Per White's Law, American Culture is Quantitatively Defined by Its Per Capita Energy Use

At the heart of the American industrial revolution of the later 19th century was the expenditure of increasing amounts of energy per person (per capita) to make life better. In a general sense, per capita energy use is a good quantitative measure of our culture or standard of living since, by White's Law, they are related.

To discuss per capita energy use, we need a readily understandable unit of measure. For this paper, the barrel of oil equivalent or BOE is this unit. An actual barrel of oil contains 42 U.S. gallons. By international agreement, this amount of oil is assumed to contain 5.8 million British Thermal Units or BTUs of energy.[7]

---

[6] The reader should consider the implications of liberalized U.S. immigration policy, as proposed by some, on any estimate of the size of the U.S. population in 2100. Most immigrants come to America to "adopt" our standard of living which, by White's Law, means they and their children are adding to our future energy needs. There is nothing in White's Law granting them a waiver with respect to their impact on future U.S. energy needs.

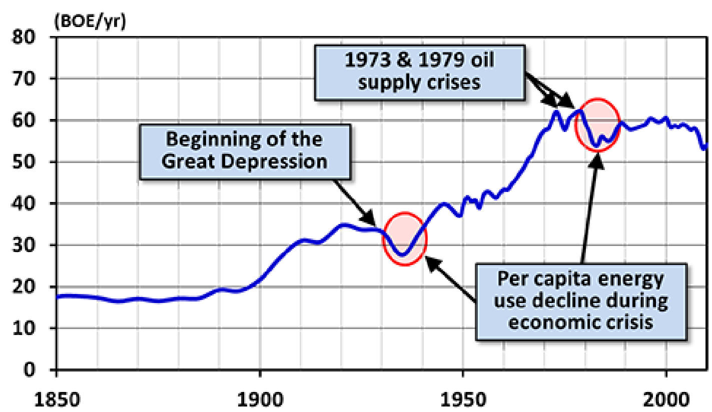
[7] A British Thermal Unit or BTU is the amount of thermal energy required to increase the temperature of one pound of water by 1°F. The BTU was defined in the early days of steam engine development to quantify how much thermal energy was released by the combustion of fuels such as wood and coal. To understand better how much heat is involved, heating a cup of tap water to the start of boiling to make a cup of tea requires about 70 BTU.

1 BOE = 5.8 million BTU

All forms of energy production or consumption can be expressed in terms of the BOE of gross thermal energy produced or consumed. This is true even for production methods such as hydroelectricity that do not involve any form of combustion. In such cases, the actual electrical energy generated is replaced by the amount of oil that would be required to generate the same quantity of electrical energy using an oil-fired power plant.

The U.S. Government has kept reasonably good energy production and consumption statistics since the 1850s. By summing up the types of energy produced, converting this to the common unit of BOE, and then dividing by the U.S. population at the time, an historical per capita energy use, expressed in BOE/yr., can be determined. The calculated annual U.S. per capita energy use from 1850-2010 is shown in Fig. 5.[8]

Fig. 5 - U.S. per capita energy use (1850-2010)



(Data source: Composite of publicly available data)

Up until the Civil War, non-food per capita energy consumption was primarily for cooking and space heating. The 17 BOE/yr. of per capita energy consumption was almost entirely from wood fuel—around five cords of seasoned hardwood per person per year. While there was a modest amount of steam-powered transportation and industry, prior to the Civil War this did not significantly impact per capita energy use. For example, in 1850 there were only about 9,000 miles of railroad. Also, during this mid-century period, building construction and heating technology (T) improved, especially with the introduction of cast iron stoves to replace open hearths for cooking and heating. This increased the efficiency of the use of wood fuel, allowing more work to be performed per cord of wood fuel.

[8] Note that annual energy production/consumption data reporting did not start until 1950. Prior to that year, reporting was at 5-year intervals creating the impression of less year-to-year variation.

The impact of the American industrial revolution began to be reflected in increased per capita energy use about 1890 as the nation shifted from wood fuel and human/animal power to steam-powered transportation and industry; to electricity generation; to coal, oil, and natural gas fuels; to oil-fueled transportation; and to electricity-powered communications, entertainment, homes, and industry. As seen in Fig. 5, with the exception of the Great Depression, per capita energy use climbed fairly continuously from 1900 until the early 1970s—rising from about 22 BOE/yr. in 1900 to the historic peak of about 62 BOE/yr. just prior to each of the two oil supply crises of 1973 and 1979.

Despite 30 Years of Intense Emphasis on Conservation, American's Per Capita Energy Use Has Only Very Modestly Declined

To forecast the average U.S. per capita energy need in 2100, a baseline representative of the future American culture is needed. The period of 1960-2010—roughly the last half-century—is used. This covers the period of the rapid rise in per capita energy use during the 1960s, the peak in domestic oil production in 1970,[9] the twin historic peaks in the 1970s, the two oil crisis-induced economic recessions,[10] the subsequent two decades of a very modest decline in per capita energy use, and the beginning of the current recession. It was during this half century that the modern American lifestyle was established—a lifestyle that, it is presumed, Americans in 2100 will wish to continue if not improve.

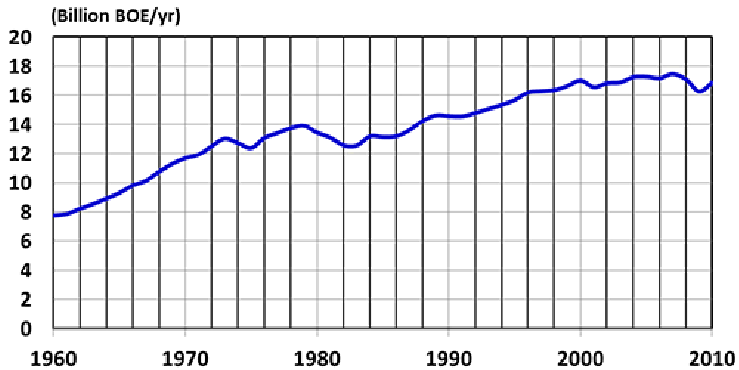
Figure 6a shows the total annual gross thermal energy used over the last half century more than doubling from 8 billion BOE/yr. in 1960 to nearly 18 billion BOE currently. The key point of this figure is emphasizing the fact that the U.S. total energy consumption continued to increase at a fast pace despite, as seen in Fig. 6b, a leveling off and modest decline in per capita energy use. This emphasizes the major influence of population size in defining America's energy needs in the future.

---

[9] Beginning in the late 1950s, the United States began to import large quantities of oil as demand outpaced domestic production. In 1970, domestic oil production peaked even as domestic demand continued to grow. At this point, the U.S. vulnerability to a disruption in oil imports became significant as oil imports surged from about 1 billion BOE in 1970 to over 2 billion BOE in 1973 at the time of the first oil supply crisis.

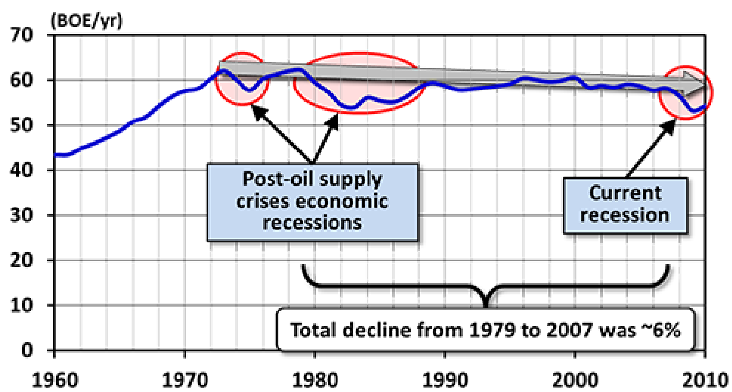
[10] The first oil supply crisis arose in 1973 during the 4th Arab-Israeli War, also known as the Yom Kippur War. Due to a reversal of fortunes on the battlefield by the attacking Arab forces, some oil-exporting countries in the region initiated an embargo of the United States in an attempt to dissuade U.S. military support for Israel during the conflict. World oil prices more than doubled. While the military aspects of the conflict were resolved in fairly short order, the economic consequences persisted in the United States for nearly five years before per capita energy use returned to pre-crisis levels. The second oil supply crisis started following the hostage-taking of U.S. citizens in Iran in 1979. The hostage situation persisted for well over a year. In response, the United States embargoed oil imports from Iran. This drove world oil prices to near $100/barrel in 2010 dollars. With oil supplies constrained, with natural gas supplies also constrained due to over-regulation by the government, and with high world oil prices, the United States entered a severe recession with high unemployment, high interest rates, and high inflation. It took nearly a decade for per capita energy use, as a measure of the standard of living, to return to near pre-crisis levels.

Fig. 6a – Annual U.S. gross thermal energy consumed (1960-2010)



(Data source: U.S. Government and author's projection)

Fig. 6b - U.S. per capita energy use (1960-2010)



(Data source: Composite of publicly available data)

The chart of U.S. per capita energy use over the last 50 years, seen in Fig. 6b, is a remarkable example of a civilization adapting to circumstance. Imagine it is still the early 1970s and you are plotting per capita energy use since 1900 in order to forecast America's energy needs in the 21st century. What would you have forecast for 2010? A simple linear extrapolation would put per capita energy use somewhere in the range of 100-120 BOE/yr. The United States would today be annually consuming about 31-37 billion BOE. Given the standard of living Americans have today at about 58 BOE/yr., it is difficult to visualize what standard of living would need 100-110 BOE/yr.—flying cars, perhaps? The point of this thought exercise is to appreciate the fundamental transformation that America underwent in the 1970s and 1980s as the near-continuous century-long growth in annual per-capita energy use halted, leveled off, and then began a modest decline.

The twin oil-supply crises of the 1970s obviously triggered this transformation. The severity of the back-to-back recessions, the increased energy costs, the accompanying inflation, the imposition of Government mandates with new energy efficiency standards (e.g., car mileage), and, especially, the emergence of new technologies ended the pre-crisis year-over-year growth in per capita energy use. In effect, Americans became content with the standard of living they had achieved by 1980 and, going forward, were content to let technological improvements, rather than increased per capita energy use, achieve future increases in their standard of living. In essence, Americans made White's Law work for them, instead of against them. Of course, it helped immensely that the United States had affordable replacement energy sources to turn to.[11]

The historic peak of U.S. per capita energy use occurred in 1979. After that, the United States has seen a modest long-term decline in per capita energy use even during prosperous times. While many in the environmental movement had advocated for significant reductions, the reality is that over the nearly thirty-year period of 1979 to 2007, per capita energy use declined only a total of a 6%. Obviously, there has been an improving energy efficiency technology component of White's Law responsible for part of this reduction, e.g., car mileage standards. However, there are also social and consumer trends of an aging population, more single households, larger homes, longer commutes, more electronic communications, larger TVs, a higher standard of living at the lower end of the economic spectrum and during retirement, etc., which also have impacted per capita energy use.

The very important historical lesson learned from these past 30 years is that despite significant government and societal emphasis on achieving substantial decreases in per capita energy use through energy conservation and technological energy utilization efficiency improvements, <u>the actual real reduction in per capita energy use was only about 0.2% per year</u>. It strongly argues against the proposition that America can be expected voluntarily to "conserve" its way out of the pending energy crisis absent draconian Government mandates.

U.S. Per Capita Energy Need in 2100 is Forecast to Be 50 BOE/Yr.

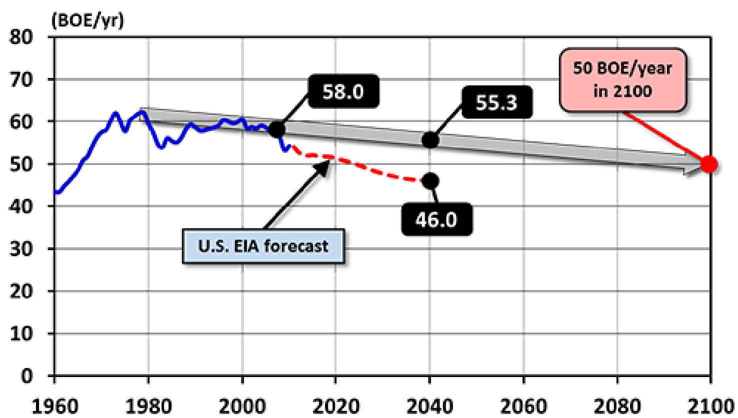
Drawing on the last 30 years' data, in Fig. 7, the author linearly extends the 1979-2007 trend to 2100, where the U.S. per capita energy use would be in the ballpark of 50 BOE/yr. This equals a 14% reduction from the current U.S. per capita non-recession energy use of about 58 BOE/yr. Accomplishing this modest decline would be expected to come from technological advancement with no loss of standard of living—making White's Law work for us. This means that our grandchildren living in 2100 would live in

---

[11] One important outcome of the second oil-supply crisis is that U.S. per capita oil consumption was permanently lowered—falling about 25%—despite oil prices returning, in the mid-1980s, to near pre-crisis levels. During the six years of the recession, the United States shifted away from oil where technologically and economically feasible. Coal production expanded to replace oil for electricity generation. Natural gas production, once it was deregulated, expanded to heat homes and supply industry. Nuclear electricity, in development since the 1950s, became commercially available to help meet growing demand for electricity. In all three cases, the costs of the replacement energy sources were less than the cost of the oil they replaced. The availability and affordability of these replacement energy sources enabled the United States to return to near pre-crisis per capita energy use as the 1980s ended. Note, however, that all of these substitution energy sources were also non-sustainable. Consequently, this was only a temporary fix.

homes comparable to ours today, have personal transportation comparable to ours today, travel for business and vacation, etc. Of course, there would twice as many Americans, meaning that housing and roads would double, food and water production would double, etc.[12]

Fig. 7 - U.S. per capita energy use & EIA forecast (1960-2100)



(Data source: Composite of publicly available data)

For comparison, the U.S. Energy Information Administration (EIA) 2013 projection of U.S. per capita energy use through 2040 is also shown in Fig. 7. This EIA projection reflects a number of separate inputs including increased environmental regulation and a decreased long-term rate of economic growth. While the author's linear projection would see a 55 BOE/yr. rate of consumption in 2040, the EIA is forecasting only 46 BOE/yr.—16% lower.

Recall that the total reduction from 1979-2007 was only about 6%. Also, take note of the fact that this EIA projection begins at the current depressed mid-recession per capita energy use and forecasts a permanent, long-term decline from this depressed starting point. Compare this to the experience after the 1979-1985 recession—Fig. 6b—when, as the economy and consumer confidence improved, per capita energy use returned to near-historic peak levels. No such recovery is seen in the EIA forecast as the economy recovers. Hence, the author believes the EIA forecast to be unreasonably optimistic—yes, optimistic—for use in projecting U.S. energy needs through 2100 because projections of future total U.S. energy needs, based on this EIA forecast, are likely to be low. Energy security planning would then miss the mark in terms of having adequate future energy supplies. Draconian government mandates may then be necessary to force lower per capita consumption to meet the inaccurate forecasts and correspondingly inadequate energy supplies.

[12] One unknown is the growth of humanoids—robots replacing humans at work or serving humans as machine butlers. It is possible there may be tens of millions of such robots in the United States in 2100, all requiring energy to operate, maintain, repair, replace, and transport.

At the author's forecast per capita energy use of 50 BOE/yr. by 2100, U.S. per capita energy use would have declined by nearly 20% from the 1970s historic peak. While more energy conservation may be achievable, it is also important to recall, as noted earlier, that the future population size projection is now trending higher, meaning that the United States may actually have more than 625 million people in 2100. Thus, the 50 BOE/yr. per capita energy use and the 625 million U.S. population in 2100 combine to provide, at least for now, a reasonable set of assumptions for assessing future U.S. energy security needs. Adjustments, of course, will be necessary as the future unfolds.

The United States Will Need About 31 Billion BOE Annually By 2100 to Maintain Its Standard of Living

The calculation of the U.S. energy need any particular year is simple:

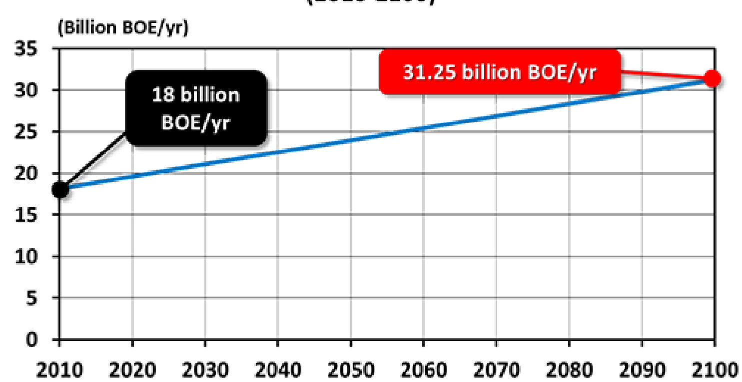
Population size x per capita energy use = total energy needed

Using the population growth data shown earlier combined with the linear decrease in per capita energy use to 50 BOE/yr. forecast for 2100, the annual U.S. energy need from 2010-2100 can be computed.

625 million x 50 BOE/yr. = 31.25 billion BOE/yr. in 2100

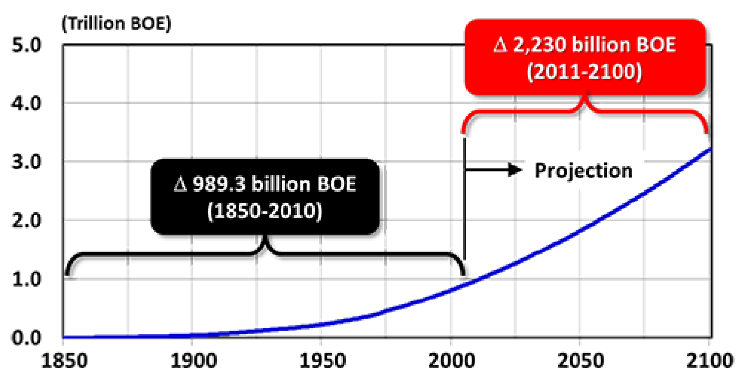
The annual need from 2011-2100, plotted in Fig. 8, will grow by nearly 75%. While this increase sounds large, as noted earlier, the U.S. total energy consumption more than doubled in the last half-century. Thus, planning for a U.S. energy infrastructure capable of supplying in the ballpark of 31 billion BOE by 2100 is prudent.

Fig. 8 - Projected annual U.S. gross thermal energy need (2010-2100)



From 2011-2100, the United States Will Need a Secure Supply of 2.23 Trillion BOE

Fig. 9 - Cumulative U.S. gross thermal energy consumed and needed (1850-2100)



(Data source: U.S. Government and author's projection)

Figure 9 shows the cumulative energy use and projected future need from 1850-2100. From 1850-2010, the United States consumed just shy of 1 trillion BOE. From 2011-2100, the forecast is that the United States will need an additional 2.23 trillion BOE. Hence, through the remainder of this century, the United States will need more than twice the amount of energy consumed since 1850.

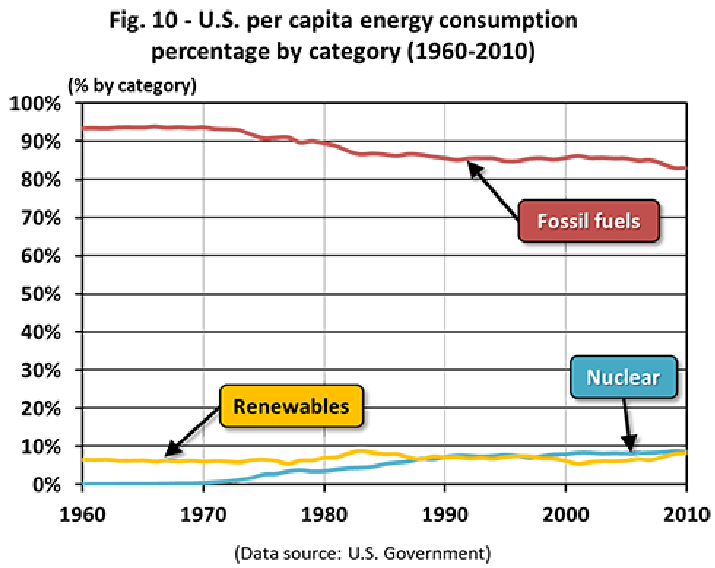
For U.S. energy security planning purposes, there are now two targets that must be met to ensure energy security and economic prosperity:

- An annual energy supply growing to about 31 billion BOE per year by 2100.
- A total energy supply of about 2.23 trillion BOE through 2100.

Of course, remember that the U.S. energy needs do not simply end in 2100. These targets are, essentially, intermediate planning milestones.

Section III – How Long Will Fossil Fuels Continue to Sustain America's Energy Needs?

Where will this 2.23 trillion BOE of energy come from? Almost everyone assumes the vast majority of this will be supplied by fossil fuels. As seen in Fig. 10, over the last 30 years, fossil fuels have provided about 85% of America's energy needs. Is it reasonable to expect this level of supply to continue, especially as the total U.S. energy need substantially increases by 2100? If the answer is no, then the United States has a serious energy security problem. To find out, the U.S. fossil fuel endowment needs to be determined and compared against the 2.23 trillion BOE needed through 2100. The starting point is to understand the terminology.

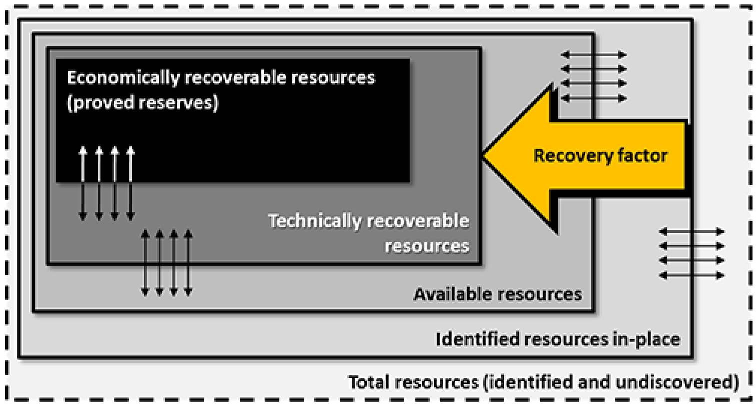


Terminology is Important in Understanding the U.S. Endowment of Useable Fossil Fuel Resources

Prior to the start of the current recession, nuclear and renewables provided about 15% of the annual gross thermal energy supply. Fossil fuels provided the balance of about 85%. Also, as seen in Fig. 10, for the last twenty years, even as wind and ground solar energy have been emphasized, the total contribution of renewables, as a percentage of per capita energy use, has stayed about the same percentage. Thus, a substantial continued reliance on fossil fuels would be expected into the foreseeable future. The United States simply has no other choice at this time.

As estimated earlier, from 2011-2100 the United States will need about 2.23 trillion BOE of gross thermal energy. If 85% of this is to be provided by fossil fuels, the United States will need about 2 trillion BOE of coal, oil, and natural gas through 2100. Does the United States have at least this amount of available domestic resources of these fuels—what the Congressional Research Service calls the “endowment”? The starting point for answering this question is to define some terms particular to non-sustainable natural resources like fossil fuels. These are illustrated in Fig. 11.

Fig. 11 - Terms used to define fossil fuel resources



The Earth has immense stores of fossil fuels accumulated through some truly amazing geological processes over a period of several hundred million years. These range from coal, formed under tall mountain ranges, to methane hydrates stored in a unique form of water ice generally buried under the seafloor in the deep ocean.

Fossil fuels, of course, are solar energy stored as chemical energy in carbon molecules. In all fossil fuels, releasing the stored solar energy requires combustion with oxygen from the air, yielding carbon dioxide as the primary unavoidable waste product. Eventually, plants use photosynthesis to convert the carbon in carbon dioxide back into new complex carbon molecules, releasing the oxygen back into the air and beginning the natural cycle of fossil fuel formation all over again.[13]

The above illustration is of a series of nested boxes showing the relationship between the terms used to characterize fossil fuels. These terms are defined as:

- **Total resources (identified and undiscovered)** is really just a mental anchor for these discussions. Geologists can provide a rough ballpark estimate of the total resources of a particular fuel, e.g., coal, but this is really just a guess.
- **Identified resources in place** is the estimate of the known resources of a particular fuel type within a defined geographic area, generally the land area of a nation and, possibly, its surrounding ocean.
- **Available resources** is that portion of the identified resources in-place that can be extracted in accordance with political, legal, and regulatory constraints.

[13] Currently, about two percent of the Earth's land surface is peat bog. As the plants in these bogs die, they form the peat that begins the natural cycle for fossil fuel formation leading to coal. Peat accumulates at a rate of about 1 inch in 25 years. This illustrates that the natural cycle of fossil fuel formation continues even today, although at a very slow pace compared to humanity's rate of extraction.

- **Technically-recoverable resources** is that portion of the available resources that can be extracted using available technical means and done per existing safety and environmental regulations. The ability to produce the fuel profitably may or may not be a consideration in making the estimate of the technically-recoverable resources. The size of the technically-recoverable resources is defined by the U.S. Government as the nation's "endowment" of fossil fuels and is, hence, appropriate to use in energy security planning.
- **Economically recoverable resources (proved reserves)** is the portion of the technically-recoverable reserves/resources that can be produced profitably at current market, legal, and regulatory conditions. Proved reserves—the terminology typically used— are normally owned or controlled by private industry.

In Fig. 11, the small arrows reflect the fact that these estimates change as more field data is collected and analyzed, as market, legal, and regulatory conditions change, and as new extraction technologies are introduced, e.g., hydraulic fracturing.

The large arrow represents what is referred to as the recovery factor. This is the percentage of the identified resources in place that can be permissibly extracted with available technologies. This percentage ranges from about 55% for coal, to 50-60% for conventional oil (with enhanced recovery methods), and to 80-90% for conventional natural gas. For oil and natural gas located in shale and tight rock formations—accounting for the recent boom in domestic oil and natural gas production and where guided drilling and hydraulic fracturing are required to be used—the recovery factor can be much lower—often less than 20%.

The U.S. Fossil Fuel Endowment is About 1.4 Trillion BOE

From a strategic energy security perspective, understanding how much technically-recoverable fossil fuel resources the United States has is critical. Figure 12 shows the summary table from a 2011 study done by the Congressional Research Service.[14] The report estimates that the United States has a remaining "endowment" of 1,366.8 billion BOE of technically recoverable resources. This includes economically recoverable resources (proved reserves) plus that portion of known and undiscovered technically recoverable resources thought by the Government to be profitable to produce. For example, the 261 billion short tons (2000 lbs.) of coal included in this endowment reflects only that portion of 486 billion short tons of available resources—called "demonstrated reserve base" in coal industry terminology—thought by the Government eventually to be profitable to produce.

[14] Carl R. Behrens et al., "U.S. Fossil Fuel Resources: Terminology, Reporting, and Summary," Congressional Research Service, R40872, December 28, 2011.

Fig. 12 - U.S. Congressional Research Service estimate of proved reserves and technically-recoverable resources

Table 4. U.S. Fossil Fuel Reserves Plus Undiscovered Technically Recoverable Resources Expressed as BOE
(BOE = Barrels of oil equivalent)

Fossil Fuel	Native units	BOE
Technically recoverable oil[a]	161.9 billion barrels	161.9 billion BOE
Technically recoverable natural gas	1717.8 trillion cubic feet	304.4 billion BOE
Recoverable reserve base of coal	261 billion short tons	900.5 billion BOE
TOTAL U.S. technically recoverable fossil fuel endowment		1366.8 billion BOE

Source: USGS, http://certmapper.cr.usgs.gov/data/noga00/natl/graphic/2010/summary_10_final.pdf; BOEMRE, http://www.boemre.gov/revaldiv/ResourceAssessment.htm; and EIA, http://www.eia.doe.gov/cneaf/coal/reserves/reserves.html.

a. Technically recoverable resources of oil and natural gas include proved reserves plus undiscovered technically recoverable resources. Includes conventional and unconventional (continuous), offshore and onshore.

Proponents of a continued substantial reliance on fossil fuels will often point out that the endowment estimate does not include two additional resources: unconventional oil from shale (oil shale) and unconventional methane from methane hydrates.

- Oil shale is not the same as the "shale oil" being recovered from shale and tight rock formations using guided drilling and hydraulic fracturing. Oil shale is actually a primitive form of petroleum called kerogen. This is viscous goo found in some porous rock formations. While the United States is thought to have on the order of 1 trillion BOE of oil shale, the technologies to produce this economically with adequate environmental protections have not yet been developed. This author believes that oil shale is best thought of as a true strategic oil reserve to be tapped only if energy supply circumstances become dire.
- Exploration has determined that the world has immense stores of methane locked in a form of water ice called methane hydrates. When formed under high pressure in the presence of methane in the water, the water ice forms around a methane molecule, locking the methane into the ice. To recover the methane, the ice needs to be melted. The typical deep locations of the methane hydrate under the seafloor, the diffuse distribution of the methane hydrate, and the likely significant environmental impact of methane recovery is thought, by the author, to make this fossil fuel resource uneconomical/socially unacceptable to produce in substantial quantities. Hence, it is not appropriate to include this in U.S. energy security planning.

With these perspectives on oil shale and methane hydrates, the Congressional Research Service's endowment estimate of 1.4 trillion BOE is a reasonable estimate to use in assessing U.S. fossil fuel energy security.

The U.S. Fossil Fuel Endowment is Far Less Than Needed to Remain Energy Secure Through 2100

Recall that the United States used just shy of 1 trillion BOE of gross thermal energy from 1850-2010. With this in mind, the endowment of nearly 1.4 trillion BOE does sound like the United States has satisfyingly large remaining useable fossil fuel resources. But is this really the case considering that the U.S. population will likely more than double by 2100?

Of the 1.4 trillion BOE endowment, 261 billion short tons or 900 billion BOE comes from coal. The United States is currently producing about 1 billion short tons of coal per year with almost all used for electricity generation. Keeping this rate of coal production constant would consume about 90 billion short tons—about 310 billion BOE—of coal through 2100.

If we assume that all of the endowment's oil and natural gas—shown in Fig. 12—would be extracted by 2100, the total fossil fuels produced through 2100 would total about 776 billion BOE.

162 billion BOE of oil + 304 billion BOE of natural gas + 310 billion BOE of coal
= 776 billion BOE

Of the 2.23 trillion BOE needed through 2100, let us assume that nuclear and terrestrial renewables continue to provide 15%. The balance of 85% would need to come from fossil fuels. As shown in the following computation, the United States would have an energy supply shortfall of 1.2 trillion BOE—about 53% of what is needed.

2,230 billion BOE needed through 2100 x 0.85
– 776 billion BOE of fossil fuels extracted through 2100
= **1,179 billion BOE shortfall**

Not good enough is it?

Let us assume a crash program—and a substantial relaxation of environmental regulations—to boost coal production so that the entire coal endowment of 900 billion BOE is extracted by 2100. In other words, let us assume the entire fossil fuel endowment of 1,367 billion BOE would be extracted by 2100. This still yields a shortfall of 529 billion BOE or about 24% of the total needed.

2,230 billion BOE needed through 2100 x 0.85
– 1,367 billion BOE of fossil fuels extracted through 2100
= **529 billion BOE shortfall**

This "what if" analysis indicates that even with a crash program to mine all of the technically-recoverable coal, the United States would exhaust its useable/affordable fossil fuel supplies well before 2100—within the lifetime of our children and grandchildren. As a result, U.S. annual energy supplies would dramatically fall unless some means of substantially increasing imported energy were possible. But that would also increase U.S. energy insecurity, just as happened with oil in the 1970s, and would force the United States to compete with other nations of growing economic power, e.g., China, for these resources.

Consequently, continuing forward on today's path of a substantial reliance on fossil fuels with no useful transition strategy to replacement energy sources is folly, is it not? It is a sure path to catastrophe that needs to be avoided. Thus, with the information available—U.S. energy needs through 2100 and the size of the U.S. endowment of fossil fuels—what path forward makes sense?

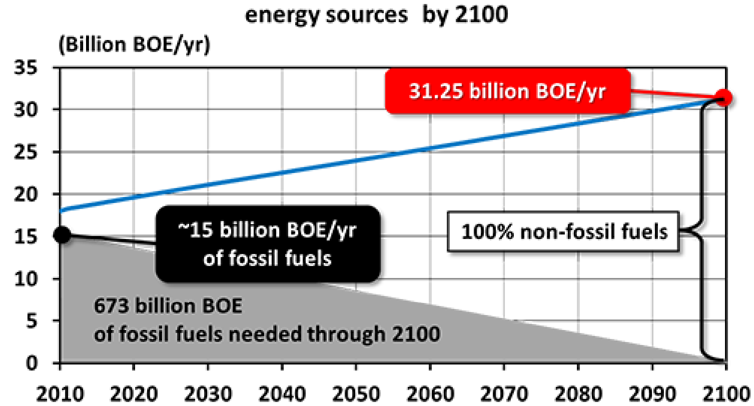
Section IV – Defining a Rational Path Forward to Achieve Energy Security

It should now be crystal clear that the age of fossil fuels is ending in the United States and America must prepare for the new future. White's Law explains the terrible consequences of failure to plan and act accordingly. Without adequate per capita energy supplies, a nation's culture or standard of living cannot be maintained. It is foolish to hope otherwise, is it not? Consequently, from a strategic energy security planning perspective, this means that the United States needs to replace fossil fuels with something else before affordable fossil fuels are no longer available.

This is where picking a planning horizon of 2100 comes into play. As will be seen in the following analyses of a hypothetical all-nuclear energy infrastructure, the size of the replacement non-fossil fuel energy infrastructure is quite large. Such a large infrastructure will not be built quickly. Thus, while picking 2100 may now appear to be impractically far in the future, as the scope of the effort required to implement a practical solution to replace fossil fuels is identified, this initial impression may change.

With 2100 being the hypothetical goal for achieving energy security with domestic non-fossil fuel energy sources, the transition would look like Fig. 13 below. By 2100, the United States would no longer be using a significant amount of fossil fuels.

Fig. 13 - U.S. transition to non-fossil fuel energy sources by 2100



Currently, the fossil fuel industry often takes great umbrage at any discussion of transitioning America to non-fossil fuel energy sources. Many see this as an either-or future. In reality, to maintain order in the U.S. energy market, it is important that both sides work together. The United States cannot make it to 2100 primarily on fossil fuels, as the earlier quantitative analysis shows. At the same time, the United States cannot simply abandon fossil fuels because the replacements are not yet available. Hence, the transition strategy shown in Fig. 13 is not only good for America, but good for the fossil fuel industry as well.

Let us put this transition into numbers. From around 15 billion BOE/yr. of fossil fuel energy consumed presently, the consumption of these fuels would, ideally, steadily decline to zero in 2100. To make this happen without supply disruptions, the U.S. fossil fuel industry would still need to produce about 673 billion BOE of fossil fuels or about 50% of the remaining U.S. fossil fuel endowment discussed above. This means that current private investment in fossil fuel production capabilities and privately-owned reserves would not be arbitrarily diminished in value. Instead, a robust U.S. fossil fuel industry would continue for most of the rest of the century.

With this new appreciation that the fossil fuel industry is not the enemy, but the underpinnings of maintaining America's energy security, what will replace fossil fuels? Conventional fission nuclear energy? Ground solar energy? Wind? Fusion nuclear energy? There can be no real transition plan for America to follow without identifying a suitable replacement energy supply capable of tens of billions of BOE annually. The first step is to analyze the magnitude of the non-fossil fuel energy supply needed by 2100, starting with an understanding of the units of energy used in this analysis. The unit "BOE", after all, is oriented towards fossil fuels. We need to switch to the unit made famous by the *Back to the Future* movie's Doc Brown—the gigawatt.

Section V – A Short Tutorial on the Power Unit of the 21st Century—The Gigawatt

As we move away from fossil fuels, the usefulness of using the BOE as the unit for measuring energy production and consumption diminishes. The reason is that the BOE relates to the thermal release of energy through combustion of some carbon fuel. Do we have any carbon fuels to replace fossil fuels? No, not really. Thus, what will replace fossil fuels will almost certainly be some form of electricity generation—nuclear-electric, geothermal, hydroelectric, solar, wind, etc. Characterizing the future power and energy needs, respectfully, in terms of the electricity generation units of gigawatts (GW) and gigawatt-hours (GWh) is, therefore, useful.

Power and Energy are Not the Same

It is important to recognize that "power" is not the same as "energy", although they are related. Energy reflects how much power is required over a period of time.

The watt is the international unit measuring the production or consumption of power.[15] Example: When a 100-watt light bulb is turned on, it consumes 100 watts of power

[15] The unit "watt" is named after James Watt, the 18th century inventor of the improved steam engine that enabled the industrial revolution.

continuously. At the end of one second, the bulb has consumed 100 watt-seconds of electrical energy. At the end of one hour—3,600 seconds—the bulb will have consumed 0.36 million watt-seconds. Obviously, such numbers rapidly become quite large. Thus, the number of watt-seconds is divided by 3,600 to yield watt-hours. Then, this is further divided by 1000 to yield kilowatt-hours or kWh. A 100-watt bulb operating for one hour will consume 0.1 kWh of energy. Residential electricity consumption is usually measured in kWh. A typical 2,000 sq. ft. home will consume about 1,000 kWh per month of electrical energy.

Units of Power and Energy Step Up and Down by Increments of 1000

If we divide the number of watts by 1000, this yields the number of kilowatts (kW). A home emergency generator will usually be in the range of 4,000-5,000 watts or 4-5 kW of power.

1 kW = 1,000 watts

Dividing again by 1,000 yields the number of megawatts (MW). Many utility generators are rated in terms of the MW of power produced. These typically natural-gas-fueled generators will be in the range of 100-200 MW of power.

1 MW = 1,000,000 watts

The next step up is to divide the number of MW by 1000 to yield the number of gigawatts (GW). Large baseload utility generators, such as coal and nuclear power plants, are generally in the range of 1000 MW or 1 GW.

1 GW = 1,000,000,000 watts

The final step is to divide the number of GWs by 1000 to yield the number of terawatts (TW). This unit is usually used to describe power consumption at the national or planetary level.

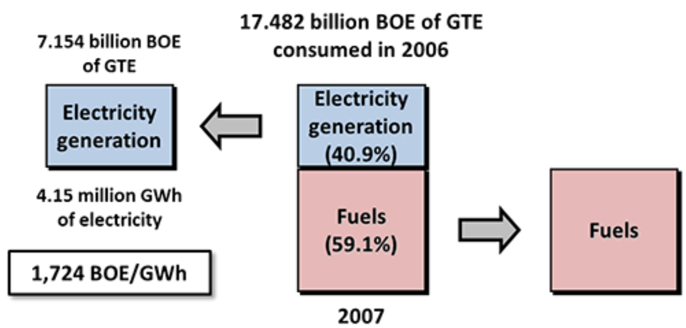
For this paper, U.S. national electrical power needs are described using the unit GW. In 2100, as the United States completes its transition from fossil fuels, the entire energy supply of the United States can be defined in terms of *XX* GW-years, rather than 31.25 billion BOE/yr. The number *XX* GW-years represents a continuous supply of *XX* GW of electrical power 24 hours a day, 365 days a year. The size of this number *XX* will surprise you.

Section VI – Assessing a Hypothetical All-Nuclear Energy Infrastructure for 2100

While currently the United States consumes around 18 billion BOE of gross thermal energy, in actuality, this energy is provided to the end consumer in two basic forms—dispatchable electricity and fuels used directly by the consumer for transportation, heating, industrial processing, etc. From 2007 data for the year prior to the start of the current recession, the distribution of gross thermal energy consumed as electricity and as fuels can be determined.

As shown in Fig. 14, in 2007, the United States consumed 17.482 billion BOE of gross thermal energy. That same year, 4.14 million GWh of electricity was generated. The EIA provides historical data on the thermal efficiency of the conversion of fossil fuels and nuclear energy into electricity, as well as the number of GWh generated by each.[16] In 2007, the average thermal conversion efficiency was 1,724 BOE per GWh of electricity generated. Using this conversion, 7.154 billion BOE of gross thermal energy was used to generate that year's 4.14 million GWh of electricity. The balance of 10.328 billion BOE was, thus, consumed as fuel by the end-consumer. That year, the split was 40.9% of the total BOE used for electricity and 59.1% for fuels. (The split each year, of course, varies somewhat due to weather, price, and other economic factors. In recent years, the split has been right around 40%/60%, so 2007 is a representative year.)

Fig. 14 - 2007 distribution of U.S. energy use



(Data source: U.S. Government)

Recall that the projection for 2100 is 31.25 billion BOE of gross thermal energy needed. Compared to 2007, this represents a growth of about 79%.

31.25 billion BOE in 2100 ÷ 17.482 billion BOE in 2007 = 1.788

Applying this to the 2007 electricity consumed yields a projected need for 7.42 million GWh in 2100.

4.15 million GWh in 2007 x 1.788 = 7.42 million GWh in 2100

In 2100, the estimated need for end-consumer fuels is about 18.5 billion BOE.

10.328 billion BOE of fuels in 2007 x 1.788 = 18.47 billion BOE in 2100

The balance of about 12.8 billion BOE would be used to generate the needed electricity.

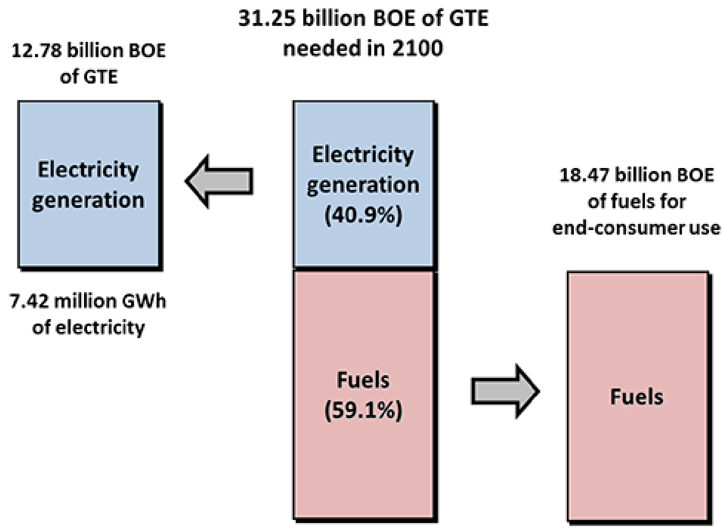
31.25 billion BOE needed in 2100 – 18.47 billion BOE of fuels in 2100

[16] In these calculations, the contribution of renewables was included with that of nuclear-electricity since a hypothetical all-nuclear energy infrastructure is being assessed.

= 12.78 billion BOE used to generate electricity in 2100

These results are shown in Fig. 15.

Fig. 15 - 2100 distribution of U.S. energy use



If Using Only Nuclear Energy, the United States Will Need 6,500 1-GW Plants Operating By 2100

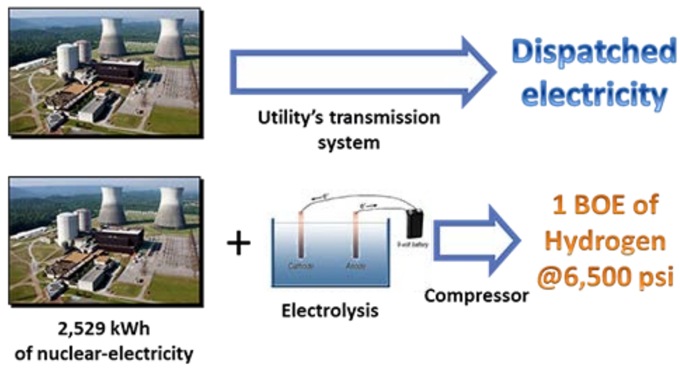
For this hypothetical assessment of an all-nuclear energy infrastructure, it is assumed that in 2100 the United States is powered only by nuclear fission power plants. The nuclear electricity generated is used to supply electrical power to the end-consumers and to produce hydrogen fuel to be used as fuel by the end-consumers. This is depicted in Fig. 16.

Using this model, how many 1-GW nuclear power plants would need to be operating in 2100 to provide:

- 7.42 million GWh of dispatched electricity.
- 18.47 billion BOE of hydrogen fuel compressed to 6,500 psi.[17]

[17] Hydrogen, as a gas at normal pressure and temperature, has a density of only 0.006 lb/cu. ft. Thus, to store hydrogen in bulk, it must be compressed to high pressures. For comparison, natural gas storage is in the range of 2,000-4,000 psi when stored as a gas rather than a liquid. As it takes more energy to liquefy hydrogen, compared to pressurizing it to 6,500 psi, high pressure storage is the most likely method that would be used.

Fig. 16 - Nuclear energy production model



In this analysis, each of these nuclear power plants is assumed to generate 1 GW of power and to operate at full power for 95% of the year.[18] Each of these 1-GW plants would be capable of delivering 8,322 GWh of energy a year.

1 GW x 24 hours/day x 365 days/yr. x 0.95 = 8,322 GWh per plant

In 2100, the projected electrical energy need for the United States is 7.42 million GWh. To produce this with 1-GW nuclear power plants would require 892 plants.

7.42 million GWh ÷ 8,322 GWh/plant = 892 1-GW plants

Obviously, conventional nuclear power plants do not produce hydrogen directly.[19] As seen in Fig. 16, hydrogen is produced through electrolysis where nuclear electricity is used to split the H_2O water molecule into its constituent hydrogen and oxygen atoms. The hydrogen is captured, compressed, and stored for end-consumer use as a fuel replacement for oil and natural gas.

The author estimates that—allowing for some technology improvement in the energy efficiency of the electrolyzers and compressors—producing and storing hydrogen for a lower heating value (LHV) use, such as home heating, will require 2,529 kWh of nuclear-electricity to produce one BOE of hydrogen fuel compressed to 6,500 psi.[20] As

---

[18] The remaining 5% of the year—about 18 days—is used for refueling and plant maintenance. Modern plants operate up to 18 months between refueling.

[19] There are proposals for advanced fission nuclear power plants that use thermal energy to split water directly in the reactor to yield hydrogen. This is not, however, state-of-the-art for fission nuclear power.

[20] The condition under which any fuel is combusted controls how much useful thermal energy is produced. There are two standard sets of conditions for determining the useful thermal energy produced by gas and liquid fuels. These are referred to as the "lower heating value" or LHV and the "higher heating value" or HHV with the latter due to more efficient conditions of combustion such as ultra-high efficiency, combined-cycle gas turbines. Most other combustion conditions, such as home heating and transportation, fall in the LHV category. At the HHV conditions of hydrogen combustion, the author's estimate is that 2,137 kWh of electricity is required per BOE of hydrogen compressed to 6,500 psi. Because the combustion process is more efficient, about 15% less electricity is needed to yield 1 BOE of

seen in the following calculation, to produce 18.47 billion BOE of end-consumer hydrogen fuel used at LHV conditions, it requires 47 million GWh of electricity. This is ten times (10X) the amount of electricity consumed in the United States in 2006.

18.47 billion BOE of hydrogen fuel x 2,529 kWh/BOE of hydrogen @ 6,500 psi
÷ 1000 kW/MW ÷ 1000 MW/GW = 46,710,630 GWh for producing fuel

Recalling that each 1-GW plant will ideally yield 8,322 GWh per year, a total of 5,613 1-GW nuclear power plants would be required, in 2100, to provide U.S. consumers with needed end-consumer fuels.

46,710,630 GWh in 2100 ÷ 8,322 GWh/nuclear power plant/yr.
= 5,613 1-GW plants needed in 2100 for fuel

By combining these two estimates for the number of 1-GW nuclear power plants required to produce both dispatched electricity and hydrogen fuel, an estimate of the total *XX* GW of generation capacity needed in 2100 to provide 31.25 billion BOE can be determined. <u>To replace fossil fuels by 2100, the United States would need about 6,500 GW of continuous generating capacity—or 6,500 1-GW nuclear power plants</u>!

892 for electricity + 5,613 for fuels = 6,505 1-GW plants in 2100

Currently, the United States has about 1,100 GW of generating capacity. Further, the United States only has 104 GW of nuclear power generating capacity. The fact that the United States will need in the ballpark of 6,500 GW of non-fossil fuel generating capacity by 2100 illustrates the magnitude of the challenge America has to overcome to become energy secure by 2100.

Expanded Conventional Nuclear Fission is Not a Solution for 2100

The likely eventual non-fossil fuel energy source will be fusion nuclear energy. Developing this new type of nuclear energy has been underway for over half a century. While progress has been made in understanding the basic physics of non-explosive fusion energy, there is no current estimate for when commercialization of this technology will enable fusion plants to be built. Thus, with advanced nuclear fusion not being a current candidate for replacing fossil fuels, can conventional nuclear fission be used instead?

Fission nuclear energy, with sound plant siting and modern designs, offers a highly reliable and operationally safe baseload electrical power generation capacity. The challenges it faces, however, are not insignificant. These include physical security, damage containment in the event of extreme acts of nature (e.g., earthquakes) or

---

net thermal energy. The LHV of hydrogen is 51,682 BTU/lb. Thus, 1 BOE equals 112.22 lb. of hydrogen or 50.9 kg. The author's estimate of 2,529 kWh/BOE, for both electrolysis and compression to 6,500 psi for storage, corresponds to 50 kWh/kg. According to Wikipedia, the typical range today is 50-79 kWh/kg for just electrolysis. The author's estimate anticipates some modest improvement in the efficiency of the electrolyzers and gas compressors.

terrorism, developing decades-long acceptable local waste storage at nuclear power plants, identifying acceptable millennia-long environmental radioactive waste disposal methods, denying uranium/plutonium production for weaponization by potentially hostile nations, and having sufficient fuel to power the plants for their expected 100+ year lives. Balancing these serious issues with the need to maintain a robust domestic nuclear power industry—anticipating the industry's eventual transition to fusion nuclear energy—leads the author to conclude that the use of uranium fission nuclear power will remain modest in the United States this century. Current plants totaling only about 104 GW—many with designs dating from the 1970s—will likely be modernized or replaced. A modest expansion of the total generation capacity to about 150 GW may also be undertaken, depending on the size of U.S. reserves of uranium fuel. However, any broad expansion of conventional uranium fission is unlikely.

Section VII – Assessing Ground-Based Solar Energy and Wind for Meeting U.S. 2100 Energy Needs

With conventional and advanced fusion nuclear energy being unlikely to replace fossil fuels this century, the only other practical terrestrial options are the renewable energy sources of wind, ground solar, hydroelectricity, geothermal-electricity, biomass, and tidal/wave-generated electricity. Can they provide the equivalent of 6,500 GW of dispatchable generation capacity?

The last four options fall into the category of either being impractical, e.g., tidal/wave-generated electricity, or not being capable of significant expansion.

- The United States has about 78 GW of installed hydroelectric generating capacity and the potential to add only about 30 GW of new generating capacity.[21]
- The United States has about 4 GW of geothermal-electricity generation. In 1978, the U.S. Geological Survey estimated the total identified and undiscovered geothermal electrical power generation potential in the United States at 95-150 GW. Yet, over the last 30 years, very little of this potential has been developed indicating the difficulty in commercializing this potential.[22]
- In 2005, the Departments of Energy and Agriculture evaluated the potential of land biomass as a fuel source.[23] This author estimated that the Government's projected potential could yield about 16.4 quadrillion BTU or 2.8 billion BOE of combustible fuels—alcohol, biodiesel, etc.[24] This required the substantial use of genetically-modified crops to increase residual biomass production and the use of nearly all recoverable agriculture, farm, and forestland waste from roughly one million sq. mi. of farmland and forestland. A key point of this 2005 study,

---

[21] Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants, DOE-ID-11263, January 2006, 1, http://hydropower.inl.gov/resourceassessment/pdfs/main_report_appendix_a_final.pdf.

[22] United States Geological Survey Circular 790, Assessment of Geothermal Resources of the United States, 1978, http://www.geo-energy.org/aboutGE/potentialUse.asp.

[23] Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply, April 2005, http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

[24] James Michael Snead, "The End of Easy Energy and What to Do About It," 2008, 82.

> however, was that it was based on meeting the food and feed needs of the U.S. at the present time and not in 2100 when the population will likely have doubled. All of these factors indicate that any significant expansion of biomass use for energy production is unlikely.

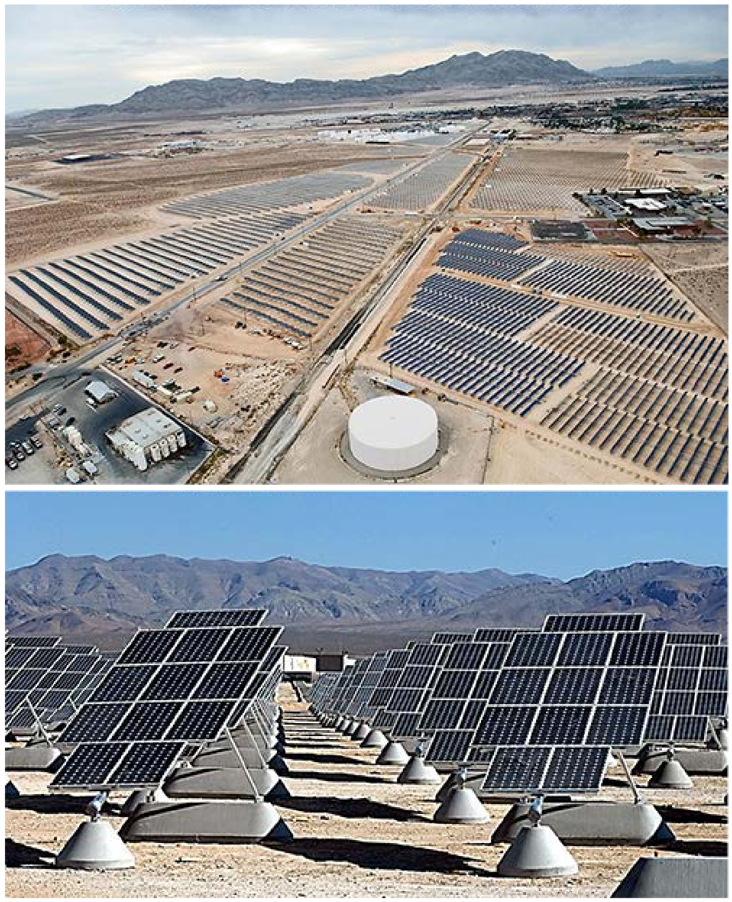
Consequently, of these remaining terrestrial renewable energy alternatives, only ground solar and wind have the potential to be scaled up to the necessary capacity. By using the information from the earlier all-nuclear energy assessment, the practicality of building ground solar and wind farms of sufficient scale to meet the 2100 energy needs can be readily evaluated.

The 14 MW Nellis Air Force Base Solar Farm is Used as a Baseline for Evaluating the Potential of Ground Solar Energy

In 2007, the U.S. Air Force installed a moderately-sized ground solar photovoltaic farm at the Nellis Air Force Base outside of Las Vegas, Nevada. Nellis Air Force Base is a primary flight training facility, indicating that clear blue skies are the norm and good solar insolation (watts of sunlight/sq. ft.), should be available most days. In fact, in terms of the level of solar insolation, this is one of the best locations in the continental United States. This makes this solar farm's performance a good baseline for evaluating the potential of ground solar energy.

The solar farm covers 140 acres (0.219 sq. mi.) and is comprised of solar photovoltaic panels mounted either on a translating stand, as seen in the bottom photograph in Fig. 17, or a standard fixed panel stand. The advantage of the translating stand is that it rotates the panels from east to west to track the movement of the sun across the sky to maximize solar-electricity output throughout the day. However, the disadvantage is the tracking system's added cost and maintenance needs.

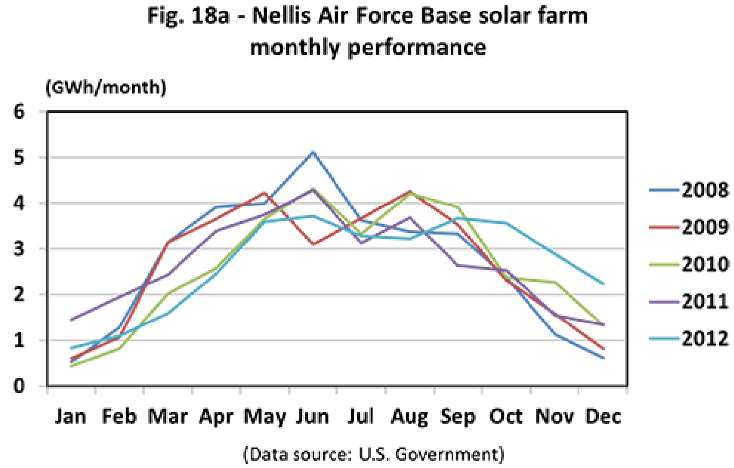
Fig. 17 - Nellis Air Force Base 140-acre solar farm

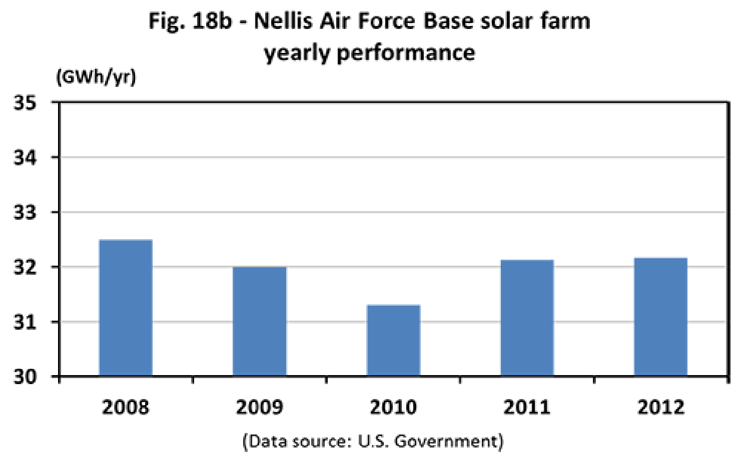


(Source: U.S. Government)

The nameplate generation capacity of the 72,000 installed panels totals about 14 MW.[25] The monthly and annual performance of this solar farm over the years 2008-2012 is shown in Fig. 18a and 18b. The monthly output is shown in Fig. 18a while the year-to-year variation in total annual output is shown in Fig. 18b.

[25] The nameplate generation capacity of a panel is based on tests under simulated sunlight positioned directly over the panel. It is the maximum output of the panel under ideal conditions that rarely occur in practice.





During the first five years of operation, the 0.219 sq. mi. solar farm produced an average of 32.0 GWh/yr. of electrical energy. This equals 146.1 GWh per sq. mi. per year.

$$32.0 \text{ GWh} \div 0.219 \text{ sq. mi.} = 146.1 \text{ GWh/sq. mi.}$$

To model a solar farm output using this Nellis data, the following adjustments are included:

- Increase the net output of the solar panels by 33% to account for more efficient photovoltaic cells, mounting, and positioning within the farm.
- Apply a 90% adjustment to account for lower average insolation values, primarily due to weather, as the area of the solar farms expands to cover most of the Southwestern United States.

- Apply a 73.9% adjustment to account for the use of lower-cost and easier-to-maintain fixed-panel mounting rather than the translating stand used primarily at Nellis.
- Assume 95% availability.

Applying these adjustments to the real-world Nellis data yields a model estimate of 122.8 GWh/sq. mi. for solar farms located across the American Southwest. This will be used in computing how many sq. mi. of solar farms are needed to yield the 31.25 billion BOE of gross thermal energy needed in 2100.

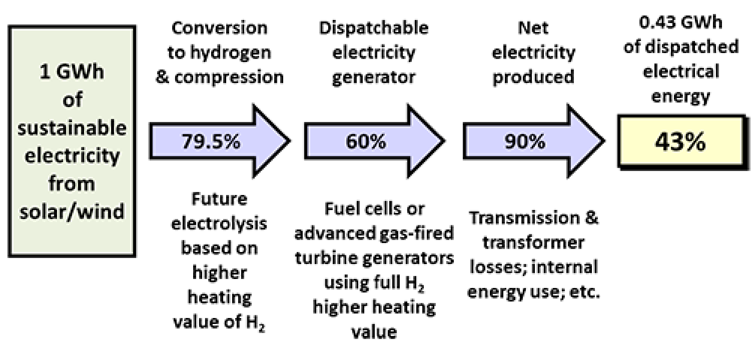
146.1 GWh/sq. mi. x 1.33 x 0.9 x 0.739 x 0.95 = 122.8 GWh/sq. mi.

To Meet U.S. 2100 Energy Needs with Ground Solar Energy Would Require About 521,000 Sq. Mi. of Solar Farms

As mentioned, a primary issue with ground solar (and wind) is the variability of the electricity produced by a solar farm, as seen in Fig. 18b. The U.S. electrical power infrastructure is tightly regulated and controlled to ensure continuous, high-quality electrical power at all times. What the end-consumer receives from the utility is referred to as “dispatched electricity.” This electricity must be continuously generated because it only takes a fraction of a second for the generated electrical power to reach the end-consumer. (Electricity is not stored in the utility’s transmission and distribution system.)

As can be easily imagined, trying to deliver high-quality dispatched electricity from a variable input source, such as ground solar or wind, is very difficult, especially as the scale of production grows. The solution used in this model is to change the solar-electricity into hydrogen, store the hydrogen, and then use hydrogen-fueled gas-turbine generators at the local utilities to generate the needed dispatched electricity. The overall efficiency of this, using the same improved technology assumptions as were included in the previous nuclear model, is 43% (See Fig. 19). This means that 1 GWh of solar-electricity from a solar farm will yield 0.43 GWh of dispatched electricity from the utility to the customer.

Fig. 19 - Overall efficiency in producing dispatched electricity from a variable electrical power source



From Fig. 15, the U.S. will need 7.42 million GWh of dispatched electricity in 2100. To provide this from ground solar farms, the total area of the farms would need to be about 141,000 sq. mi.

7.42 million GWh needed in 2100
÷ (122.8 GWh/sq. mi. of solar farm x 0.43)
= 140,520 sq. mi.

A slightly different analysis is used to compute how many sq. mi. of solar farms are needed to provide the 18.47 billion BOE of hydrogen fuels needed in 2100. For this simple analysis, all of the solar-electricity generated for this purpose is assumed to be converted to hydrogen fuel. As in the all-nuclear case, the conversion rate is assumed to be 2,529 kWh per BOE of hydrogen stored at 6,500 psi. Repeating the calculation from the all-nuclear analysis, this requires around 46.7 million GWh. With each sq. mi. of solar farms yielding an estimated 122.8 GWh, the area needed to produce fuel in 2100 is about 380,000 sq. mi.

18.47 billion BOE of hydrogen fuel x 2,529 kWh/BOE of hydrogen @ 6,500 psi
÷ 1000 kW/MW ÷ 1000 MW/GW = 46,710,630 GWh

46,710,630 GWh ÷ 122.8 GWh/sq. mi. = 380,380 sq. mi. of solar farm

By adding these two estimates, the total net area of advanced ground solar farms needed in 2100 is about 521,000 sq. mi. The continental United States totals about 3 million sq. mi. Nearly 18% of the U.S. lower 48 states would need to be bulldozed flat and planted with solar arrays. Additional ground would be needed for access roads, transmission and distribution systems, substations, etc.

140,520 sq. mi. for dispatched electricity + 380,380 sq. mi. for fuels
= 520,900 sq. mi. of solar farms

An important point to recognize is that in the Southwestern United States, only a modest percentage of the ground is sufficiently flat to be used for solar farms. Hence, while the actual farms may require 520,900 sq. mi., this will be spread out over a much larger geographic area. For comparison, the entire land area of New Mexico and Arizona totals only about 236,000 sq. mi. Hence, virtually all of the flat ground in the southwestern states extending as far east as western Texas and as far north as northern Nevada would be needed for solar farms. Is this practical?

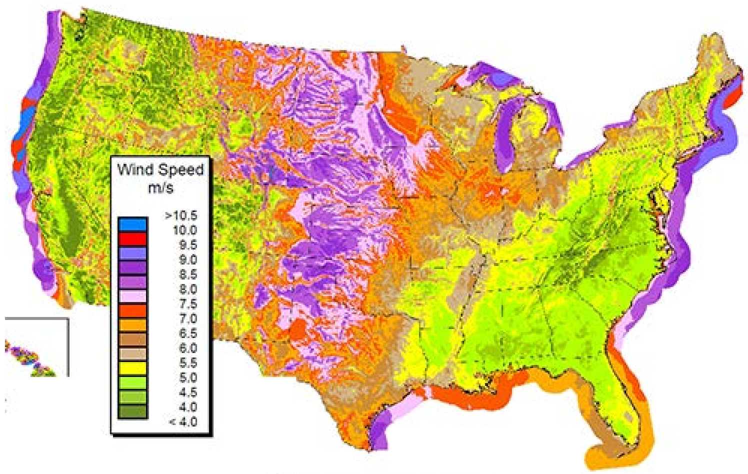
To Meet the U.S. 2100 Energy Needs with Wind-Electricity Would Require 1.4 Million Sq. Mi. of Wind Farms

Wind has been the fastest growing segment of the renewable energy portfolio. Wind, like ground solar, is a variable power source and must be treated in much the same way by producing hydrogen to generate both dispatched electricity and end-consumer fuel.

The Federal Government has mapped the wind energy potential across the United States. Figure 20 shows the distribution of average wind speed at 80 meters (262 ft.)

above the ground. This corresponds to the hub height of a typical 1.5-MW wind turbine. The purple-red areas in the map below have the greatest potential, with average wind speeds in the range of 8.5-9.5 meters/sec (19-21 mph). Most of the continental United States, however, has poor wind power potential. This means that wind farms must necessarily be located in the central United States—the primary food growing region of the country.

Fig. 20 - U.S. 80-meter wind power map

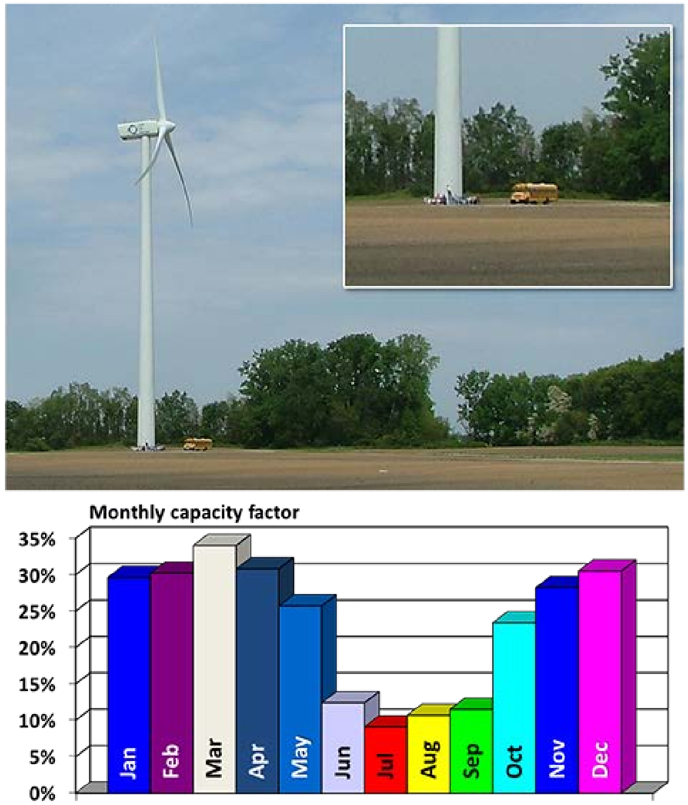


(Source: U.S. Government)

Figure 21 shows the variation in monthly output for four 1.8-MW wind turbines—7.2 MW total—located in northwestern Ohio. The "capacity factor" is the percentage of the total potential wind energy—expressed in GWh—that the wind turbine actually generates each month or year.[26] For the 12-month period of November 2003-October 2004, the average capacity factor was about 22%. To be clear, this means that over this 12-month period, the wind turbines produced only 22% of the energy that would have been produced had the turbines been generating their nameplate 7.2 MW continuously.

[26] The available wind power is a function of the wind's velocity raised to the third power. Hence, increasing the turbine's hub height generally raises the rotor into winds of higher speed, making more wind power available to be harnessed. Commercial wind turbines currently fall into two groups: 80 m hub heights, with a nameplate generation capacity of 1.5 MW, and 100 m hub heights with a 2.5 MW capacity. A wind turbine only produces its nameplate power when the wind speed is equal to or greater than the turbine's rated speed but less than the maximum permitted speed. For 2.5-MW turbines, this is usually in the range of 28-56 mph. Below the rated speed of 28 mph (12.5 meters/sec), the electrical power output is less than the nameplate power. Below about 7 mph, the turbine is stopped. Above 56 mph the turbine is also stopped to prevent structural damage. Most of the time, the wind speed is below the rated speed, which is why the capacity factor is less than 100%. In the best areas, the capacity factor is in the range of 35-40%.

Fig. 21 - Actual monthly capacity factors at four Ohio 1.8 MW wind turbines for Nov 2003-Oct 2004



(Photograph: Author)

Early wind farms were concentrated on low mountain ridges in California because the ridge accelerated the wind's speed and, consequently, the available wind power. These wind farms positioned the turbines along the ridge because the wind direction was usually blowing in just one direction—across the ridge. Such ideal ridge locations are only a small percentage of the land area of the United States with good wind conditions. In more typical circumstances, the wind turbines are spaced in a grid to enable the wind to be harnessed regardless of the direction the wind is blowing. Wind turbines extract power by slowing down the wind. If the turbine spacing is too close, the wind speed does not have sufficient distance to recover and the wind farm loses generation potential.

For this reason, wind turbines are assumed to be optimally spaced in a grid such that the total installed nameplate power per sq. mi. of wind farm is about 12.9 MW.[27] If a

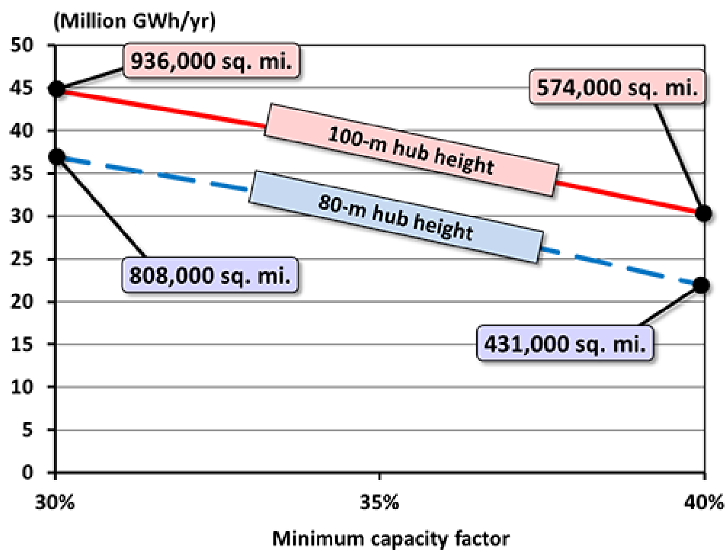
[27] 5 MW of installed nameplate power per sq. km—12.9 MW per sq. mi.—is the value used by the federal government to estimate the optimum spacing of wind turbines in wind farms. The actual value for a specific wind farm depends on a number of factors including average wind speeds, terrain, and hub heights.

wind farm uses 1.5-MW turbines, optimally 8.6 turbines would be installed per sq. mi. If a wind farm uses the 500 ft. tall 2.5-MW turbines, optimally 5.16 would be installed per sq. mi.

Using wind power surveys, the Federal Government has projected the wind energy potential of the United States. This is shown in Fig. 22 for a range of minimum capacity factors and hub heights. From this estimate, wind farms, with 100 m (328 ft.) hub heights and covering 936,000 sq. mi. of primarily the central United States, would be capable of generating about 45 million GWh of variable wind-electricity per year.[28] Assuming 95% availability, about 46 GWh of wind-electricity is generated per sq. mi. per year.

45 million GWh ÷ 936,000 sq. mi. x 0.95= 45.7 GWh/sq. mi.

Fig. 22 - Potential installed wind energy annual output (lower 48 states)



(Data source: U.S. Government)

Recall that the annual energy output of the ground solar farms was estimated to be 122.8 GWh/sq. mi. This required a total of 520,900 sq. mi. of advanced solar farms to meet the U.S. 2100 energy needs. Scaling this farm area up to account for the lower output from the wind farms, <u>the required wind farm area in 2100 would be about 1.4 million sq. mi.</u>—substantially greater than the suitable land in the United States for commercial onshore wind farms according to Fig. 22.

---

[28] As seen in Fig. 22, the 936,000 sq. mi. value corresponds to a minimum capacity factor of 30%. While wind farms can be built in areas with a lower capacity factor, some argue that economically this does not make sense.

520,900 sq. mi. of solar farms x 122.8 GWh/sq. mi. of solar farms
÷ 45.7 GWh/sq. mi. of wind farms = 1,399,705 sq. mi. of wind farms

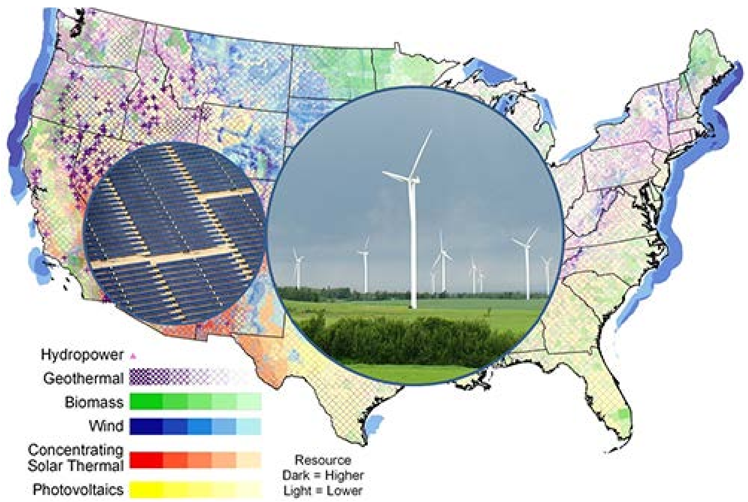
Other issues associated with large-scale wind farms include distribution of royalties to benefiting vs. impacted landowners; safe setback distances from inhabited buildings and roads; bird and insect kills; farm land compaction during construction and loss of productivity; interference with pivot irrigation systems and aerial spraying; impact on aviation, especially general aviation; impact on pollination; impact on soil moisture content; impact on crop moisture conditions; and a general change in the visual (shadow flicker) and acoustic conditions of the impacted and surrounding farmland. Given the obvious increasing demand for food as the nation's population more than doubles by 2100, any measurable impact on agricultural output will be a significant issue. As seen in Fig. 20, the heart of the wind power zone is America's breadbasket states in the central United States.

Offshore wind farms are now being installed around the world because the average wind speed is often greater. As shown in Fig. 20, the United States has belts along its coasts and on the Great Lakes that have substantial wind power potential. The challenge in installing substantial offshore farms is that they impede ship transport, often impact the view from the shore where tourism is important, are more difficult to connect to onshore utility grids, and can require elaborate anchorage systems in deeper waters, especially where hurricanes and/or ice are possible. Consequently, the potential for added wind-electricity generation from offshore farms is likely quite modest.

Neither Ground-Solar nor Wind Power Provide Practical Solutions for Meeting U.S. 2100 Energy Needs

The net land area required to meet the U.S. 2100 energy needs of a population of 625 million consuming 50 BOE/yr. using ground solar and wind farms is, respectively, 521,000 sq. mi. and 1.4 million sq. mi. This is what is required to equal the 6,500 GW of continuous nuclear-electricity sized to provide the same 2100 energy needs. To help appreciate the impact of the needed land areas, these are illustrated in Fig. 23.

Fig. 23 - Comparison of ground solar farm and wind farm net areas needed to meet U.S. 2100 energy needs



(Map and photograph source: U.S. Government)

An important point to reemphasize is that these are the net land areas, not the gross impacted land areas. The actual impacted land area in each case will be greater due to local terrain; set-asides for parks, roads, existing construction, etc.; local social/political opposition; aviation flight restrictions; availability of electrical power transmission lines, etc. With this understanding, <u>it quickly becomes apparent that neither ground solar nor wind—or a combination of these—will be capable of providing a substantial percentage of the U.S. 2100 non-fossil fuel energy sources</u>.

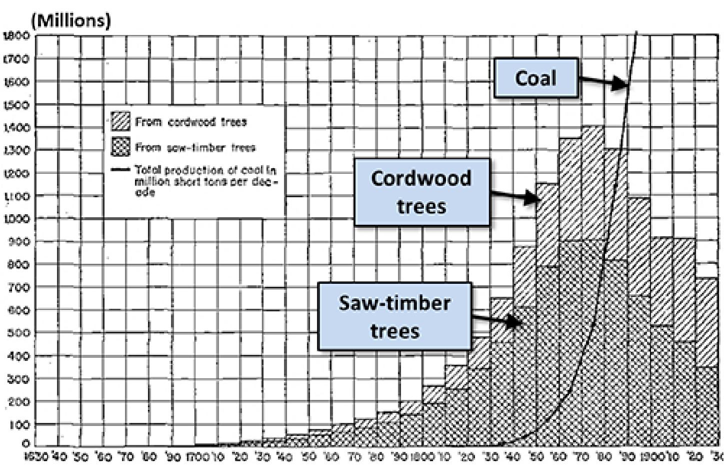
Section VIII - The Energy Security Dilemma Facing the United States is Serious
By now it should be clear that the United States has inadequate technically recoverable resources of ground solar and wind energy to replace fossil fuels. Hydroelectricity, geothermal-electricity, and biomass are not capable of significant increases in energy production. Finally, conventional nuclear fission energy cannot be scaled up by any significant amount and fusion nuclear energy is not yet available. Still, the need for a replacement for fossil fuels is readily apparent. Where must the United States now turn to find industrial-scale replacements for fossil fuels? This is the energy security dilemma the United States now faces; a dilemma that raises the very ugly “solution” of warfare—a solution that, surprisingly, the United States avoided in the 19th century while Japan did not in the 20th century.

What Would Have Happened Had America Not Had Fossil Fuel Resources?
As we now consider the dilemma the United States faces in how to replace fossil fuels, we return our attention to the first energy support crisis the United States faced in the mid-1800s. Since our distant human ancestors learned to harness fire, biomass (primarily wood) has been human civilization’s energy source.

Over the time period that Leslie White examined in formulating what became known as White's Law linking energy and technology to cultural advancement, wood was the primary energy source for human civilization's advancement across some 600 generations. Eventually, the size of the human population grew to the point that the rate of the natural replenishment of wood—about one-half cord per acre per year—failed to meet the growing demand for energy. The United States, with the European-standard of living brought by immigrants beginning in the early 1600s, hit this point in the early 1800s. Consequently, sometime in the 1830s-1840s, wood fuel, along with wood being used for other purposes, was being consumed at a rate higher than natural replacement.[29]

Figure 24 plots the consumption of wood fuel from 1630-1930—across 300 years. This is an excellent example of the classic sinusoidal recovery pattern of over-harvested resources seen with fossil fuels, minerals, fish, etc. Imagine for a moment you are a government economist in the latter 1800s tracking wood fuel production. Further, for the purpose of this thought experiment, assume that fossil fuel recovery was still negligible. Perhaps, in this alternate history, anti-coal, anti-oil, and anti-natural gas commercial coalitions formed to protect the timber and whaling industries from competition.[30] As seen in Fig. 24, up through the 1870s, wood fuel production was still expanding with no evidence of decreasing production apparent.

Fig. 24 - Fuel wood and coal used in the U.S. (1630 – 1930)



(Source: U.S. Government)

As an economist, you note the first falloff in wood fuel consumption in the 1880s, indicating the lack of an adequate supply at affordable prices. Yet, the U.S. population is still rapidly growing and per capita energy use is also growing due to the technological

[29] England had already passed this point when the first English settlers arrived in America in the 1600s. Endless old-growth forests stretching to the horizon were a fantastic sight to them.

[30] The first primary use of oil was to distill kerosene to replace whale oil for lighting. Natural gas then became a second source for lighting.

and societal changes brought by the industrial revolution. Your energy security forecast is bleak. The United States is consuming wood fuel at rates the forests cannot naturally replenish. Forests across the country are being clear cut. The U.S. industrial economy, approaching the point of inadequate energy supplies, will collapse back to an agrarian economy unless new replacement energy sources for domestic wood fuel are found. But there are none now available in the United States with the industrial scale capacity needed to keep the United States prosperous with a growing population and increasing per capita energy use. The fledgling fossil fuel industries could have done this had it not been for political opposition and Congressional naiveté preventing growth and technological development of these new energy sources.

The president, reading your report, notes the seriousness of your conclusion that it would take decades to develop the needed fossil fuel recovery technologies and build up this new industry to achieve the level of energy production needed to replace wood fuel. The rate of forest clearing is expanding to try to keep up with demand, but prices are inflating while production is declining. The report is forwarded to the Secretary of War for review. The War Department proposes, to prevent dramatic energy supply shortfalls and the accompanying severe economic decline, to invade Canada and seize sufficient Canadian forests to give the United States the time it needs to develop its fossil fuel industry. Canada, noting the devastation brought to America's forests, has declined to let American companies conduct the large-scale forest cutting needed to meet U.S. energy needs. Hence, instead of warfare with Spain, the Canadian-American War commences in the 1890s as escalating wood fuel prices and fuel scarcity forces American action to sustain its wood-fueled, steam-powered cultural evolution.

When Japan Faced This Choice, It Led to War

While you may find this alternate history incredible, a version of this played out in the early 20th century. Japan, adopting the Industrial Revolution in the late 1800s to transform its medieval society into a modern industrial society, lacked the fossil fuel and other industrial natural resources needed to thrive per White's Law. It began colonial expansion and military conquest to obtain these resources in northern China as early as the 1890s. A key part of this strategy was to build a modern military, becoming the preeminent military power in the Pacific from the 1920s until the early 1940s.

Fig. 25 - U.S. Navy under attack at Pearl Harbor on December 7, 1941

(Source: U.S. Government)

In particular, Japan needed oil and through the 1930s the United States was then its primary oil supplier—the United States being the OPEC of the early 20th century. When the United States cut off oil supplies to try to get Japan out of China, Japan decided to settle the issue by militarily seizing oil facilities in Southeast Asia belonging to European countries then at war with its ally Germany. However, to achieve this goal, Japan first had to neutralize the U.S. Navy's Pacific fleet then stationed at Pearl Harbor. When Japan attacked the United States, as seen in Fig. 25, it had, by some accounts, less than a year's worth of oil remaining—even less with substantial military warfare. Setting aside the cruelty with which Japan undertook many of its military campaigns, answer this important question: What really distinguishes Japan's energy security circumstance in the early 20th century from that of the United States in the early 21st century? White's Law applied then; it applies now.

The Development of America's Fossil Fuel Industry Shows That Substantial Change Can Occur, But This Takes Time

The primary focus of this paper on America's growing energy insecurity due to this century's pending exhaustion of technically-recoverable and affordable fossil fuels was first brought to the public's attention during the 1950s and again in the 1970s.[31] Further, the shortcomings of terrestrial renewable energy sources in becoming practical industrial-scale energy sources were also apparent in the late 1970s and 1980s. It was not a lack of renewable energy technology, but the scale needed to meet U.S. needs. The U.S. population and per capita energy needs were simply too large and still growing. Yet, White's Law tells us that either America solves the challenge of returning

[31] See the work of American geophysicist M. King Hubbard with respect to his publications in the 1950s forecasting the peak in U.S. oil production around 1970.

to energy security by increasing E and T or human events will address the problem by forcing a dramatic decline in C.

Fig. 26a - Pennsylvania oil refinery in 1870

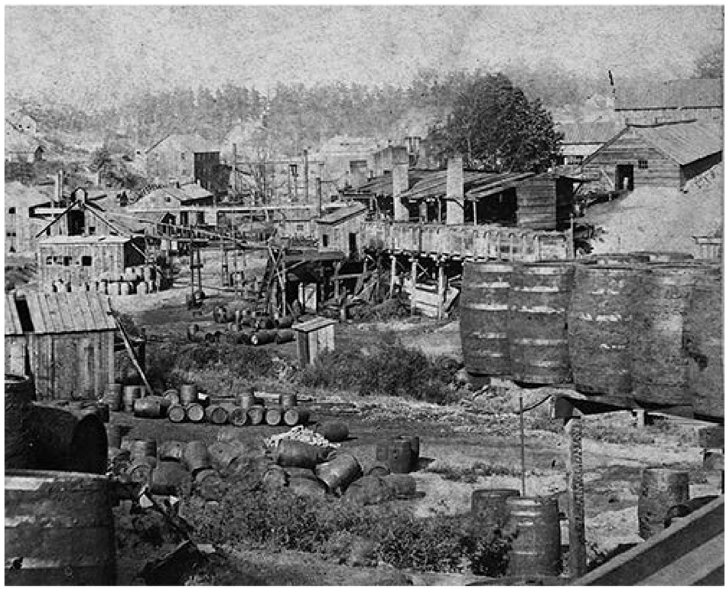


Fig. 26b - Standard Oil plant in 1905

(Source: U.S. Government)

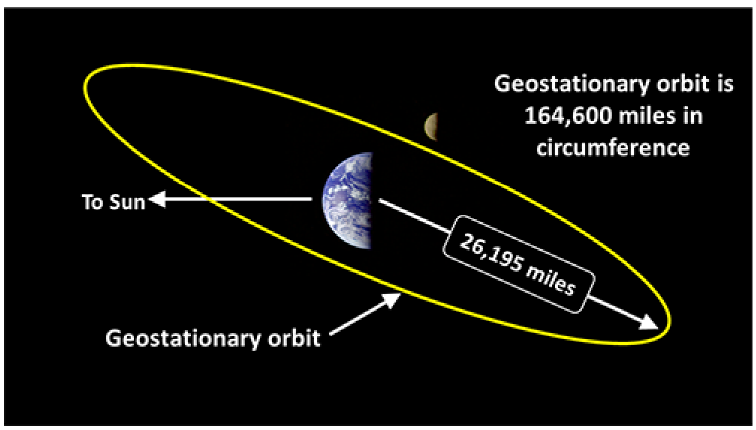
A second purpose of the earlier thought experiment was to make clear that the United States avoided its first serious energy supply crisis by a leap forward in technology to enable fossil fuels to be recovered and used on an industrial scale. Figure 24 shows how coal became king within about 50 years of when it first became commercially mined. Figures 26a and 26b show the advancement of oil refining from the crude refineries of 1870 to the fairly modern refineries in 1905—less than two generations later.

The cultural transformation America underwent in the last two generations of the 1800s was dramatic. By the turn of the century, the new fossil fuels had created modern America with automobiles, electricity, electric motors, electric lights, telephones, oil-fueled ships and trains, steel-framed buildings, steel-bridges over America's immense rivers, etc. The energy industry of America at the beginning of the 20th century was a far cry from America even at the time of the end of the Civil War. America's industrial history of the latter 19th century shows that, with determination, substantial change can be accomplished to prevent an energy security crisis from arising—but the United States needs time—several generations—for this to happen. It cannot happen overnight!

Section IX – Space Solar Power is America's Unavoidable Energy Future

Just as a leap forward in technology to fossil fuels prevented an energy supply crisis in the late 1800s, America must undertake a similar leap forward in technology to circumvent the upcoming end of the age of affordable fossil fuels. With no suitable terrestrial options available at this time, we must turn to the one truly sustainable energy source—our sun. However, with the impracticality of harvesting sufficient solar energy at ground level being apparent, the technological course of action to pursue is space-based solar power or, simply, space solar power. In space at Earth's geostationary orbit, sunshine is nearly continuous.

Fig. 27 - Geostationary orbit

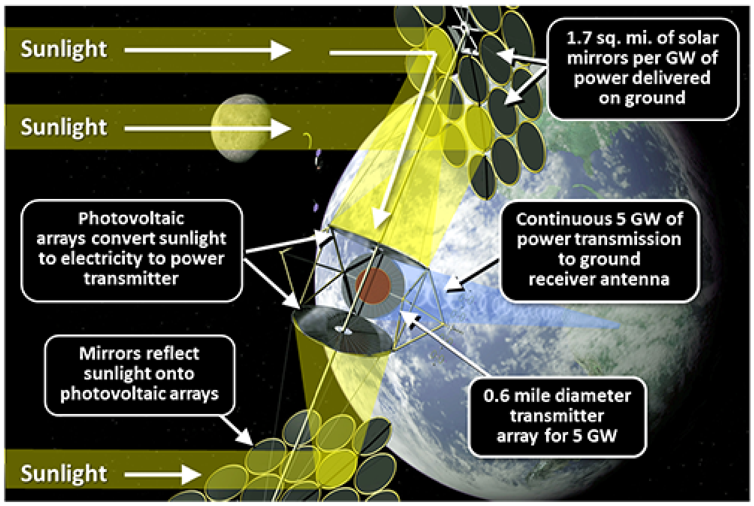


While there are several approaches to implementing space solar power, the baseline approach is to undertake this in geostationary orbit. Geostationary orbit or GEO is, as shown in Fig. 27, a circular Earth orbit about 26,000 miles above the Earth's equator. A satellite located in this specific orbit will circle the Earth once every day making it appear stationary in the sky. Thus, just as it is the ideal location for broadcasting television signals to Earth receivers, it is also a good location for a satellite that transmits electrical power to the surface to supply terrestrial power grids.

About 50,000 Sq. Mi. of Land Would Enable the United States to Use Space Solar Power

Invented in 1968 and studied extensively in the 1970s and 1980s—almost two generations ago—one concept for a space solar power satellite is shown in Fig. 28. In this illustration, sunlight (yellow) is reflected by arrays of circular mirrors onto two circular arrays of photovoltaic panels. These panels generate electricity that powers a transmitter to transmit the electrical power to the receiver site on the ground. With the exception of only a few short periods each year, the sunlight is continuous, meaning that the power transmitted to the ground is continuous and suitable for baseload power much as that supplied by nuclear and coal power plants.[32] Each solar power satellite (SPS) would transmit between 5 and 10 GW if it is based in GEO (5 GW is used in this example).

Fig. 28 - Space solar power satellite in GEO beaming power to Earth receiving sites



The author estimates that 1.7 sq. mi. of solar mirrors or direct collector area would be needed to yield 1 GW of power output from the ground receiver site.[33] Recall from the nuclear power example, the U.S. 2100 energy need would be met by 6,505 GW of continuous power. Hence, at 5 GW from each solar power satellite, the United States would need about 1,301 solar power satellites operating in 2100—the rest of the world perhaps 6X more. With each satellite requiring about 8.5 sq. mi. of solar mirrors or collectors, a total of 11,059 sq. mi. of mirrors or collectors would be needed in GEO. Is there enough room in GEO? Yes. The circumference of GEO is about 165,000 miles. Nature, once again it would seem, has given humanity the source of the energy it needs just as the T needed to harness this energy becomes available.

6,505 GW needed in 2100 ÷ 5 GW per satellite = 1,301 solar power satellites

6,505 GW needed in 2100 x 1.7 sq. mi. per GW
= 11,059 sq. mi. of collector in GEO

---

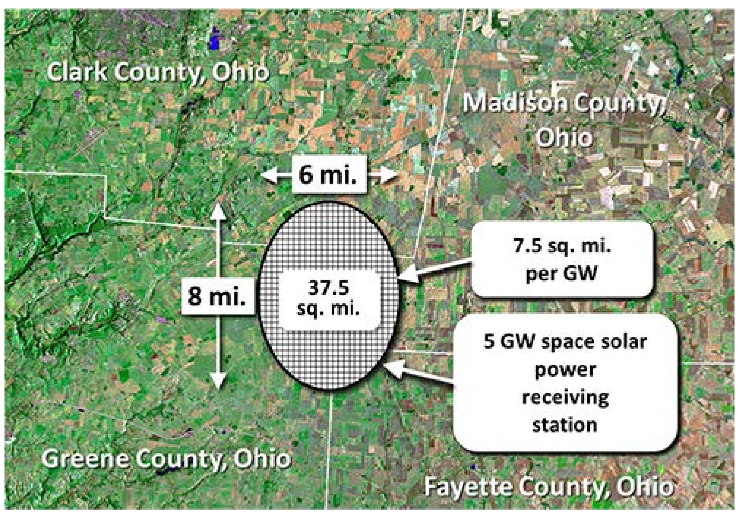
[32] A satellite in geostationary orbit will enter the Earth's shadow for up to several hours at local midnight on and near the spring and fall equinoxes. This corresponds to the period of typical minimum power demand due to the time of year and the time of day. Ground receiving stations would use secondary power, using stored hydrogen, to generate electricity during this period. All ground receiving stations would have secondary power generators for peak power and emergency generation needs.

[33] The gross solar insolation on 1.7 sq. mi. in geostationary orbit is about 6 GW. The conversion of this to electrical power, the transmission of the power to the ground receiving site, and the conversion back into electrical power fed to the local utility grid yields 1 GW. The end-to-end efficiency is about 17%.

In the baseline space solar power design studied in the 1970s and 1980s, the electrical power is transmitted to the ground receiving site as microwave energy. This means that the ground receiver is not photovoltaic arrays but radio antennas. The frequency of the microwaves is primarily governed by the transparency of the atmosphere to the microwave energy. With this fact, combined with the distance the power is transmitted and the peak power level to be permitted at the ground receiver, the size of the ground receiving antenna can be computed.

Figure 29 illustrates the size of a ground receiving site producing 5 GW of baseload power. The immediate area occupied is 37.5 sq. mi. The site produces about 0.133 GW/sq. mi. The transmitted power is at its maximum at the center of the ellipse. There the power level is about one fourth of sunlight at noon on a clear summer day. The power level tapers off to near zero at the boundary of the site, consistent with federal regulations. As with other industrial facilities, the site would be fenced off out to a distance of a mile or so to keep the public from any potential harm. That land would be suitable for farming. In sparsely populated locations, such a fence may not be needed.

Fig. 29 - Space solar power 5 GW ground receiving site



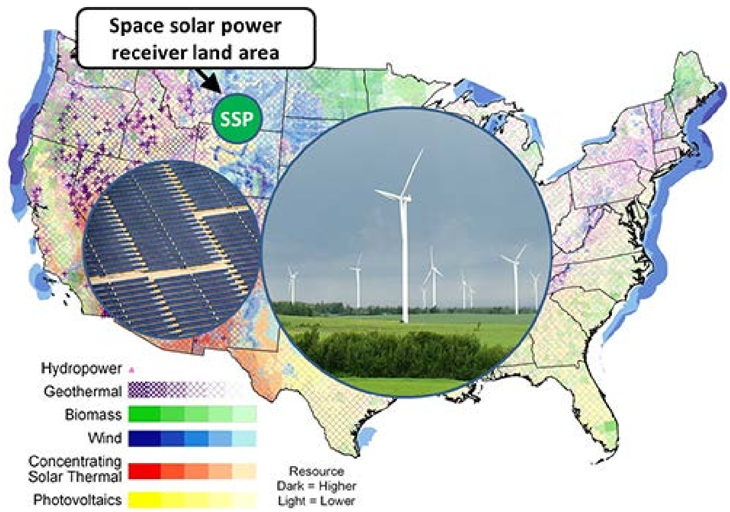
The 6,505 GW of baseload electrical power needed in 2100 would require about 50,000 sq. mi. of land for the space solar power receiver sites. This is illustrated in Fig. 30 compared to the net land area estimated to be needed for ground solar and wind. The difference is striking.

6,505 GW of electrical power in 2100 x 7.5 sq. mi. per GW
= 48,788 sq. mi. of SSP receiver sites

Recall that the advanced ground solar farms would likely yield in the ballpark of 123 GWh of variable solar electricity per sq. mi. per year. Wind farms will yield about 46 GWh of variable wind electricity per sq. mi. per year. Space solar power, immune to the variability of the day-night cycle and local weather, will yield an average of about 1,100 GWh of base load electricity per sq. mi. of ground receiver per year.

0.133 GW/sq. mi. x 365 days/yr. x 24 hours/day x 0.95
= 1,107 GWh/sq. mi. per year

Fig. 30 - Comparison of total space solar power receiver land area to the ground solar farm and wind farm net areas needed to meet U.S. 2100 energy needs



Map and photograph source: U.S. Government)

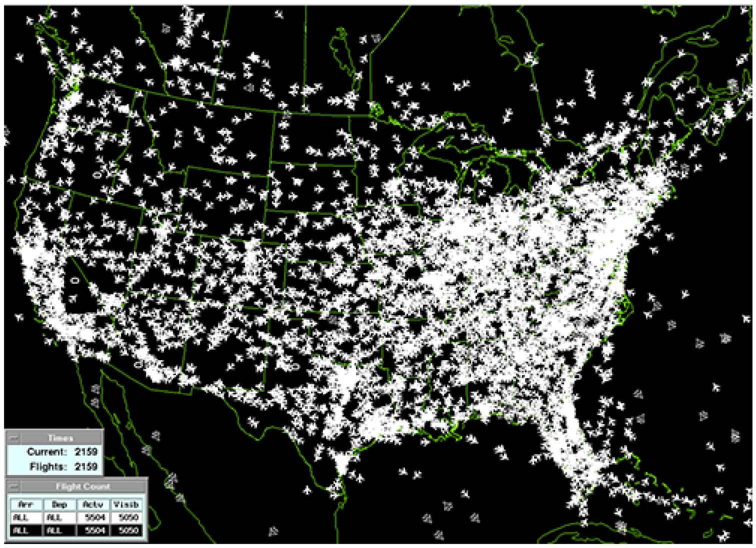
When looking at Fig. 30, take note of the fact that these space solar power receiving sites would be spread out across most of the lower 48 states. The western states, in particular, have a great deal of open land suitable for their placement and would likely host most of the receiving sites. However, most states would be able to host some receiver sites to provide in-state baseload electrical power production.

A Spacefaring Industrial Revolution is Needed to Undertake Space-Based Solar Power

In 1976, Gerard K. O'Neill, a professor of physics at Princeton University, released the book *The High Frontier: Human Colonies in Space*. He introduced the new paradigm of transforming humanity into a true human spacefaring civilization focused primarily on the construction of space solar power platforms.[34] This book spurred tremendous public and professional interest in space solar power and the emergence of a spacefaring civilization. The key point of Dr. O'Neill's writing was that the magnitude of effort required—in terms of in-space industrial capacity and the use of extraterrestrial natural resources for fabrication—will invariably move humanity into the Earth-Moon system in large numbers and will do so permanently.

[34] Gerard K. O'Neill, *The High Frontier: Human Colonies in Space* (New York: Morrow, 1976).

Fig. 31 - Radar snapshot of commercial air traffic over the U.S.



Some will scoff at this as being unrealistic. Yet, consider the situation with aviation only a century ago and compare its technologies at the start of World War I, when aviation was barely a decade old, with where it progressed less than three generations later at the start of the jet age. Today, as you read this, there are likely several thousand commercial aircraft and a quarter million passengers in the skies above America and we don't give it a second thought. Unthinkable a century ago; ignored today due to its commonplace part of our culture.

The Earth-Moon system by the end of this century will witness a comparable cultural transformation as America undertakes its only real current engineering-ready replacement for fossil fuels—space solar power. Human space flight will expand beyond the current meager capabilities of infrequent access to low Earth orbit to achieve routine and safe operation throughout the Earth-Moon system. In leading this transformation, America will undergo a substantial spacefaring industrial revolution—rivaling the emergence of commercial aviation—as American industry develops the industrial mastery needed to meet the challenge of replacing fossil fuels with space solar power. It should not take a genius to understand the national potential of this coming spacefaring industrial revolution. Just as aviation defined the 20th century, the 21st century will be defined by America becoming a true commercial human spacefaring nation.

Section X – If Only the Titanic Had 30 Seconds More of Warning

America's need for a replacement for fossil fuels is undeniable. The age of affordable fossil fuels will end in America, likely within the lifetime of our children and grandchildren. Only through a decades-long concerted effort will America be able to build the new spacefaring industrial capabilities, infrastructure, and space solar power satellites needed to meet this clear energy security challenge successfully.

In terms of White's Law, America's energy future can now be expressed as:

$$E_{SSP} \bullet T_{spacefaring} \Rightarrow C_{United\ States\ in\ 2100}$$

Thus, for what reason do we dawdle? Imagine, for a moment, the thrill of sailing on the Titanic on its maiden voyage and of the awfulness that would have been avoided had there been only another 30 seconds of warning. Imagine now the thrill of setting America on a course of becoming a true human spacefaring nation, of being among the coming generations that will lift American culture permanently into space, that will develop the new T to allow us to exploit the new E from the solar power awaiting us in geostationary orbit and then exploiting all this new E and T to open the entire solar system to humanity. Imagine now the calamity of an America that waits too long, figuratively enjoying a peaceful but tragic cruise into the future, until one day there is no more affordable gas at the corner gas station, your home's natural gas supply ends, and rolling blackouts begin. Then, what will America's leaders say—"If only we had more time. "

White's Law really is not an obituary of an unavoidable failure of civilization, but a roadmap of the path forward for America to follow to remain prosperous. Unmistakably, it now tells us it's time for America to climb a new mountain to achieve energy security—and to do so by becoming a true commercial human spacefaring nation. Again, with this new understanding, for what reason do we dawdle?

****

About the Author: James Michael "Mike" Snead is a professional engineer; Associate Fellow, American Institute of Aeronautics and Astronautics, and President, Spacefaring Institute LLC. See spacefaringinstitute.com for additional biographical information and publications.

Editors' Notes: Mike Snead is highly regarded within the Space Community for his extended dedicated research of all energy alternative systems. His conclusion that Space Based Solar energy is the major long-term solution for Earth's energy needs deserves the attention of decision makers worldwide. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Political Feasibility and Space Solar Power Implementation

By Bob Krone and James Michael "Mike" Snead

Introduction

We assert that because decisions for major U.S. Space programs are biased by politics, this political reality must be now factored into the emerging public debate on the vital need to adopt space solar power to replace fossil fuels this century. The purpose of this article is to link Bob Krone's theory of political feasibility with Mike Snead's research into the United States' future energy alternatives. Bob Krone begins by providing readers the validated theory of the political feasibility phenomenon. Mike Snead follows with a discussion of why space solar power is needed and what public policy decisions are needed to undertake this effectively in the United States. We conclude with recommendations of immediate specific actions to take. ***Bob Krone and Mike Snead***.

****

Political Feasibility

By Bob Krone

Political feasibility is the real, or perceived, probability that a policy proposal will be accepted for implementation by the decision-maker(s). It has been an academic focus of Political and Policy Sciences since mid-20th Century. It is the most difficult of the three feasibility studies which are economic feasibility, technological feasibility, and political feasibility. The reasons it is so difficult are that (1) it is not quantifiable to an acceptable degree of confidence; (2) it is ephemeral and reactive to the multi-directional changes of the political process; (3) it is linked to power, which is an equally elusive concept; and (4) it contains a large extra-rational component. Those difficulties make political feasibility an enigma wrapped in a dilemma for professional analysis. That dilemma is critically important because no decision is ever made in public or private systems without political feasibility having played some role. Gravity exists everywhere in the universe. Political feasibility exists everywhere in human social systems. Given that fact, the significance of political feasibility as a motivator of behavior in decision processes warrants the application of energy and professional tools for understanding its functioning and its impacts. A factor that makes its formal analysis even more difficult is that it often is not politically feasible to include formal political feasibility analysis into decision making. These complexities are addressed in detail in my two journal publications on the subject.[1]

---

[1] Robert M. Krone, "Political Feasibility and Military Decision Making," *Journal of Political & Military Sociology* 9, no. 1 (Spring 1981): 49-60; Robert M. Krone, "Political Feasibility and the Manager," *The Bureaucrat: Journal for Public Managers* 10, no. 4 (Winter 1981-1982): 17-21. The theory in these articles has been referenced and validated. They can be found at www.bobkrone.com/category/publications-category/journal-space-philosophy.

Describing Political Feasibility

The best definition of politics was made by Harold D. Lasswell in 1936, as *Who gets What, When, How*.[2] Values are fundamental in politics and are defined as principles or things preferred by individuals, group, societies, and nations. Values analysis is a huge part of academic decision-making analysis. Attempting to discover the preferences of decision-makers before committing oneself to advocate a course of action and then proposing what one thinks is preferable is playing the political feasibility game. Political feasibility is a powerful force for molding consensus. At the top levels of military decision-making, it is even a legal requirement embedded in the Constitution and United States Laws. Political feasibility is not something analysts have created, although the term is – it always exists in every public or private organization, agency, or company. Where politics exists, political feasibility will be functioning.

The set of potential impacts on individuals playing the political feasibility game are: (1) access to power levers and tools of the system; (2) knowledge access – the larger the political feasibility domain of an individual with leadership the greater is the access; (3) constraints on permissible expression – especial to the media, but this constraint can also apply to all out-of-house and many in-house contacts; (4) constraints on permissible alternatives proposed for action or policy; (5) effectiveness reports and advancement; (6) opportunities within and without the system; (7) the size and growth or decline of the management empire; (8) self-image and ego; (9) workload; (10) job security; (11) pressures for group-think; (12) acceptance or rejection by colleagues and leadership; and (13) the existing level of professional mendacity.

To minimize the theoretical text for this *Journal of Space Philosophy* paper, I will not delve into the methodology of political feasibility analysis, the constraints, case studies, the recommendations for playing – or avoiding – the political feasibility game, or how political feasibility is changed. Readers interested can find those subjects in the referenced journal articles. Playing the game has both potential costs and benefits. It can propel an expert game player to continual promotion or cause his or her immediate firing. History is filled with both scenarios. Expending resources to study or implement alternatives that have extremely low estimates of political feasibility is wasteful. Restricting alternatives only to those judged to be politically feasible insures incremental, conservative policymaking. Because a proposal is politically feasible does not make it the best alternative. Breakthrough thinking has produced both dramatic successes and catastrophic failures. Culture created in the organization by leadership that *the more politically feasible the better* can be a road to disaster for individuals, the program being worked on, the company, or the nation. But readers will remember organizational cultures in their experience *where the more politically feasible the better* assumption was deeply rooted. There are always opportunity costs when a decision is made from a set of alternatives. Often that set is constrained without serious analysis because of the political feasibility domain of leadership.

[2] Harold D. Lasswell, *Politics: Who Gets What, When How*? (New York: Whittlesey House, 1936).

Given the difficulties and complexities of political feasibility, why spend time in thinking about it? My answer is that not thinking about it may exclude from decision-making a wide spectrum of alternatives that would be far better than any of those addressed by decision makers.

****

Space Solar Power Implementation

By James Michael "Mike" Snead

Introduction

This author's article, "The American Energy Security Crisis Solution—Space Solar Power" identifies why a tsunami of cultural destruction—of a substantial lowering of the American standard of living—is coming to America if it does not find suitable replacements for fossil fuels this century. While this is an alarming statement of what the future holds, as discussed in detail in the article, America's population growth and per capita energy use, America's inadequate remaining fossil fuel endowment, and America's insufficient land area for ground solar and wind farms all support this conclusion. The only path forward that can be identified today is to undertake space solar power as the industrial-scale sustainable energy source sufficient to replace fossil fuels before they become unaffordable and America suffers economically and socially.

America's Future Energy Security is Now at Risk

Throughout the 20th century and now in the beginning of the 21st century, America's fossil fuel resources have literally fueled America's prosperity and rising standard of living. But with each new gas tank to fill up, each new electronic device to power, each new net birth, and each new immigrant, America's total demand for energy grows and America's remaining endowment of fossil fuels shrinks faster. Consequently, America's energy supply balance sheet will turn red within the lifetime of our children and grandchildren. Life in America will cease to be what we, today, take for granted. To put it bluntly, America's energy security "back" is against the wall.

We are at the point where critical public policy decisions are needed. If we dawdle, it will become too late to react. Even beginning now, an aggressive transition to sustainable energy sources of sufficient scale of production to meet America's growing energy needs will take generations to accomplish—repeat, generations to accomplish.

The time for ignorance of this crisis by America's leadership has passed; the time for solution-enabling policy and clearly needed leadership changes, particularly in America's space program, is now at hand. To survive the 21st century, America must become a true commercial human spacefaring nation tapping America's historic strengths of engineering professionalism, entrepreneurship, and hard work to turn the endless sunlight and extraterrestrial natural resources available in the Earth-Moon system into America's new 21st-century sustainable energy source. By doing so, America can solve its energy security crisis while enabling our children and grandchildren to create substantial new wealth and prosperity selling this capability worldwide.

America's Energy Security Crisis is Very Real

For those who have not yet read the above-referenced article and to clarify the seriousness of the energy security challenge now facing America, the key quantitative information in the article is summarized:

- By 2100, based on U.S. Census Bureau projections, the population of the United States is likely to more than double to around 625 million. About two thirds of this growth will be due to immigration before any additional immigration liberalization is adopted.
- By 2100, the total U.S. annual need for energy will likely climb by about 75% to about 31 billion barrels of oil equivalent (BOE).
- From 2011-2100, the United States will need about 2.23 trillion BOE of energy to remain economically prosperous at roughly today's standard of living.
- Per the Congressional Research Service's 2011 report, the U.S. endowment of technically recoverable oil, coal, and natural gas is about 1.367 trillion BOE. <u>Even if all of this endowment could be recovered</u>, it is only 61% of what is needed through 2100.
- Today, fossil fuels provide about 85% of the total U.S. energy consumed each year. At anywhere near this level of continued dependency, <u>the United States will exhaust affordable fossil fuels well before 2100</u>.
- To replace all energy sources with a hypothetical all-nuclear energy infrastructure, the United States would need to have 6,505 1-GW nuclear power plants operating in 2100.
- To replace all energy sources with ground solar energy, the United States would need to have about 521,000 net sq. mi. of solar farms in 2100, covering most of the southwestern United States.
- To replace all energy sources with wind energy, the United States would need to have about 1.4 million net sq. mi. of wind farms in 2100—covering nearly half of the continental United States.

From this summary, America actually faces three separate energy security challenges:

1. Despite America's still large domestic fossil fuel resources, the energy demands of the still growing American population will exhaust these resources this century. Immigration—the primary driver for U.S. population growth this century—has consequences in terms of demand on all natural resources, including fossil fuels, that should be taken into account.

2. For many different reasons—including a lack of sufficient uranium, a suitable number of plant locations, a suitable means of waste disposal, and the increased threat of nuclear weapon proliferation—terrestrial fission nuclear power is not capable of being scaled up to anywhere near the 6,500 GW needed.
3. Despite being a continental nation with nearly three million sq. mi. in the lower 48 states, the continental United States has insufficient land suitable for ground solar and/or wind farms without major environmental, social, and agricultural impacts.

This is what having America's energy security back against the wall means. There are no politically acceptable terrestrial solutions to replace fossil fuels while retaining our economic prosperity, standard of living, and national security.

America Will Need to Spend Over $1 Trillion a Year for the Rest of the Century on New Energy Sources

To help understand the seriousness of the challenge further, ballpark estimates of the cost of conversion to replacement non-fossil fuel energy sources will be made using all-nuclear and all-wind energy infrastructures. As noted above, the all-nuclear answer would require 6,505 1-GW nuclear plants operating in 2100; the all-wind solution would require 1.4 million sq. mi. of wind farms operating in 2100.

The All-Nuclear Energy Solution Would Cost About $84 Trillion Through 2100

Construction has recently started in the United States on a new generation of uranium fission nuclear power plants. These are intended to be both safer and less expensive to build and operate. For this analysis, these plants are assumed to be designed for a 60-year life. After 60 years, the plant will be decommissioned and replaced or rebuilt.

If construction were to start in 2015, 86 new plants would need to be started each year. With a 10-year construction period to first commercial power and accounting for the earlier plants needing to be decommissioned and replaced, a total of 7,874 plants would need to be built and brought into operation by 2100.

The anticipated cost of a new nuclear power plant design in serial production is about $6 billion per GW of plant generation capacity.[3] Plant decommissioning and replacement is estimated to cost another $6 billion. The 60-year cost of refueling is estimated to be $1.6 billion. Further, another 40% is added to the cost of each plant to cover plant operation and security; nuclear waste storage and disposal; long-term debt financing; hydrogen electrolysis, pressurization, storage, and distribution; and electrical power transmission infrastructure. Using these estimates, the total cost to build and operate the all-nuclear energy infrastructure through 2100 is estimated at $84 trillion.

[3] This includes direct construction costs, land purchase, initial fueling, cooling towers, and construction financing under normal financial conditions. This cost, however, is highly dependent on commodity prices, such as steel and cement, and interest rates. For comparison, two new nuclear power plants now beginning construction in the United States have a projected cost of about $6.3 billion/GW.

7,874 1-GW plants x $7.6 billion/plant x 1.40 = $83.80 trillion

The All-Wind Energy Solution Would Cost About $88 Trillion Through 2100

Commercial wind farms are now being built with 2.5-MW 500 ft. tall wind turbines installed with an optimum spacing of 5.16 turbines per sq. mi. The 2012 installed cost of commercial wind turbines was in the range of $1.3-2.2 million per MW. (The average of $1.75 million per MW will be used here.) The wind turbines are assumed to be replaced or rebuilt every 30 years. This means that the total number of wind turbines actually built through 2100 is twice the number needed to be operating in 2100. To the cost of each wind turbine, another 40% is added to cover wind farm operation and security; long-term debt financing; hydrogen electrolysis, pressurization, storage, and distribution; and, electrical power transmission infrastructure.[4] Using these estimates, the total cost to build and operate the all-wind energy infrastructure through 2100 is estimated at $88.5 trillion.

1.4 million sq. mi. x 5.16 wind turbines/sq. mi. x 2.5 MW/turbine
x $1.75 million/MW x 2 for replacements x 1.40 = $88.49 trillion

Averaging these two estimates and dividing by 85 years yields an average annual expenditure of about $1 trillion per year. This is a rough estimate of how much America must spend each and every year, on average, through the end of this century—across four generations—to replace fossil fuels with a new energy infrastructure.

($83.8 trillion + $88.49 trillion) ÷ 2 ÷ 85 years = $1.01 trillion/yr.

For perspective, this is roughly 30X the NASA budget at the peak of the Apollo program, in current dollars, or 50X the current NASA budget. And, it should be understood, these are most likely lower bound estimates for what it will actually cost to build a real sustainable energy infrastructure to replace fossil fuels because neither conventional uranium fission nuclear energy or wind are practical solutions.

With Its Energy Security Back Against the Wall, America Must Turn to Space Solar Power

With no terrestrial answers to America's energy security crisis, America has two fundamental choices. Option 1 is to wait, endlessly fund the research community—meaning fusion nuclear energy—and hope for a scientific breakthrough leading to practicable commercialization in time to prevent widespread affordable energy shortages. Option 2 is immediately to pursue, as a national priority, the one solution capable of beginning formal engineering development—space solar power.

[4] Each wind turbine in the 1.4 million sq. mi. of wind farms must be connected to the electrical power transmission and distribution system. This is not an insignificant cost.

While a reasonable level of funding for breakthrough research should be pursued, Option 1 is not a responsible path to follow.[5] This then leaves America with the singular, but pragmatic option, of undertaking space solar power.

From the ballpark cost estimate above, the scale of this effort will likely be pushing $2 trillion each year on average through the end of the century. This is about 3X the budget for the Department of Defense. To accomplish this, **a new spacefaring era of the American "space age" must begin** where roughly 5% of the U.S. GDP—around $1 trillion per year on average—will be expended in commercial human spacefaring operations throughout the Earth-Moon system, including permanent human operations as envisioned by Dr. Gerard K. O'Neill in the 1970s and 1980s. The balance of the expenditures of around $1 trillion per year will be used to build the terrestrial segment of the space solar power system—ground receiving sites, hydrogen production systems, etc.

To Remain a Sovereign Superpower, America Must Undertake Space Solar Power by Itself

Space solar power is becoming the *sine qua non* rationale for future international space programs. Many nations are coming to understand their own growing energy insecurity with respect to fossil fuels, conventional fission nuclear power, and terrestrial renewable energy sources. For similar reasons, they are now also looking seriously at space solar power. Many space proponents, therefore, conclude that similar needs should foster broad international cooperation in the building of space solar power. To be blunt, this is a bad idea for America.

For America to remain a sovereign superpower—dependent on no other nation or international organization for its national security—the need to ensure its future energy security is paramount. The foreign entanglements that have been forced on the United States since 1970 by its dependency on imported oil have cost the nation dearly. Creating new foreign entanglements by engaging in some form of international space solar power collaboration is dangerous and foolish. It is dangerous because it would continue the threat of a cutoff of vital energy supplies to force some U.S. action contrary to America's best interests. It is foolish because it would proliferate unneeded and unproductive federal government bureaucracy, dampen the U.S. commercial competitive spirit, diminish the creation of jobs and wealth in America, lose hard-won technological and economic advantages, and add to the cost and time required to bring this new energy supply into operation. Hence, as America endeavors to shift to space solar power, this needs to be undertaken as a new American enterprise with, at most, only very limited international commercial collaboration with close national security

[5] Even if the needed breakthroughs in fusion nuclear energy are achieved, these will still likely be thermal power plants requiring a means of disposing of the plant's waste heat—roughly 70% of the energy liberated by the fusion reactions. This usually requires an adjacent large river, ocean, or large lake to provide the needed cooling. Where in the United States would 6,505 1-GW thermal power plants be located?

allies.[6] In no way, ever, should the United States become dependent on another nation for energy from space or the new spacefaring logistical capabilities.

To Undertake Space Solar Power, a New Spacefaring Paradigm is Needed

Joel Barker put forth a suitable definition of a paradigm that helps to explain what will happen to U.S. space operations as the American space solar power enterprise begins.[7]

> A paradigm is a set of rules and regulations (written or unwritten) that does two things: (1) it establishes or defines boundaries and (2) it tells you how to behave inside the boundaries in order to be successful.

U.S. space operations currently fall into one of three distinct paradigms:

- Military/national security space operations.
- Civil space exploration and science operations.
- Commercial satellite telecommunication and observation operations.

Consistent with Barker's definition, each of these has its own set of boundaries and rules on how to behave and be successful within these boundaries. History has shown that crossing the boundaries of these paradigms with successful joint efforts has been very difficult. The final configuration of the Space Shuttle, for example, was substantially driven by the attempt to develop a single new launch system meeting the needs of all three of these segments. As everyone knows, it ended up doing none of these three missions well, causing most launch missions to shift back to expendable launch vehicles.

If one were to picture these elements of the U.S. space program, it would be a three-legged stool. With the emergence of space solar power/commercial human spacefaring operations as a new and, by the expected scale of operations, a dominating element, trying to force-fit these new commercial spacefaring operations into these existing paradigms is failure just waiting to happen. Consequently, the three-legged stool must now be transformed into a four-legged chair. Essentially, a new paradigm for commercial space solar power and commercial human spacefaring operations must be established. Defining what this means will be best done through a new National Spacefaring Policy.

[6] To prepare the enabling technological workforce, employees must be trained in the latest technologies and analytical and industrial capabilities and have their skills updated frequently throughout their career. Most of the enabling technologies for the space solar power and spacefaring logistics infrastructure appropriately fall under the International Traffic in Arms Regulations (ITAR). If the workforce is to be trained thoroughly, employees must be trained in ITAR-controlled technologies, probably starting in the last years of undergraduate education and, certainly, in graduate-level training. Thus, the training will be limited to those appropriate to receive ITAR information. This will limit international participation.

[7] Joel Arthur Barker, *Future Edge: Discovering the New Paradigms of Success* (New York:, William Morrow and Company, 1992), 32.

A New National Spacefaring Policy is Needed

The fundamental tenets of U.S. national space policy are stated in formal policy statements released by the president. Recognition of the paramount need to achieve U.S. energy security through space solar power—or even the mention of space solar power—is not addressed in either the existing National Space Policy[8] or the National Space Transportation Policy.[9] This is indicative of the current governmental leadership lacking an understanding of the seriousness of the U.S. energy security situation and the pragmatic choice of space solar power to resolve this situation.

An important first step in rectifying this situation is to establish a new National Spacefaring Policy and enabling legislation. Both would emphasize accomplishing these objectives:

- Establish a robust, world-leading American spacefaring industry that develops the industrial mastery necessary to undertake commercial human spacefaring operations to/from space and throughout the Earth-Moon system with regulated airline-like safety and operability;
- Establish a regulated commercial spacefaring logistics infrastructure to support commercial human transportation and spacefaring operations to space and throughout the Earth-Moon system;
- Establish an American commercial space solar power industry to supply the United States with the energy required to replace fossil fuels by 2100 and to sell energy from space to other nations via commercial contracts;
- Undertake the commercial exploration and exploitation of the Earth-Moon system and the central solar system for the natural resources needed to support a robust space solar power industry;
- Expand private and university research and development by U.S. citizens to create a "production line" of technology, intellectual property, and new products and services to feed the growing American spacefaring industry;
- Undertake government-prompted technology demonstration programs to support the growth of the American spacefaring industry;
- Establish new undergraduate and graduate engineering, technology, logistics, and operations programs to provide an American spacefaring workforce to enable substantial commercial human spacefaring operations; and,
- Extend U.S. legal authority and law to cover and enable these new extra-terrestrial commercial space operations.

---

[8] June 28, 2010.
[9] November 21, 2013.

At the same time, existing National Space Policy and legislation would be updated to provide for the safety, protection, and defense of this new U.S. commercial spacefaring industry, the space solar power system, U.S. citizens in space, and the integrity of the power delivery to America and its commercial customers. Further, a new U.S. Space Guard would need to be created to administer these actions.[10]

Two New Federal Government Corporations Are Now Needed

To implement the space solar power and spacefaring infrastructure elements of the new National Spacefaring Policy, two new organizations are needed.

The first is a new federal government corporation (FGC) to initiate and administer the new space solar power industry as a public-private partnership. This would be similar to COMSAT, established as a public-private partnership in 1962 to prompt the creation of commercial satellite telecommunications. To meet this need, a U.S. Space Solar Power Corporation would be established by an Act of Congress to do the same for American space solar power commercialization.

The second would also be a new FGC. The U.S. Spacefaring Authority would be organized as a port authority and be responsible for the new commercial spacefaring logistics infrastructure necessary to support the engineering development, fabrication, and operation of the space solar power platforms and the in-space manufacturing industry. It would also be established by an Act of Congress.[11]

In neither case is a new NASA being established. There is no need for that. The balance of direct government-to-private expenditures would be in the range of 5% government and 95% private industry. The role of the FGCs is to establish safety, operability, and performance requirements; oversee the programmatic and technical execution of contracts, oversee the government's role in the financing of the initial capabilities, and take ownership of those elements deemed appropriate for assuring U.S. energy security and spacefaring operational capability. The role of private industry —selected through competitive bidding—is to design, construct, operate, and maintain the actual systems.

This New Paradigm Will Strengthen the Existing Three Paradigms

The establishment of these two new FGCs does not mean that a wall will be built between these new space solar power/commercial human spacefaring operations and the other three segments of the U.S. space program. In fact, just the opposite will happen. Consider these points:

---

[10] James C. Bennett, "Proposing a 'Coast Guard' for Space," *The New Atlantis* (Winter 2011), www.thenewatlantis.com/publications/proposing-a-coast-guard-for-space.

[11] For ensuring human spacefaring safety, the Federal Aviation Administration would remain the certifying agency for human spaceflight systems to provide the arms-length independence needed to achieve "airline-like" safety—a technological breakthrough in its own right.

- With significant new in-space power availability and the ability to build space structures of extremely large size, the current construct of space-based telecommunications will be redefined.
- U.S. military space operations will also have access to the same power and large structure capabilities, as well as a new spacefaring logistics infrastructure that will revolutionize space transportation and in-space logistics. Beamed space energy will be available to support overseas military operations, to power long-endurance drones, to power at-sea forces, and to power in-space capabilities.
- Civil space exploration and science will also have access to the same power and large structure capabilities. Space observatories with extremely large apertures can be built for both intra- and extra-solar system observations. And, of course, NASA space scientists will lead the return to the Moon to explore it—all enabled by a new substantial Earth-Moon integrated spacefaring logistics infrastructure. Finally, the development of new electric/thermal propulsion technologies combined with beamed power transmission will make orbital spaceflight throughout the Earth-Moon system as convenient as commercial air travel is today.

Space Solar Power Must Not Be a "Rescue Mission" for NASA

When discussing space solar power, many automatically presume that NASA "owns" space solar power and would undertake this effort. Certainly, many within NASA and within Congress will concur with this presumption. One chart, developed by NASA, explains why this would be a substantial error. However, before making this point, it is very important to acknowledge NASA's important successes, scientific and organizational expertise, and suitability for leading much of the science and exploration "spear point" missions necessary for the expansion of American human spacefaring operations in this new spacefaring era. Having the NASA emblem emblazoned on the spaceships that return Americans to the Moon, land Americans on Mars, and undertake many other "firsts" in this new era of American human spacefaring operations is an appropriate organizational role. However, as history has shown, running a spacefaring "railroad" or building a massive new energy infrastructure is not an appropriate organizational role for NASA.

After the Space Shuttle concluded its 30 years of operations, NASA's independent Aerospace Safety Advisory Board commissioned an internal NASA study of the probability of crew loss in the Space Shuttle.[12] The graphic below, included in the report, shows the probability from the first mission through the last. These results are startling (Fig. 1)!

[12] oiir.hq.nasa.gov/asap/documents/2011_ASAP_Annual_Report.pdf, 9.

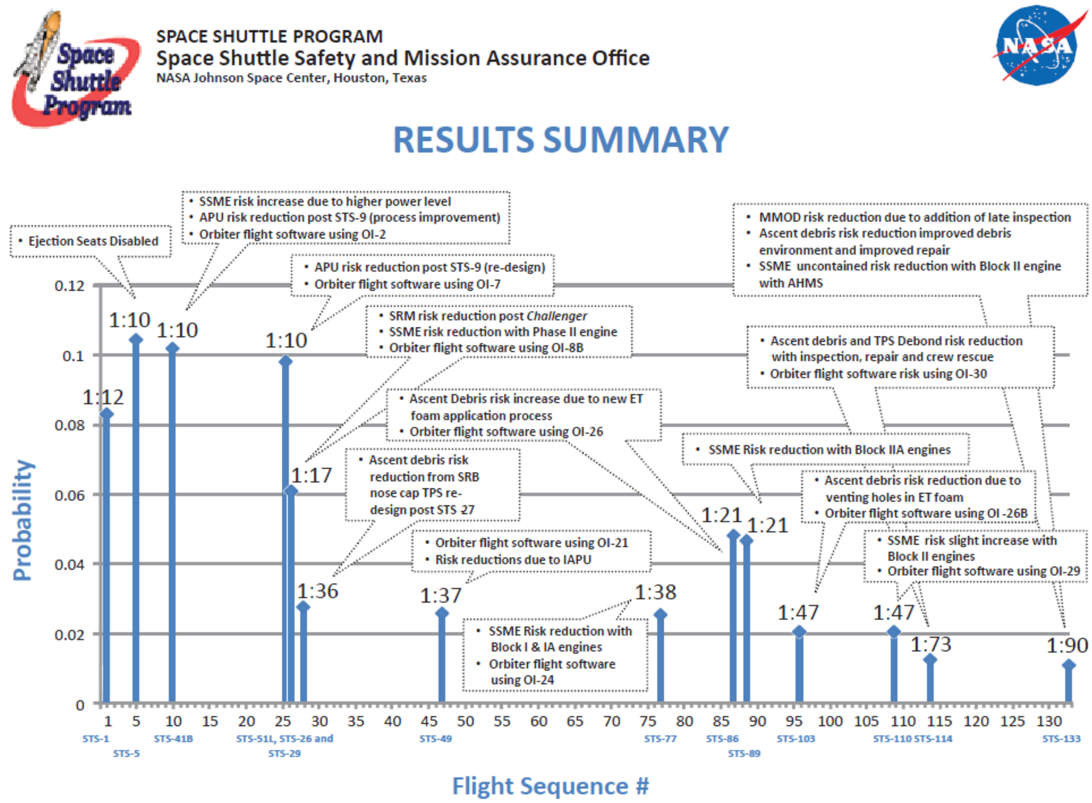


Fig. 1. Probability of crew loss in the Space Shuttle program.

In the first years of Shuttle missions, the probability of loss of crew was one in ten and remained there until the loss of the Challenger in 1985. As the report notes, when the Space Shuttle first began flying, at least one NASA source was estimating the probability of loss of crew at one in one thousand or better. The actual retrospective findings now tell us that they missed this by a factor of 100, as the report notes. This means that the cumulative probability of predicted loss was near 100% by the time of the actual loss of the Challenger on mission 25.[13] By the end of service—after nearly 30 years, 135 missions, and total costs approaching $200 billion—the probability of loss of crew had improved to only one in ninety. From a professional engineering point of view, these safety values are unacceptable.

A fundamental facet of sound leadership is establishing direction and making sound judgments. These findings are indicative that a new direction and new leadership is needed for space solar power and the enabling spacefaring logistics infrastructure. NASA has done many valuable and challenging programs quite successfully and will do more in the future. From a human safety, cost, and operability perspective, the singular American human spaceflight capability for 30 years—the Space Shuttle—was not one of these successes. This leads this author to conclude that neither commercial space

[13] Ibid, 10.

solar power nor the enabling commercial human spacefaring operations fall within NASA's demonstrated area of organizational competence. Trying to rescue NASA with these programs would be a fundamental error.

America's Path Forward Is to Become a True Spacefaring Nation

In the 19th century, America began the century running on wood fuel and ended the century running primarily on coal, oil, and natural gas. As America's once vast old growth forests were overharvested for wood fuel and timber, nature's wonderful resources of coal, oil, and natural gas enabled America's energy supply to keep pace with the increasing energy supply demands of its growing population and improving technology. By the beginning of the 20th century, modern America was established with electricity, automobiles, telephones, radio, skyscrapers, etc. Powered flight was just a few years in the future. What happened was that America "weathered" its first energy supply crisis by upping its game—adopting new technologies and new fossil fuel energy sources and using these to advance its standard of living—its culture—significantly. This fossil-fuel-led cultural evolution created the industrialized America that, in the 20th century, led the free world to victory in World War I, World War II, and the Cold War. It was American energy security, enabled by its fossil fuel endowment, that kept America secure.

Now, the "coming due" notice on affordable fossil fuels can be confidently anticipated. It will occur within the lifetime of our children and grandchildren. Like preparations for a coming hard winter, America must anticipate the coming unavoidable shift in energy supplies from fossil fuels to a new, industrial-scale renewable energy source. White's Law of Cultural Evolution—discussed in detail in the author's cited article—identifies the clear relationship between energy, technology, and standard of living. After examination of America's energy needs and potential solutions this century, the only formulation of White's Law that will work for America this century becomes:

$$E_{\text{SSP}} \bullet T_{\text{spacefaring}} \Rightarrow C_{\text{United States in 2100}}$$

America's unavoidable path forward to a successful future for our children and grandchildren is to become a true commercial human spacefaring nation undertaking commercial space solar power. What an exciting future this will be!

****

Conclusions and Recommendations

By Bob Krone and Mike Snead

Conclusions

1. Bob Krone's research highlights the importance of including Political Feasibility Analysis in the historic creation of this important new American space program.
2. Mike Snead's research provides the quantitative information needed to understand the seriousness of the looming American energy security crisis. Absent intervention to current trends, that crisis will begin to occur mid-twenty-first century, when affordable fossil fuel supplies will fail to meet America's needs.
3. Without dramatic technological advancements in nuclear fusion or new discoveries, space solar power will be the only alternative to solve the problem of how to replace fossil fuels while maintaining America's standard of living.
4. Important new U.S. spacefaring policies must be established and implemented to set America on a course to develop and deploy space solar power in time to avoid energy scarcity.
5. Good old-fashioned American commercial enterprise should serve as the backbone for building this new space solar power industry and the spacefaring logistics infrastructure. Federal Government participation should only be tangential and supportive of this effort to the extent necessary to achieve safe, secure, and cost-effective solutions.

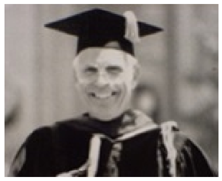
Recommendations

An American Spacefaring Foundation be created to prepare and submit recommendations, by 2016, to the American public and the United States Government regarding:

1. Future American energy security needs and the role of space solar power in meeting these needs;
2. A national energy security policy embracing space solar power;
3. A National Spacefaring Policy to implement commercial space solar power and the enabling commercial spacefaring logistics industry; and
4. The creation and initial activity of the U.S. Space Solar Power Corporation and the U.S. Spacefaring Authority.

****

About the Authors: Dr. Bob Krone is President of the Kepler Space Institute and Editor-in-Chief of the *Journal of Space Philosophy.* His complete resume is at: www.bobkrone.com/node/103. Mike Snead is a professional engineer, Associate Fellow of the American Institute of Aeronautics and Astronautics, and president of the Spacefaring Institute LLC. His complete resume and list of publications is at: http://spacefaringinstitute.com. He may be reached at info@spacefaringinstitute.com.

Editor's Notes: This article goes beyond the philosophical arguments to examine the feasibility as well as the necessity of developing space-based solar power. We commend it to those charged with making and implementing such decisions. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Earth Essay: The Promise and Wisdom of Nanotechnology

By Stephanie Lynne Thorburn

Abstract
Earth Essay is a fundamental paper. The work is advocating progressive, technological solutions and co-ordinated, holistic education for the benefit of both individuals and government to ensure a safe transitional phase toward a secure future for Earth and all its diverse incumbents. The work explores comparable approaches on environmental policy and the seductive wisdom of Nanotechnology. The author addresses the profile of the U.S. National Nanotechnology Initiative, especially the organisation's work within the Environmental Protection Agency and NASA, utilising further a strategic case study of Nanospire, Inc. The role of Oxford University Continuing Education is examined in relation to its vocational courses on Nanotech and the wider ethical/social context of new controversial technological developments. Finally, the less conventional contribution of space sciences and Kepler Space Institute are highlighted. The author proposes that the ethos of KSI offers a missing link in 21st-century progressive education, illuminating the latent potentials inherent to humanity's projected future. The paper is constructed with reference to Frank White's concept of the *Overview Effect*.

Key concepts: Environmental Sociology, Sustainable development, Nanotechnology, eco centrism, techno centrism, the Overview Effect, space sciences, transformative studies, techno humanism.

Social Theorists: Max Weber, Raymond Murphy, Frank White, Adriano Autino.

I dedicate my *Earth Essay* to the *International Association of Metaphysical Practitioners* (IAMP) and the *International Natural Healers Association* (INHA). The IAMP are the founders of the *One Planet Accord* initiative – I am a proud ambassador of *One Planet*.

Introduction

There are few persistent political issues that have frustrated me more fundamentally than the degradation of our natural environment. As a Reiki Master, I am innately a lover of Earth. My perspective on the increasing crisis humanity faces in relation to the environment is not stereotypical and has curiously not changed greatly over the past decade. As a student of environmental sociology, I learnt before recent ecological issues entered our mass media that our environment was causing much concern amongst scientists, politicians, and environmental groups. The available resolutions from a sociological perspective penetrate beyond the relatively limited social discourses that we are presented with on a day-to-day basis.

Sustainable development principles are taught amongst many counter viewpoints on social theory courses and the politically correct, palatable nature of the theory of this so-called gardening vision can be dissected critically in light of more fundamental, philosophical, and practical approaches. In a previous in-depth essay published in the American Chronicle,[1] I discussed the origins and applications of sustainable development, eco feminism, deep ecology, "techno-centrism," "eco-centrism," and social ecology in more depth. Hence, these are hotly debated concepts, interrelated to core sociological theories such as Max Weber's notions of rationalisation in contemporary industrial societies.[2] I feel that fuller consideration of such holistic sociological theoretical insights would diversify the available discussion points and potential resources available to journalists and politicians alike, as the crisis continues to worsen in context of our changing climate and natural world.

Earth's Environmental Demise: The Necessity of Co-ordinated, Progressive Technological Solutions & Holistic Education.

My work "The Astrosociological Imagination"[3] was received well within the niche market of those familiar with space advocacy issues, yet was not disseminated by all with an open mind. The reason for this is social myopia in regard to the initial labelling process when receiving information of a more unfamiliar persuasion in the public domain. The impersonality and sheer volume of information being digested would appear to lead, on occasion, to a limited ethos of inclusivity and a reactionary response. My essay in context was addressing one potential and more radical solution to our environmental problems than sustainable development via a resonance with the views of the *Space Renaissance Initiative Manifesto*, by Adriano Autino et al.[4]

As a writer and researcher, I am willing to be flexible in researching and discussing a range of progressive arguments in response to the challenges of our Earth's future. I have been disappointed at the lack of support at a practical funding level and a lack of sufficient progress in social perceptions of the potential contribution of technology for the benefit of humanity and of the space industry *per se*. Advances are definitely being made nevertheless, slowly but surely, in relation to didactic and social aspects of space sciences and cutting edge technology. Further, there are increasingly better approaches to holistic education in connection with Earth's future and our quality of life. I will explore these notions a little further, as I believe the concepts are at the heart of my own techno humanist perspective.

Environmental Problems and the Viable Resolutions.

In a nutshell, I believe that a growing population, the undermining of the rainforest, our continuing dependence on fossil fuels, and the gradual depletion of species on Earth is a serious matter that should not simply be left to conjecture or viewed with

[1] "The Astrosociological Imagination & the Space Renaissance Initiative. A Discourse Analytical Perspective," by Stephanie L. Thorburn can be found in PDF on the Space Renaissance philosophy papers archive: www.spacerenaissance.org/papers/Abridged_STR.pdf. The work draws from the founding principles of Prof. Gerard O'Neill, who advocated space sciences in relation to ecological issues to assist in our search for clean, practical energy sources and protection from industrial pollution. See Gerard O'Neill, *The High Frontier: Human Colonies in Space* (New York: William Morrow, 1977).

[2] Ibid. My study explored Max Weber's notion of rationalisation in contemporary industrial societies through the work of Raymond Murphy, particularly *Rationality and Nature: A Sociological Inquiry into a Changing Relationship* (Boulder CO, West View Press, 1994), Chapters 1-5 and 9.

[3] "The Astrosociological Imagination: The Challenge of Human Progress" was published in the *Journal of Space Philosophy* 1, no. 1 (2012): 43-49.

[4] *The Space Renaissance Manifesto* by Adriano Autino, Prof. Patrick Collins, et al. can be accessed at www.spacerenaissance.org/papers/The_Space_Renaissance_Manifesto.pdf.

deterministic eyes. Day to day there are constantly more natural disasters of potentially anthropogenic and non-anthropogenic origins. Our climate and seasonally determined weather are increasingly intertwined through dysfunctionality (winter in spring, drought surpassed by flooding, and the constant failure of basic crop production).

A solution may not be impossible, but there is a definite lack of consensus in policy and action, with our seemingly inevitable fate barely being circumvented. Continuing persistent doomsday editorials in science journals and the broadsheet press are prevalent at this time.[5]

Better and more diverse education is needed and not merely a relaying of the latest strategy or directive on sustainable development. Not only are these measures being implemented in a manner that is not effective, but they are also at times rather moot to the point. Recycling through a belief in economy of consumption and energy is very sensible when considered at face value. However, even if these policies were implemented perfectly at a local and national level, there remains the question as to whether recycling is just a sticking plaster in capitalist culture. Preventing shoppers from using adequate bags or stopping people in developed nations from drinking bottled water are rather miserable measures, lacking deeper response and insight, often creating an even more miserable social milieu. We need to be moving forward socially and technologically, not returning to regressive modernist ideals. The environmental movement needs to be progressing towards a more modern, egalitarian, advanced, energy-efficient future, not backward toward Victorian hygiene and health standards. I would point out that I myself advocate organic and home-grown produce and I believe that given a balanced approach, the best aspects of sustainability could be integrated into a more satisfactory environmental strategy.

Nanotechnology?

Fundamentally I would support the precepts of techno humanism; a concept that utilises the benefits of technology to assist humanity. Often advanced technology rarely seems to enter into the debate about our increasingly exhaustive consumption of fossil fuels. Fossil fuels are a finite resource, one that we cannot assume will remain viable for future generations, and an option we cannot afford as consumers right now! Investment in more advanced approaches to our energy crisis is essential and the potential benefits of nanotechnology need to be considered fully. As with nuclear power debates, there remains a range of safety and ethical concerns with the development of nanotechnology – however, if governments were to legislate and integrate policy encompassing the promise of nanotech resolutions thoroughly, our future might be that bit more secure. Further, the incessant guilt and regret at human's carbon footprint and technocentric excesses would not be as severe with sufficiently consolidated progress. Such anthropocentric progress would be viewed in the context of a maturing society that has evolved at times through primitive developmental stages.

[5] An example of recent pessimistic press warnings of rising CO_2 levels can be cited via *The Guardian* Environmental Network. See editorial by Fen Montaigne, *The Guardian*, May 14, 2013: www.guardian.co.uk/environment/2013/may/14/record-400ppm-co2-carbon-emissions.

Nanotechnology Definitions and the Promise of Nanotechnology.

A Profile of the National Nanotechnology Initiative.

The parameters and role of Nanotechnology to nurture progress in so many areas from health care to the environment are discussed very succinctly on the National Nanotechnology Initiative (NNI) government website. The organisation was established in 2000 and now comprises 27 federal agencies. The vision and goals of the NNI are expressed as the creation of a future punctuated by a revolution in technology and industry, with clear societal benefits. The NNI is a co-ordinated and well-articulated organisation, founded in the discovery and deployment of nanoscale science and technology to serve the public good, via ethical research and development. The NNI and affiliated agencies are working toward four central goals:

1. To advance world-class nanotechnology research and development;
2. To foster the transfer of new technologies into products for commercial and public benefit;
3. To develop and sustain educational resources, a skilled workforce and the supporting infrastructure and tools to advance nanotechnology;
4. To support the responsible development of nanotechnology.[6]

The NNI's website offers a treasure trove of pertinent information regarding the development of nanotechnology itself, ethical issues, and the scale of efficacy for such new technologies. The ethos is the development of technology to benefit the environment, public, and economy, rather than the systematic degradation of the natural environment, often associated with the process of progress and industrialisation. The key working-group areas follows: Global Issues and Nanotech, Nanotechnology; Environmental and Health Implications, Nanotechnology; Industry Liaison; Innovation and Nanotechnology; Public Engagement; and Communications. The NNI's programme component areas include consideration of nano phenomena processes, materials, standards, research, education, and society. In 2013, the NNI was apportioned $1.8 billion in the federal budget.

Inspiring the Next Generation of Scientists.

Significant federal partners of the NNI include the U.S. Food and Drug Administration and NASA. The more inspiring and sci-fi ambitions of nanotechnology can be considered via the collaboration between the goals of NASA and nanotech. NASA is orientated toward the future in space exploration, science research, and aeronautics research. NASA's role in nanotech is focussed on developing innovative concepts in electronics, computing, sensors, and advanced miniaturization systems. Recent successes include nano-aluminium, ice rocket propellant, nano-structured composites for thermal isolation applications, and smart electroactive materials. Projects include flight demonstrations on the Shuttle, International Space Station, and DoD flight opportunities. These recent significant developments technologically are certainly inspiring and promising too, for the next generation of scientists, working with and innovating through nanotechnology.

[6] See www.nano.gov.

For a fuller assessment of the work of the NNI, please investigate its website archives, educational initiatives, and forthcoming 2014 projects further through the organisation's homepage: www.nano.gov/about-nni/what/vision-goals.

"**Earth Essay: The Promise and Wisdom of Nanotechnology**" has been truncated. For the original transcription and full discussion on the promise and wisdom of Nanotechnology, see *Stephanie Lynne Thorburn*, "Progressive Etudes": http://slthorburn.edublogs.org/2013/05/22/earth-essay-the-promise-wisdom-of-nanotechonology/

The work also includes an examination of:

- Environmental discourse and the contemporary media.
- A strategic assessment of the contribution of space sciences and progressive education for the benefit of the environment and society.

****

Recommended Further Reading

Rickerby, D. G., and M. Morrison. "Nanotechnology and the Environment: A European Perspective." *Science and Technology of Advanced Materials* 8, no. 1-2 (January 31, 2007): 19-24. doi:10.1016/j.stam.2006.10.002

This paper offers a balanced scientific appraisal of the contribution of nanotechnology to the environment, in relation to the potential of metal oxide nanocatalysts to offer protection from industrial pollution. Energy-related applications for nanotech include nanostructured electrode materials that improve the performance of lithium ion batteries. This analysis is counterbalanced by equal assessment of the relatively unknown consequences and dangers of nanoparticles on the environment and their potential for toxicological effects. The process of life cycle analysis is advocated in risk assessment, together with methods of recycling and recovery of nanomaterials.

Reference and Resource Links.

The *Astrosociology Research Institute* (www.astrosociology.org) contains plenty of papers on space sciences, social science, and the environment.

The *Centre for Nanotechnology in Society* (www.cns.ucsb.edu/about) is an excellent society offering interdisciplinary research, grants, and diverse opportunities. The organisation aims to integrate regulators, educators, industrial scientists, and policy makers in the domain of Nanotechnology.

Journal of Space Philosophy http://bobkrone.com/node/120

Kepler Space Institute (www.keplerspaceinstitute.org).

National Nanotechnology Initiative (www.nano.gov).

Nanospire Incorporated (www.nanospireinc.com): Advanced cavitation.

Oxford University Continuing Education (www.conted.ox.ac.uk).

Socioastronomy research site (www.socioastronomy.webs.com).

Space Renaissance Initiative (www.spacerenaissance.org).

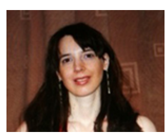
Stephanie Lynne Thorburn, author homepage (www.stephaniethorburn.webs.com).

The Overview Institute (www.overviewinstitute.org).

Web links accessed February 9, 2014.

****

About the Author: Stephanie Lynne Thorburn holds an MA in Sociology from Goldsmiths College in London with a combined honours degree in Sociology and Psychology from the City University, London. She is working on her doctorate degree. She is a Fellow of the Institute for Meridian Psychology and Associated Complementary Therapies. She is a freelance writer with vocational Diplomas and research interests in holistic health, graphic arts, parapsychology, and computing and more recently she has been researching into nanotechnology applications for Earth and for Space.



Editors' Notes: This is Stephanie Lynne Thorburn's second contribution to *The Journal of Space Philosophy* (See Fall 2012, article #12). She is a member of the Board of Editors for the Journal. Her entire article will be a nanotechnology education for readers. Her statement: "The ethos is the development of technology to benefit the environment, public, and economy, rather than the systematic degradation of the natural environment, often associated with the process of progress and industrialisation" is a valuable summary for the goals of pursuing nanotechnology science and technology. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

The Philosophy of Richard Kirby

By Gordon Arthur

I. Reflections on Dr. Richard Kirby by Gordon Arthur[1]

Trying to describe the thought or philosophy of Richard Kirby is like trying to capture a whirlwind. Ideas came at you from all directions simultaneously and it was easy either to get carried away or to get blown away.

His training was initially in psychology at North East London Polytechnic in England (now the University of East London), followed by training for ordination at General Theological Seminary in New York City, where he gained an MDiv, and post-graduate work in theology at King's College, London after his return to Britain, where he gained a PhD in theology. He lived in Britain from his birth in 1949 to 1978 and 1986 to 1994 and in the United States from 1978 to 1986 and again from 1994 until his death in 2009.

Richard's had interests including astronomy, ethics, finance, mathematics, philosophy, psychology, science fiction, theology, sociology, and the theory of government. He could speak about almost any topic at a moment's notice. His primary interests, however, were encouraging the religions to work together to relieve suffering and developing an Anglican counterpart to the Society of Jesus (called the Order of the Academy of Christ), which stressed the importance of learning within a framework of prayer, a way to combine the contemplative and the active life. Ultimately the latter project did not take off as he intended, but it was part of the impetus for the formation of the Kepler Space Institute, which was the main focus of the last few years of his life.

His doctoral dissertation was a study of the Theological Science of Thomas Torrance and it concentrated on the role of evidence in Torrance's definition of cosmic disorder. This was part of a wider project to harmonize theology and science by emphasizing that while science itself could be seen as morally neutral, the way it was applied frequently was not. He often quoted Einstein's belief and sadness that his famous equation, $E = mc^2$, had led directly to the Manhattan Project and its results over Hiroshima and Nagasaki. Accordingly, he was always keen to emphasize the morality behind scientific discovery and to encourage its practitioners to act in ways that were beneficial to humanity. He would therefore have been delighted to know that Kepler Space Institute adopted *Reverence for Life within Ethical Civilization* as the basis of its philosophy.

The People's Astronomy was his final book, compiled in three days from a collection of existing material and it was intended to build enthusiasm for astronomy among those without scientific training. The Table of Contents follows, along with the Foreword, Preface, Endpiece, and Afterword. The full book is at http://bobkrone.com/node/206.

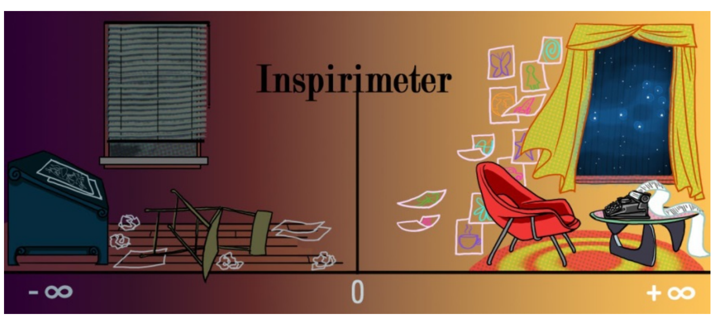
[1] I am indebted to the appreciation produced for Richard's funeral (part of which I wrote) for refreshing my memory on some of the details in this section.

II. People's Astronomy Contents

****

III. People's Astronomy Foreword: Dr. Bob Krone

Dr. Richard S. Kirby has been intellectually orbiting Earth with the ideas in this book since, as a fourteen-year old scientist in England in 1961, he knew of Yuri Gagarin, Alan Shepard, and John Glenn orbiting the Earth to begin the Space Age. On January 1, 2009, Dr. Kirby activated his de-orbit rocket and opened the Kepler Space Institute. Now he brings to Earth's people *The People's Astronomy*. Conceptual images help. So view the following image collage, which Rich Kirby created. He titled it *The Inspirimeter*:



The Inspirimeter is a conceptual overview of the desired evolution of human progress on Earth and into Space. Scientist, historian, scholar, astronomer, philosopher, minister Richard Kirby has brought the meaning of the Solar System and the stars to young and old on Earth with this small book. Similar to Stephen Hawking's *A Brief History of Time* (1998), *The People's Astronomy* answers the question for every human: "*Why should we go to space?"*

Since the Big Bang, humans have had the urge for flight as part of their genetic construct. The mythical Greek account of Daedalus's flight from prison to the Sun may be the first such story. Recorded history, science fiction, and the entertainment world continually focus on humans departing cradle Earth for good or for evil.

Dr. Kirby picked Astronomer Johannes Kepler (1571-1630) to represent our new university, because Kepler was the first to calculate the *Laws of Planetary Motion* and his laws are still used today to calculate satellite orbits.

The International Space Station has been growing since 1998, as it orbits the Earth every 90 minutes, because scientists and technologists have given us accurate mathematical means to plan and create space exploration and human development in Space precisely.

So why is this such an important book for the Space Age?

Forty-two of us, who have dedicated our lives to flying and to space over the last fifty years since John Glenn orbited the Earth, collaborated in writing *Beyond Earth: The Future of Humans in Space*.[2] Its 293 pages are filled with both the theory and detailed explanations of *How* and *Why* humans will settle in Space. It was this book that helped Richard Kirby fire his intellectual de-orbit rocket and bring his life's thinking to an Earth landing for people everywhere.

The ultimate answer to *Why Go?* is our desire for improved human evolution, and even its survival. Along the way, human space exploration and development will bring huge positive changes to our Earth and to the cultures, politics and societies on Earth. You will find Rich Kirby's imagination for those changes in *The People's Astronomy.* Working with Richard Kirby takes one on a path through forests of paradigms. He is one of Earth's most innovative thinkers for both theory and practice. We have launched the Kepler Space Institute into a sea of global problems which the leadership and Faculty are committed to address.

Whether you are an astronaut, a fourth grader, a "Woman of the Stars", a teacher, an artist or musician, in government, industry or non-profit work, and regardless of where on this planet you live, you will find your personal hopes, optimism and capabilities expanding as you envision a better future from each chapter of *The People's Astronomy*.

Bob Krone, PhD, Colonel, USAF (Ret)
Provost, Kepler Space Institute
April 11, 2009

****

[2] (Toronto, ON: Apogee Space Press, 2006).

IV. People's Astronomy Preface and Endpiece: Dr. Richard S. Kirby, Ph.D.

Author's Preface: The People's Astronomy

> Four score and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty, and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.
>
> But, in a larger sense, we cannot dedicate – we cannot consecrate – we cannot hallow – this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the unfinished work, which they who fought here have thus far so nobly, advanced. It is rather for us to be here dedicated to the great task remaining before us – that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion – that we here highly resolve that these dead shall not have died in vain – that this nation, under God, shall have a new birth of freedom – and that government of the people, by the people, for the people, shall not perish from the earth.
> **Abraham Lincoln: *Gettysburg Address***

With the death ten years ago of Carl Sagan, known as the People's Astronomer, a gulf opened in an American culture.

Although the intermittent successes of NASA and the space civilization building of the American people have gone on, sometimes slowly, sometimes fast, sometimes bravely, sometimes with less courage, sometimes profitably, and sometimes unprofitably, the space civilization building and the concept of the astronomical sciences (astronomy, cosmology, and astronautics) operative in American culture has remained essentially that of the aristocracy of the intellect.

Phrases like "it's not rocket science you know" indicate the idea that astronautics and rocket science is for the super bright, or for the technocrats called geeks, nerds, mathematicians, and assorted oddballs. Although Jacob Bronowski, in his book *The Ascent of Man*, declared himself completely opposed to the idea of an aristocracy of the intellect, saying that this could only cause the extinction of the human race, there has not been a movement towards the democratization of intelligence within the realms of Astronomical Civilization Building or ACB.

With the heroic leadership of Dr. Bob Krone and his book *Beyond Earth*, with its forty-two authors, this situation has changed. With the coming of Wikipedia, and the democratization of epistemology and public knowledge, the situation has also changed within the realm of the Encyclopedia.

It only remains to apply this to the world of the space sciences, to give a new inheritance to "every man, every woman" under the cold but perhaps friendly light of the stars. This, anyway, is the purpose of this little book.

David Livingston, the producer of *The Space Show*, is the proximal or immediate cause of the rapid appearance of this book. It is partly a compilation of my earlier writings on this subject, going back nearly forty years.

Our purpose is to show a new way of thinking about the space sciences in such a way as to offer a cosmic citizenship to all people everywhere, and to show the ways in which the magnitude of the heavens can help them be truly heavenly in delivering wealth and problem solving and even a new concept of home to the most ordinary man, woman and child everywhere. This is indeed a heroic quest, as has been pointed out by the historians of astronomy, such as Arthur Kessler in his book *The Sleepwalkers*, and was Rudolph Thiel's book *And There Was Light*.

On a personal note, I would like to say that I have been a textbook writer for nearly my whole adult life and in presenting this small textbook as a key to finding a new home in the heavens, I send it out with a blessing and a desire that it will give happiness, profitable living and effective problem solving with galactic amounts of grace. My thanks to my editors, Dan Shaw and Dr. Gordon Arthur; to my Secretary, Barbara Frost; to Dr. Bob Krone, Provost of Kepler Space Institute; to the contributor of the Afterword, Rabbi Dr. Moshe Dror; and to my students, friends, and family everywhere.

Endpiece

In this Third, Relational, Age of Space,
the cosmic beauty of the family
is now being liberated
for the people's homes and hearts

by the freeing of the gentle inner light
of the space sciences and domestic arts
for the higher nutrition
And for the good of planetary humankind
cherishing Mother Earth, reverencing environments,

blessing soil and seed and space and satellite,
as we settle civilization in space
by the awakening through kindness and forgiveness
of the women's rights, through love's ubiquitous genius
by nourishing in farm and field

Earth's and Heaven's fertility,
releasing in ecstasy Cosmic Woman's glorious fruitfulness
in the bliss-dance of galactic babe and birth, infant and child
and the women's wisdom, earthedness and peaceability
to pursue the Absolute Cultural Goods
of Sanity and Survival, Peace and Heavenly Sustenance,
in love, health and happiness
of astronomically great stature
in the present high heroines' New Time
of the Women and the Children,
and the untortured Animals, of the Stars,
for our wise old people and their worship,
in our brave young humanity and their adventures,
in the healing of our hates
through the kissing of our mates
in the quiet song of joy
in the blessed Martian fields
and in exotic cosmic climes
in asteroidal mines,
in vagrant comets' tails,
from the Cradle of Humanity
to the Cradles of the Cosmos,
seeking the Soul of the World,
finding her together.

****

V. Afterword by Moshe Dror

Hello and Welcome.

I would imagine that after reading through all of this heady and powerful material you might want to say WOW, and relax.

Not just yet.

These ideas are going to project a good part of humanity into space in the not too distant future, and they will propel you as well.

Just consider – we are the heralds of one of the most wonderful and beautiful aspects of human culture in all of its glories either what we have actually seen and witnessed or even dreamed of.

We are on the great journey of "Prophetic Imagineering". We may not be prophets, but we might actually be students in a school for prophets where we can envision our ideas as part of the Imagineering capabilities of our cyber media.

Some of this may actually happen, some are basically visions, all are desiderata – what we would like to see happen. It is important to remember that we are not going INTO space. We are already IN space. We have been IN space since we have been – period, and as Bucky Fuller reminds us – we do not have an instruction manual.

That is what this exploration is about. We are creating at least a part of the instruction manual for how to live on spaceship earth and use it as the launching pad for the extended human as we leave the cradle and become sailors into the sea of the cosmos.

It is our generation that is privileged with the multiple tasks of being simultaneously – a

> Citizen – living in a city,
> Netizen – living in Internet, networked in Cyberia
> Cosmozen – citizen of the cosmos.

We already have Cosmonauts and Astronauts. *Nautes* is Greek for "sailor". Cosmos is derived from the Greek idea of "orderly arrangement". It was Pythagoras who is said to have been the first to apply this term to the "universe" probably originally meaning "the starry firmament".

Astron – Greek for "star". So we have an ancient vision of the sailor unto the stars – US.

According to Wikipedia, there are about 500 people who have already flown in excess of an altitude of 100 kilometers (62 miles) or in the United States' definition, 80 kilometers (above 50 miles). Space travelers have ALREADY spent over 30,400 person days – a cumulative total of over 83 years – in space. These numbers will obviously only grow in the future.

One might look at another way to view this monumental journey of humanity. Nearly every religious and spiritual tradition suggests that the founder of the tradition left home and went on a journey – Jesus, Buddha, Moses, Abraham, Mohammad, and others. Indeed the very first act of the Hero's Journey is just that – to leave home and go on a journey of discovery.

The journey that still today relates to more than half of the human community is that of Abraham, and by extension all of the members of the Abrahamic faith communities.

Abraham was the first 'IVRI – Hebrew. The term "'ivri" means "crossing over". In the days of Abraham the crossing over was either of the rivers or of the desert – depending on the tradition.

So basically Abraham was a "Boundary Crosser".

The personal significance of Abraham was to cross over conceptual boundaries and develop an entirely new worldview – a z*eitgeist* – to use the appropriate term of Richard Spady.

Abraham's journey was in many dimensions. His was a journey in geographic space – across the land. Ours is in Cyberspace and Inner Space – and Outer Space. We are all boundary crossers. As Nicholas Negroponte, the founder and director of the MIT Media Lab, suggests we are the generation that is shifting from seeing the world as atoms and are learning how to see the world in terms of bits. This shift from atoms to bits is probably one of the most significant and profound boundary crossings in all of human history. It is this shift that is making possible all of the visions and actuality of our Space Age. Without this shift in *zeitgeist*, we would be still earth bound and grounded.

None of us knows how all of these visions will actually work out in our human history. And, as Andrew Cohen reminds us:

> Not knowing is the secret of wisdom. That's the mystery that gives us access to the very source of liberating clarity. When we don't know, there is an empty space through which the mysteries of life and death are revealed to us.

Richard Kirby and the contributors to this exploration of discovery do not deal with the technology of space at all. We are all dedicated to the idea of the synergy of High Tech and High Touch, and in moments of Grace – High Holiness. It is also the spiritual aspects of this journey that fascinate us all.

We are all dedicated to the power of the vision that binds all of humanity together, regardless of where their bodies may be.

Perhaps this was best said by the philosopher-mystic, Teilhard de Chardin:

> Someday, after mastering the winds, the waves, the tides and gravity, we shall harness for God the energies of love. And then, for a second time in the history of the world, man will have discovered fire.

The dimensions of awe and wonderment that so motivated Kant, who wrote of the starry skies above and the morals of humanity, are an extension of the Psalms and the analogue of every spiritual tradition of humanity where the heavens can be seen as a place of goodness and happiness. Can we get there? Who knows?

We are able to vision, dream and DO. Kirby and friends are on the same journey as Teilhard who reminds us all:

You are not a human being in search of a spiritual experience. You are a spiritual being immersed in a human experience.

WELCOME and LET'S ALL ENJOY THE JOURNEY

****

About the Author: Gordon Arthur is the author of *Law, Liberty and Church: Authority and Justice in the Major Churches in England* (Aldershot, Ashgate, 2006); "The Development of Canonical Jurisprudence in the Roman Catholic Church and the Church of England", *Ecclesiology* 4 (2008): 308-25, and *On Frustrated Vocation* (Ilford: FeedARead, 2012) He gained a BSc in Physics from Birmingham University in 1984, an MA in Philosophy of Religion from King's College, London in 1998, and a PhD in theology, also from King's College, London in 2004. Gordon is Associate Editor of the *Journal of Space Philosophy*.

For more details see www.linkedin.com/in/gdarthur.

Editor's Notes: Publishing Dr. Gordon Arthur's article on the special life and works of Dr. Richard Kirby gives us, in Kepler Space Institute, Inc., great satisfaction. Rich Kirby's inspirational leadership, 2006 to 2009, was the stimulation for us to operationalize our years of discussions about a new education and research entity into what Rich titled *The Kepler Space University* (headquartered in California) on 1 January 2009. He became our founding President. Kepler Space Institute, Inc. is the corporate entity that sponsors our activities today, in 2014, and which holds our visions for the future formal establishment of the first Space University in the United States. Gordon Arthur has been critically important throughout this entire period. He was a protégé of Rich Kirby and has been our Associate Editor for the Journal of Space Philosophy since its founding in 2012. Dr. Moshe Dror, who authored the *Afterword* for Rich's *People's Astronomy* book, was an Israeli scholar who worked closely with Rich Kirby from the 1990s until Rich's death in September 2009. We mourned his passing in 2012. ***Bob Krone, Editor-in-Chief.***

Arthur C. Clarke's Philosophy for the 21st Century

By Bob Krone

Joseph Campbell (1904-1987) was a renowned scholar in comparative mythology. In his book, *The Inner Reaches of Outer Space: Metaphor as Myth and As Religion,* he wrote:

> It then occurred to me (after Armstrong and Aldin stepped on the moon) that outer space is within inasmuch as the laws of space are within us; outer and inner space are the same. We know, furthermore, that we have actually been born from space, since it was out of primordial space that the galaxy took form, of which our life-giving sun is a member. And this earth, of whose material we are made, is a flying satellite of that sun. We are, in fact, productions of this earth. We are, as it were, its organs. Our eyes are the eyes of this earth; our knowledge is the earth's knowledge. And the earth, as we now know, is a production of space.[1]

Inner Space, for us in Kepler Space Institute, is in the minds of humans. And the philosophy, values and beliefs found there will be the motivation for Space exploration, development, and human settlements.

Arthur C. Clarke

Arthur C. Clarke is one of the top Space storytellers. His books, and the films made from his books, are permanent best-sellers. This *Journal of Space Philosophy* article summarizes his philosophy existing in that legacy. They reflect the insights of Arthur C. Clarke spanning a wide range of topics concerning the human condition, our existence on Earth, and Earth's place in a greater cosmos. Sources are Neil McAleer, Arthur C. Clarke's biographer, and primary sources in the collection of the Library of Congress in Washington, DC. See:

http://www.clarkefoundation.org/sample-page/sir-arthurs-quotations/

Freedom of Information

In 2014, information freedom is a global issue. Arthur wrote: "In the struggle for freedom of information, technology, not politics, will be the ultimate decider."[2] He was almost right. The political ramifications of making classified information free fill today's media. But it is the technology that fires the politics.

[1] (Novato, CA: New World Library, 2002), 2.

[2] www.goodreads.com/ and www.quotationspag.com. Note: Arthur C. Clarke has filled his books with quotes that flow from his personal philosophy. The ones selected here for thirteen subjects provide his relevant basic beliefs in summary form. Those thirteen could become the table of contents for a book titled *Arthur C. Clarke's Philosophy for the 21st Century.*

Reality, Fiction, and History

Arthur wrote: "Any sufficiently advanced technology is indistinguishable from magic."[3] Arthur's stories are filled with his science and technology know-how combined with scenarios that readers often interpret as magic. His science-fiction magic has a way of becoming reality

> The limits of the possible can only be defined by going beyond them into the impossible. One of the biggest roles of science fiction is to prepare people to accept the future without pain and to encourage a flexibility of mind. Politicians should read science fiction, not westerns and detective stories. *2001* was written in an age which now lies beyond one of the great divides in human history; we are sundered from it forever by the moment when Neil Armstrong and Buzz Aldrin stepped out on to the Sea of Tranquility. Now history and fiction have become inexorably intertwined.[4]

Morality

Arthur wrote: "As our own species is in the process of proving, one cannot have superior science and inferior morals. The combination is unstable and self-destroying."[5] Here Arthur identifies what may be the major astrosociology problem for the future of humans in Space. If we specify for our purposes here that *morality* is an umbrella term for the whole set of human pathologies that have caused death, destruction, and reverses in civilization, then Arthur Clarke is right – superior science with inferior morals will be self-destructive for humankind and create huge barriers for Space missions. Yehezkel Dror, The Co-Founder and leading scholar in the Policy Sciences wrote in his 2006 "Governance for a Human Future in Space":

> New values focused on the long-term good of humanity, within pluralistic normative systems, are needed. This goes far beyond a code of ethics for space settlement, however important, involving human values as a whole. Needed is what I call Raison d'Humanite values displacing, in part at least, Raison d'Etat, and also going beyond the propensity of countries to regard what is good for them as good for humanity as a whole. Developing Raison d'Humanite is a sorely neglected task for value creators and moral philosophers. Present efforts in this direction are often very narrow in scope, doubtful in terms of serious moral reasoning, and not fitting the nature of human settlement of space, which necessarily will be "tough" in many respects.[6]

The Kepler Space Institute has formulated its Space Philosophy into three basic components: (1) reverence for life, (2) ethical civilization, and (3) policy sciences. See the Fall 2012 issue of the *Journal of Space Philosophy,* Article #8 by Bob Krone.

---

[3] www.goodreads.com/ and www.quotationspag.com.
[4] www.goodreads.com/ and www.quotationspag.com.
[5] www.goodreads.com/ and www.quotationspag.com.
[6] Yehezkel Dror, "*Governance for a Human Future in Space*," chapter 5 in *Beyond Earth: The Future of Humans in Space*, ed. Bob Krone (Toronto, ON: Apogee Books, 2006), 41-45.

Laws of Nature

Clarke wrote, "Human judges can show mercy. But against the laws of nature, there is no appeal."[7] Human evolution on Earth has adapted *homo sapiens* so it lives in comfort with Earth's natural laws. The past sixty years of humans venturing into Space have validated that Clarke quote. Kepler, Newton, Galileo, Einstein, and others have defined enough laws of nature in Space that today's science and technology is capable of sending humans to the Moon and of orbiting Earth. In 2014 we know something about gravity, mass, energy, and relativity and we are learning about "Nature's Cosmic Intelligence." See the *Journal of Space Philosophy,* Fall 2012, Article 7, by Joel Isaacson.

Nationalism

Arthur's quote is: "It is not easy to see how the more extreme forms of nationalism can long survive when men have seen the Earth in its true perspective as a single small globe against the stars."[8] This is a subject that Frank White has championed with his Overview Effect (see the *Journal of Space Philosophy*, Fall 2012, Article 9 and Fall 2013, Article 10). The resource requirements of Space missions make strictly national sponsorship difficult. The International Space Station has been the most successful example of international cooperation. But the issue has far greater implications than for individual missions. The larger research question is: *How should successful Space Settlement Governance be designed?* If internationalism is part of the answer *then what will be impacts for nationalism on Earth?* And does seeing the world absent national borders erase the historic reasons for maintain national borders? The Space Age commencement will foster serious social-political questions like these. Arthur's bias against nationalism is clear from his quote: "There is hopeful symbolism in the fact that flags do not wave in a vacuum."

Intelligence

"The best proof that there's intelligent life in outer space is the fact that it hasn't come here," wrote Arthur Clarke. "The fact that we have not yet found the slightest evidence for life — much less intelligence — beyond this Earth does not surprise or disappoint me in the least. Our technology must still be laughably primitive; we may well be like jungle savages listening for the throbbing of tom-toms, while the ether around them carries more words per second than they could utter in a lifetime."[9] We don't believe Arthur Clarke knew of Dr. Joel Isaacson's discoveries and research into *Nature's Cosmic Intelligence*, but that final thought is remarkably close to Recursive Distinctioning. See Joel Isaacson's article, "Nature's Cosmic Intelligence," in the Fall 2012 issue of the *Journal of Space Philosophy*. Arthur also wrote: "Two possibilities exist: Either we are alone in the Universe or we are not. Both are equally terrifying. The Information Age offers much to mankind, and I would like to think that we will rise to the challenges it presents. But it is vital to remember that information — in the sense of raw

[7] www.goodreads.com/ and www.quotationspag.com.
[8] www.goodreads.com/ and www.quotationspag.com.
[9] www.goodreads.com/ and www.quotationspag.com.

data — is not knowledge, that knowledge is not wisdom, and that wisdom is not foresight. But information is the first essential step to all of these."[10]

New ideas

> Every revolutionary idea seems to evoke three stages of reaction. They may be summed up by the phrases: (1) It's completely impossible. (2) It's possible, but it's not worth doing. (3) I said it was a good idea all along. This is the first age that's ever paid much attention to the future, which is a little ironic since we may not have one.[11]

Religion

Arthur Clarke described himself as an atheist:

> It may be that our role on this planet is not to worship God but to create him. The greatest tragedy in mankind's entire history may be the hijacking of morality by religion. The rash assertion that "God made man in His own image" is ticking like a time bomb at the foundations of many faiths, and as the hierarchy of the universe is disclosed to us, we may have to recognize this chilling truth: if there are any gods whose chief concern is man, they cannot be very important gods.[12]

We created a multi-faith *Space Faith Think Tank* within Kepler Space Institute in 2008 that searched for spiritual commonalities across faiths. See Dr. (Pastor) Lawrence Downing's article #11 in the Fall 2012 issue of the *Journal of Space Philosophy.*

Automation

> Any teacher that can be replaced by a machine should be![13]

Human extinction

> The danger of asteroid or comet impact is one of the best reasons for getting into space. I'm very fond of quoting my friend Larry Niven: "*The dinosaurs became extinct because they didn't have a space program. And if we become extinct because we don't have a space program, it'll serve us right!*"[14]

Scale of the Universe

> We have abolished space here on the little Earth; we can never abolish the space that yawns between the stars. Once again, as in the days when Homer sang, we are face-to-face with immensity and must accept its grandeur and terror, its inspiring possibilities and its dreadful restraints. To obtain a mental picture of the distance to the nearest star, as compared

[10] www.goodreads.com/ and www.quotationspag.com.
[11] www.goodreads.com/ and www.quotationspag.com.
[12] www.goodreads.com/ and www.quotationspag.com.
[13] www.goodreads.com/ and www.quotationspag.com.
[14] www.goodreads.com/ and www.quotationspag.com.

> with the distance to the nearest planet, you must imagine a world in which the closest object to you is only five feet away — and there is nothing else to see until you have traveled a thousand miles. Space can be mapped and crossed and occupied without definable limit; but it can never be conquered. When our race has reached its ultimate achievements, and the stars themselves are scattered no more widely than the seed of Adam, even then we shall still be like ants crawling on the face of the Earth. The ants have covered the world, but have they conquered it — for what do their countless colonies know of it, or of each other? So it will be with us as we spread out from Mother Earth, loosening the bonds of kinship and understanding, hearing faint and belated rumors at second — or third — or thousandth hand of an ever-dwindling fraction of the entire human race. Though the Earth will try to keep in touch with her children, in the end all the efforts of her archivists and historians will be defeated by time and distance, and the sheer bulk of material. For the numbers of distinct human societies or nations, when our race is twice its present age, may be far greater than the total number of all the men who have ever lived up to the present time. We have left the realm of comprehension in our vain effort to grasp the scale of the universe; so it must always be, sooner rather than later.[15]

Predicting

> [We] cannot predict the new forces, powers, and discoveries that will be disclosed to us when we reach the other planets or can set up new laboratories in space. They are as much beyond our vision today as fire or electricity would be beyond the imagination of a fish.[16]

Entropy

> Maybe those nihilist philosophers are right; maybe this is all we can expect of the universe, a relentless crushing of life and spirit, because the equilibrium state of the cosmos is death.[17]

For his 90th birthday in December 2007, Arthur C. Clarke recorded a greeting to his friends around the world. As part of the message, Clarke expressed three wishes:

> Firstly, I would like to see some evidence of extra-terrestrial life. I have always believed that we are not alone in the universe. But we are still waiting for ET to call us — or give us some kind of a sign. We have no way of guessing when this might happen — I hope sooner rather than later!

---

[15] www.goodreads.com/ and www.quotationspag.com.
[16] www.goodreads.com/ and www.quotationspag.com.
[17] www.goodreads.com/ and www.quotationspag.com.

> Secondly, I would like to see us kick our current addiction to oil, and adopt clean energy sources. Climate change has now added a new sense of urgency. Our civilisation depends on energy, but we can't allow oil and coal to slowly bake our planet.
>
> The third wish is one closer to home. I've been living in Sri Lanka for 50 years — and half that time, I've been a sad witness to the bitter conflict that divides my adopted country. I dearly wish to see lasting peace established in Sri Lanka as soon as possible.

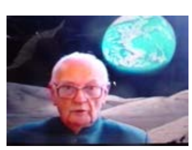
In his 90th birthday message, Clarke also addressed his legacy:

> I'm sometimes asked how I would like to be remembered. I've had a diverse career as a writer, underwater explorer, space promoter and science populariser. Of all these, I want to be remembered most as a writer — one who entertained readers, and, hopefully, stretched their imaginations as well.

****

About the Author: Dr. Bob Krone is President of Kepler Space Institute, Editor-in-Chief of the *Journal of Space Philosophy*, and Emeritus Professor of Systems Management, University of Southern California. His curriculum vitae can be found at www.bobkrone.com/node/103.

Editor's Notes: Arthur C. Clarke published 34 novels between 1951 and 2008. His non-fiction publications numbered 31 between 1950 and 2005. Wikipedia documents 70 cited references, 19 external links, and 15 Awards, Honours, and recognitions. During WWII he served in the Royal Air Force as a radar specialist. He was commissioned as a Pilot Officer in May 1943 and became Chairman of the British Interplanetary Society from 1946 to 1947 and again from 1951 to 1953. One of his most important contributions was his concept for geostationary satellites to be communications relays. The geostationary orbit at 22,000 miles above the equator is officially recognized by the International Astronomical Union as the "Clarke Orbit." See en.wikipedia.org/wiki/Arthur_C_Clarke. ***Gordon Arthur.***



Journal of Space Philosophy 3, no. 1 (Spring 2014)

Celestial Values

By Kim Peart

As we travel through space on Starship Earth, we may wonder about the values that could guide us in a future we look to among the stars.

At the world premiere of a film on the Overview Effect at Harvard, Frank White spoke of his vision, "we're on a spaceship.... We are the crew. We need to work together as the crew of spaceship Earth.... We're astronauts."[1]

Often we see ourselves as helplessly trapped on a planet and totally at the whim of the forces of Nature. If we see the Earth as a spaceship of any kind, then we may see ourselves as passengers. If we take Ron Garan's cosmic view to heart, then as the crew of this great ship, we are in one sense all astronauts, as we travel through space.

We are space-farers and if we wish the ship to remain in good condition, we must ensure that our life-support systems are all in good working order. If we dare face the brutal truth in these matters, then we have to admit that there are life-support problems that must be addressed.

Too many of our fellow crew members are trapped in poverty and starving. On a well-run ship, this should not be happening. We look around and see sections of the crew at war and killing one another. With some nations bristling with nuclear weapons, conflict on our starship is a dangerous thing.

We can look at our evolution and see that it has delivered our civilization to the edge of space development, but progress there has slowed to a snail's pace and this is a problem. To get to where we are now, we have burnt a huge volume of fossil fuel and a direct consequence has been the release of fossil carbon into our starship's life-support systems. This carbon, as carbon dioxide (CO_2), is now increasing the greenhouse effect of the ship. Getting the carbon out of balance, however, presents a great risk to the security of the ship, which is now overheating.

In evolutionary terms, we needed to burn fossil fuel so that we could lift our game from the planetary surface of our starship and begin operating in space. The key to running our civilization is energy and fossil carbon is a transition energy from which we should have moved on by now, by building solar power stations in space to harvest the

[1] The Overview Effect: Freethink@Harvard www.youtube.com/watch?v=0X_fhLIPydE. The earliest known reference to Earth as a spaceship is by Henry George in his 1879 book, *Progress and Poverty*, in which he wrote, "It is a well-provisioned ship, this on which we sail through space." In 1965 Adlai Stevenson said in the United Nations, "We travel together, passengers on a little space ship." Buckminster Fuller explored the concept in his 1968 *Operating Manual for Spaceship Earth*. See en.wikipedia.org/wiki/Spaceship_Earth. Further on in the space age, Frank White explored the concept that we are all crew on the spaceship Earth in his book, *The Overview Effect*, in which he writes, "become a crew member on spaceship Earth" (2nd ed.; Reston, VA: American Institute of Aeronautics and Astronautics, 1998), 169.

unlimited energy-well of our star, the Sun, which has so much fuel in reserve, it will burn brightly over the next 5 billion years, until it expands beyond the orbit of the Earth as a red giant. We are yet to wake up to the need for energy transition from carbon to solar and this is a double banger problem that directly impacts on our values as star-farers.[2]

We could have begun the great energy transition in the 1970s, but we could not see past the need to keep on burning fossil fuel for energy, even though the way was worked out by visionaries like Dr. Peter Glaser and Professor Gerard K. O'Neill. Now we face the consequences of our inaction, with the planet getting hotter, polar ice melting, the sea level rising, climate areas shifting, and with CO_2 being absorbed into the oceans, the sea is becoming more acidic.

Concerns are being expressed in some scientific quarters that conditions could now be gathering for a repeat of the Great Dying that happened 251 million years ago, when 90% of life on Earth perished in the first great extinction event on our planet. At the time, massive volcanic activity in Siberia saw the release of large volumes of CO_2, which likely came from coal being ignited by volcanic ash and which drove up the planet's greenhouse effect, causing temperatures to rise and climates to change.[3] The extra heat in the air in turn warmed the oceans, which caused methane hydrate deposits on the ocean floor to be released. This went into the atmosphere and further increased the planet's greenhouse effect. Extra CO_2 in the air was also absorbed by the ocean, making the sea more acidic and hostile to life.

Similar changes to our planet starship's life-support systems are happening now and are happening so fast that evolution cannot meet the demand for new species in the traditional way of mutation and adaptation. Unless there is a dramatic turnaround in the current trend, it is feared that the oceans could begin to die, leading to sulphur bacteria in the sea releasing a vast amount of hydrogen sulphide gas that can kill life on land and damage the ozone layer.[4] To survive in this hot toxic future, human communities on starship Earth may need to live in protected environments, as if in space.

Often in human history, an environmental crisis has resulted in conflict. As the crew of our starship begins to panic, with the life-support systems breaking down, there is the ever-present risk that any conflict will tumble into nuclear madness, ending all hope for the future. Even if an atomic insanity is avoided, if we lose the cutting edge of space technology, including access to key resources, the surviving crew may find itself trapped on a hulk in space, with a total loss of hope for the future.

When astronomers and cosmologists look out among the stars, they are puzzled by the great silence that echoes back at us. They believe that because there are so many stars and galaxies in the Universe, there should be evidence of alien civilizations in one form or other. An older species should have a presence in the Solar System, as it is at least

[2] I have explored why we failed to make the energy transition in a timely fashion in my article, "A Deeper Level of Denial," tasmaniantimes.com/index.php?/article/a-deeper-level-of-denial/.
[3] http://www.abc.net.au/science/articles/2011/01/24/3120458.htm.
[4] http://en.wikipedia.org/wiki/Permian%E2%80%93Triassic_extinction_event.

possible for robot craft to travel among the stars powered by a solar sail and then establish a base and factory in any star system, to send exploration craft on to the next star system.[5]

We can only wonder if many civilizations have risen up in the history of the cosmos but, like us, have burnt their fossil fuel too long, instead of investing in energy transition to become a star-faring species. One day, should we survive our own lax approach to survival, we may discover the remains of failed civilizations among the stars and lament the loss. For now, we need to heed the silence of the stars and look to our own survival, while we have time to act.

It is also possible that extra-terrestrial civilization could have been eliminated by a natural catastrophe, such as a super volcano, a solar flare, or an asteroid strike. Only 12,800 years ago all human communities in North America were eliminated in an asteroid fire-storm.[6] Many asteroids are made up of boulders and rubble, so that when they strike, they break up and come in many parts that may explode in the air. When a small meteor exploded above a Russian city last year, we found out just how dangerous asteroids can be to life on Earth.[7]

The First Celestial Value: Survival

Any set of values is only useful if the practitioners can actually survive to practice it. Without survival, no other activity is possible.

Considering the march of evolution on Earth and how humankind has arrived on the scene with an ample energy supply in the form of fossil fuel that opens the way for energy transition from carbon to stellar, it is our failure to act on this that may make any set of celestial values a moot point. Our most basic value must therefore be to act on energy transition as a survival priority.

Unfortunately, to achieve this we will need to burn a whole lot more fossil fuel, but this can be offset as the construction of solar energy plants on Earth and in space gathers pace. With direct access to the unlimited energy-well of the Sun, we will have the power to extract excess carbon from the biosphere and also process extracted carbon back into a useful resource for Earth and space industries.

At this stage of our survival neglect, we cannot expect to avoid a worsening of starship Earth's environmental condition, with increasing heat and even toxic fumes from dying oceans. With a clear survival plan in action, hope would be generated to inspire the crew to work like crazy to win back a safe starship with a healthy life-support network.

---

[5] This concept is explored in my document, "Creating a Solar Civilization," www.islandearth.com.au/index.php?option=com_content&view=article&id=46&Itemid=64.

[6] "Comprehensive analysis of impact spherules supports theory of cosmic impact 12,800 years ago," *Space Daily*, May 27, 2013, www.spacedaily.com/reports/Comprehensive_analysis_of_impact_spherules_supports_theory_of_cosmic_impact_12800_years_ago_999.html.

[7] "Defending Earth from Space," tasmaniantimes.com/index.php?/article/defending-earth-from-space/.

With solar power stations in space, industry could be launched beyond Earth that would allow the building of the defences of our starship against killer asteroids or comets. We would also be able to press on to build Earth gravity orbital space settlements anywhere in the Solar System, which could be the basis of future stellar migrations. With the human population dispersed, our species would be able to survive a natural catastrophe that we could not prevent on Earth.

The greatest anti-value is to cling to the Earth and pretend that we will be alright. That is a gamble with life and right now, it is a punt that we are on the way to losing. Nature is not kind to those who ignore the demands of survival.

Another basic aspect of survival in space is to bring an end to human aggression, as in space human communities are located in bubbles in a vacuum, all too easily burst from within or without by conflict and/or terrorism. Part of ending aggression is to send poverty into history on Earth, so all the children of Earth can grow up in a happy and healthy environment. This work has been attempted by many over the decades, but now it must become a core challenge of all the crew members of starship Earth. Only where we invest in a harmony that includes all life can we hope to assure our survival, by eliminating the threat from within.

The Second Celestial Value: Harmony

In space, which must be made clean of rock and trash so that human settlements in a vacuum can be protected and defended, where we must defend Earth and all space settlements from the risk of asteroids and comets, we cannot afford the prospect of conflict or terrorism. Only by building harmony among all crew members and their children can we hope to avoid the inner enemy.

With survival assured and the long hard road begun to repair starship Earth, we could settle into some seriously creative activity, on our starship and across the Solar System. At the heart of creativity will be the building of a stellar economy that maintains fairness for all citizens. To maintain harmony, we can no longer afford the silliness of an economy where a few control most of the wealth and too many people get nothing.

In Nature we see both competition and cooperation are needed to maintain a healthy ecology. Why should the economy of a stellar civilization be any different to Nature? Many companies succeed as a competitive free enterprise, but competition does not work for all citizens, or we would see a full-employment society. Part of the problem is that the socio-economy is ever on the move with industrialisation and automation. Now, with the arrival of robots, fewer workers will be needed in a new wave of eliminating employment options.

If we made a decision to connect all citizens to the economy, this decision could be realised through establishing cooperatives. As full employment must be seen as a natural given in a healthy economy, we need to build systems that share the wealth created in an equitable way. If we rely on competition alone, we will fail to build a fair society.

One detail that enables a whole new approach to the stellar economy is the fact that we would be gaining direct access to unlimited energy from the Sun, energy which will be used to power factories in space to provide any product for Earth and space markets. Though the initial investment will be humongous, in time the return on the investment will be infinite, from across the Solar System and among the stars.

If we had not been so obsessed with burning fossil fuel, we could have secured the stellar economy by now. We must now catch up with the future.

The Third Celestial Value: Creativity
By applying creativity to a problem, we demand a solution. Through creativity, we can create the future.

When Edwin Hubble discovered that the Universe was expanding, he sparked cosmologists on a quest to reverse the process and see where everything began. This resulted in the Big Bang theory, which describes the cosmos beginning as an infinitely small point, or singularity, nearly 14 billion years ago, gaining prominence. The Universe stretched as a primal singularity to become the seemingly infinite space-time continuum that we see around us. Our cosmic home is a point stretched to near-infinity.

Concluding that the Universe has a finite beginning, the question arises about the larger environment in which our cosmos exists, often referred to as the multiverse, which could be home to an infinite number of other universes. Though we sail on starship Earth through the cosmos, we are also denizens of a much vaster realm, which begins to reveal mysteries beyond imagining. Accepting that we dwell in a realm that transcends the Universe, we may wonder how amazing the larger transcendent environment is.

The key to approaching the transcendent realm lies in the nature of the cosmic birth, where we see space-time stretching from the primal singularity to near-infinity. If we wonder where it all began, we can know that we occupy the space where the cosmic birth happened. It is the appreciation of this very simple aspect of space-time being a stretched singularity that opens the way to approaching the multiverse. When we can know that we are part and parcel of the cosmos, that there is no difference between who we are and the Universe, then we focus on a central awareness, that we are one with space-time.

In this awareness we may wonder what the highest experience of life is and we may consider happiness as being a pleasant state of mind that is at peace and yet also playful. When we experience happiness, we can be in a state of mind that is expansive, like space-time.

The Fourth Celestial Value: Happiness
A transcendent experience of happiness allows connection with the Universe and the multiverse. Being happy is a liberating experience.

The transcendent state of happiness, like space-time stretched, is a singular experience. Honesty is therefore natural to a happy state of mind. Out of simple honesty, the concept of truth that is so vital to the arts of science and revealing the mysteries of Nature stands. In this honesty, there is no fear, as there is nothing to hide. The art of veracity, of living and telling the truth, is spontaneous in a state of happiness.

To build a stellar economy without poverty and to repair and defend our starship Earth calls for the emergence of empowered individuals who have connection with their inner happiness. These will be people who practice the art of fearless compassion, which is described so well in the story of the Good Samaritan.[8] Fearless compassion is the ultimate expression of happiness in life, seeking the well-being of others. It is this dynamic happiness that we need now to build a stellar economy without poverty.

Will we, the crew of starship Earth, sing a happy song of our voyage among the stars, as we build new cities in space?

****

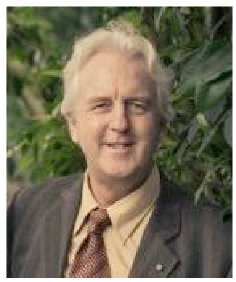
About the Author: Born in 1952, Kim Peart was raised in the Australian island state of Tasmania, where he trained as a visual artist, launched a Viking Society in 1975, and became a life-long space advocate in 1976 when joining the L5 Society. He founded the Southern Cross L5 Society in 1981, now the National Space Society of Australia, which was given its national launch in the Observatory at The Rocks in Sydney in early 1982. After a journey to India in 1986, he became a human rights defender and urban environmentalist, gaining an entry among Tasmania's top 200 movers and shakers in 2007 at number 123. In 2006, he wrote the document "Creating a Solar Civilization," moved north to Queensland in 2007, and is currently director of Space Pioneers.

In March 2012, he worked with research scientist Dr. Jennifer Bolton, to identify a way to build a working model of an orbital space settlement in the virtual world, the virtual orbital space settlement (VOSS), which allows any number of people to be involved in a space-like virtual environment, as if in space. When they discovered that Second Life had activated the RayCasting function, it became possible for an avatar to walk around the inside of a torus space station, as if in space. Responding to this new potential, they built a torus space station above Nautilus in Second Life to develop their virtual space program further. They now look toward the potential of the Oculus Rift and the Omni to provide a more realistic virtual experience of space, as well as the development of a more advanced form of the virtual world by High Fidelity, where astronauts may train in a realistic virtual space environment and people can prepare for space tourism.

[8] Luke 10:25-37.

Over the past couple of years they have been working with members of the Overview Institute, seeking to develop a virtual experience of the Earth from space. They are also pleased to develop their relationship with the Kepler Space Institute, seeking ways to develop space studies in a global context in the virtual world.

They see a unique opportunity with the virtual world environment for people to meet globally and plan locally, toward building celestial futures. Kim Peart now lives in Mountain Creek on Queensland's Sunshine Coast with his wife and partner in space and virtual world development, Jennifer.



Editors' Notes: Kim Peart not only describes the four celestial values – he has created them in his Virtual Orbital Space Settlement. Kepler Space Institute is proud to have Australia's Space visionary as member of the Board of Editors for the *Journal of Space Philosophy*. ***Bob Krone and Gordon Arthur.***

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Human Space Activity: The Spiritual Imperative

By Madhu Thangavelu (www.usc.edu/ur/federal_relations/experts/bios/1073.html)

When Pope Benedict called the ISS crew, to ask how they felt floating over our fragile blue planet, whether they see ravages of war, what they think of it, and whether the crew prays on-orbit, one wonders what was on the pontiff's mind and agenda.[1]

Religion and scientific pursuits parted company centuries ago, at least in the eyes of the public, most notably in the West during the historical inquisition of Galileo, a devout Christian. He is reputed to have stood by his empirical evidence of the Copernican, sun-centered view of our solar system even under the threat of death by the preferred torture method of the day for heresy: burning at the stake. How dare a commoner employing lowly empirical objective logic challenge the supreme authority, especially on heavenly matters? The church, struggling with the dogma of the time, confined Galileo to house arrest for the rest of his life.

Religion and science have butted heads before and after Galileo and they continue to seek common ground, but to the layman the philosophies are irreconcilable. How can we expect a dogma that rests its case at every turn on divine intervention to come to terms with one that employs impeccable logic coupled with incremental data-gathering to bolster evidence to arrive at its conclusions?

The refined sensitivity of the human mind to the Cosmos and environment is clearly evident in the verses of the song called Laudes Creaturarum (Praise of the Creatures, also known as Canticle of the Sun), attributed to St. Francis of Assisi. The Sun and the Moon, the most prominent orbs that grace our skies, have a deep-rooted significance in every great religion as well as in Science, which employs state-of-the-art technologies to explore and understand the workings of these celestial bodies in our neighborhood and yet the philosophies could not be further apart. Perhaps that is how it is meant to be? Often, opposing philosophies are needed for the fertile mind in order to imagine and create new visions.

After all, religion was the primary purveyor of science, and especially astronomy, as is evident in the symbols and images projected in cathedrals and churches and temples all over the world. The heavens belonged to God and religion. Even today the architecture of religious structures, altars, and prayer spaces around the world aspire to the heavens and some elaborate geometries are summoned in their planning and design.[2] It is interesting to note that the term "Big Bang", though coined by Fred Hoyle, referring to the birth of our universe, was conceived by a clergyman, Monsignor Georges Lemaître of Belgium.[3]

---

[1] R. Z. Pearlman, "Pope Benedict XVI Makes 1st Heavenly Call to Astronauts in Space," May 21, 2011, www.space.com/11741-pope-benedict-xvi-calls-astronauts-space-station-sts134.html.

[2] R. Lawler, *Sacred Geometry: Philosophy and Practice* (London: Thames & Hudson, 1989).

[3] G. Lemaître, "The Beginning of the World from the Point of View of Quantum Theory," *Nature* 127 (1931): 706, www.nature.com/nature/journal/v127/n3210/abs/127706b0.html.

People are born into religion and ritual and end their lives in the same way, even though most of us stray away from organized religion and liturgy for most of our lives. Never do we hear of a scientifically accurate christening of a new arrival or send-off for the soul of the departed. Religion and spirituality console and comfort the human soul in a way that science cannot.

Albert Einstein once responded to a question about his religious beliefs by saying that that he was utterly in awe and wonderment as Nature slowly gave up her secrets and that he was a religious practitioner of Science in that respect.[4] Here we see a thought linking religion and spirituality. I think he was referring to spirituality, the essence of all religion, the belief in a supreme power of nature that seems to run the universe with some, yet to be wholly grasped, supralogical processes, with ultra-mathematical precision to which Vivekananda refers in his lecture on Immortality delivered at the Chicago World's Fair in 1893.[5] Even atheists find the power of nature utterly overwhelming.

Religion stripped of all customs and liturgical practice may be termed spirituality. It is the essence of wonderment that explorers feel when they are exposed to Nature's secrets and subject to awe-inspiring new dimensions in human experience. The great director Peter Brook once said that the man-made world around us is conspiring at every moment to rob us of the sense of awe and wonder that the universe and nature continually presents to us.

Now, this unfathomable power seems to run into trouble with conventional scientific thought all the time; just ask Stephen Hawking or Richard Dawkins. Of course, it is taboo to bring up issues relating to religion or spirituality in modern scientific discussion, though many scientists are privately very spiritual in their beliefs. It is worthwhile to note that doctors practicing modern medicine use spirituality and prayer in the healing process and hospitals have religious or non-denominational spaces just for patients.

A definition that encompasses both of these great philosophies is that proposed by Tolstoy in his essay entitled "Confessions," in which he presents the idea that the greatest science of all is the science of the universe and humanity's place in it. He paints the range of human thought as that anchored at one end by theology and at the other by pure mathematics; no reconciliation this, but at least it puts philosophies along a continuum of human thought without artificial walls. John Templeton sought to bring discussion of Science and Religion closer and the Templeton Foundation offers annual prizes to those attempting to weave the philosophies together.[6]

---

[4] Albert Einstein, "Response to Atheist, Alfred Kerr," quoted in H. G. Kessler, *The Diary of a Cosmopolitan* (London: Weidenfeld and Nicolson, 1971), 157.

[5] Swami Vivekananda, "Immortality" (lecture delivered at the World Fair, Chicago, in 1893). www.vivekananda.net/booksbyswami/JnanaYoga/13_Immortality.html.

[6] See www.templeton.org.

Seeking new models for rapidly evolving governance of societies, moving from nationalism to internationalism and beyond, grappling with global issues and the economics of globalization, we seem to be at the threshold of a newly refined era.

Due to globalism, a wholesome new view of our planet and all its contents, the integration of the stewardship of planet Earth and nature in the wake of the effects of climate change, we are coming full circle to embrace the mystical philosophy of transcendentalism,[7] articulated nearly two centuries ago by Thoreau and Emerson among others. This holistic notion of our planet is being advanced and enhanced by human space activity.

Teilhard de Chardin presents the case for the evolution of global consciousness and the arrival of the Omega Point for humanity[8] and Vladimir Vernadsky talks about the Noosphere or the emergence of the global mind, a new layer addition to our planet on top of the geosphere and the biosphere.[9] We live in the Anthropocene epoch and stewardship of Eden has now become the sole responsibility of our species.The Global Consciousness Project run by Princeton University and projects at the Institute of Noetic Sciences (IONS) are currently engaged in extending the Noosphere philosophy. Rapid advances in Information Technology are changing the scope of our situational awareness and a global brain with newly evolved and refined sensitivities towards humanity and life, ecology and environment is emerging. Vernor Vinge[10] and more recently Ray Kurzweil talk about the acceleration of technology toward a point referred to as Singularity,[11] projecting visions of merging humanity and technology, blurred, fused and indistinguishable as separate; human evolution on an accelerated path ?

NASA spends a lot of time and resources focusing on the technology that sustains human space explorers engaged in scientific exploration: a term used to say that these highly specialized professionals are engaged in the pursuit of scientific discovery. It is a very narrow view of human space activity. Space commerce is brimming with ideas beyond the mature and revenue-generating satellite communications field that are awaiting exploitation, among them, beaming solar energy from space and providing extensive refueling operations for outbound vehicles. It is well known among engineers that erecting and deploying large structures such as the ISS or endurance-class spacecraft and space-based solar array farms require on-site human supervision. These crews will find spiritual solace after a hard day's work, looking out at the Earth's disc, from their private quarters in orbit.

---

[7] Philip F. Gura, *American Transcendentalism: A History* (New York: Hill and Wang, 2007).

[8] Pierre Teilhard de Chardin, *Le Phénomène Humain* (Paris: Editions du Seuil, 1955), English translation, *The Phenomenon of Man* (New York: Harper, 1961); P. R. Samson and D. Pitt (eds.) *The Biosphere and Noosphere Reader: Global Environment, Society and Change* (Abingdon: Routledge, 1999).

[9] Georgy S. Levit, *Biogeochemistry, Biosphere, Noosphere: The Growth of the Theoretical System of Vladimir Ivanovich Vernadsky (1863-1945)* (Berlin: VWB, 2001).

[10] Vernor Vinge, "The Coming Technological Singularity," paper presented at the VISION-21 Symposium sponsored by NASA Lewis Research Center and the Ohio Aerospace Institute, March 30-31, 1993, www.aleph.se/Trans/Global/Singularity/sing.html.

[11] T. S. Perry, "Ray Kurzweil and Neil Gershenfeld: Two Paths to the Singularity," June 1, 2008, spectrum.ieee.org/computing/hardware/ray-kurzweil-and-neil-gershenfeld-two-paths-to-the-singularity.

As the government astronaut corps around the world continues to shrink, a growing number of human space explorers are wealthy individuals without the professional background or rigorous training of government astronauts. They are seeking to experience spaceflight, to feel outer space in their bellies and souls, and to witness the fragile planet directly while floating above it. The driver seems to be spirituality; physically seeking, experiencing, and appreciating man's place in the universe. We call them space tourists. Space adventurers or spiritual tourists, a better term, perhaps?

Are there areas of science and technology that weave into religion and spirituality? It appears that human space activity offers a venue to explore possibilities. While robotic spacecraft roam the solar system, sending us intriguing images from worlds afar, the yearning of humanity to be physically present there is what drives NASA and others to pursue space exploration. Without a vibrant human space activity component, NASA may not have a reason to exist.

As the crew lifts off into orbit, though their eyes are on the cockpit monitors and their ears tuned to mission control jargon above the roar of those mighty engines, they are praying for a successful and smooth launch. That is because, despite checks and cross checks and counter checks, despite the best efforts of ground crew and controllers, many things can still go wrong in such a complex system. The monitoring of the final minutes before launch is so rigorous and intense that the entire sequence is handed off from the crew to a set of computers. When your life is in the hands of machines, prayer is important.

Upon arrival at ISS, the first thing on their minds is to look out at planet Earth. The ISS now sports the Italian-made cupola, a large and exquisite window that looks toward planet Earth, and it is perhaps the most aesthetic component of the entire facility. Of course, it is no secret that the ISS crew spends a lot of its free time just looking out this cupola and marveling at the dynamic colors and drama the Earth gliding below them offers, even as the day becomes night and back again, all in a matter of minutes, as they orbit the planet. As they gaze at Earth through this large cupola, the crew is immersed in a spiritual experience.

I have had astronauts stare me back in the eye when posed the question, how does it feel to be walking on the surface of the Moon?

Well, you really have to be there to experience it, they say. Words will not do. It appears their sensory systems are turned up to highest alertness levels, heartbeats racing like athletes during peak performance, and they are soaking in terabits of information. This rush of data is simply too hard to debrief, in technical terms, prose, or poetry. When faced with such a high, though they are fully aware that it is Newton and Kepler's Laws that guided them there, their minds and souls quickly gravitate toward the scriptures. And human space explorers seek that intense spiritual experience and are willing to risk their lives for it.

Most crews of space missions come back changed forever. This phenomenon is addressed in several books, notably in *The Overview Effect* by Frank White.[12] Astronauts do not see national boundaries, they do not see warring nations, and they rarely notice the ravages of humanity and industry on the face of the planet.

All they see is a stunningly vibrant planet, lots of blue, aquamarine ocean, virgin white snow-tops on mountain ranges, and scattered puffs of cloud cover, dynamic with flashes of electric blue lightning, as the continents whizz by below them in absolute silence, no one asking them for country of origin or standing in line for visa verification. They see the whole world as one giant harmonious living entity and globalism, that feeling of oneness with nature, takes root in their hearts and souls. A common humanity becomes reality from orbit and Cosmopolitanism, the philosophy of acceptance and inclusion of all peoples, the richness and strength of plurality of diverse old cultures and heritage of customs and shared values become obvious. E Pluribus Unum rings loud and clear from orbit.

In worldly affairs and governance, in daily life and commerce, culture and religion, ritual and spirituality all trump science and technology every time. Science and technology are but tools, sophisticated tools of our time, merely used to fulfill human urges and nourishment for our intellect. When faced with the raw wonder and awe of nature, humans always gravitate toward spirituality. That is why when Apollo 8 slipped into lunar orbit, the crew recited from Genesis and Aldrin made communion before he stepped on the Moon.

Yes, perhaps human spaceflight can bring science and religion closer together as more people from various nations, cultures, and walks of life experience space first hand. Pope Benedict is known for his intellectual acumen and academic rigor as much as Pope John Paul was for his charismatic persona. Perhaps Pope Benedict had these thoughts of science-technology-theology synergy in mind when he dialed that ISS number in-orbit?

****

About the Author: Madhu Thangavelu - www.usc.edu/uscnews/experts/1073.html

Madhu Thangavelu conducts the ASTE527 graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering within the Viterbi School of Engineering and he is also a graduate thesis adviser in the School of Architecture at USC. He holds degrees in both engineering and architecture and has contributed extensively to concepts in space architecture, especially dealing with extraterrestrial development. He is the author or co-author of over 50 technical papers in space architecture, lunar base design, and human factors. He is co-author of the

[12] Frank White, *The Overview Effect: Space Exploration and Human Evolution*, 2nd ed. (Reston, VA: American Institute of Aeronautics and Astronautics, 1998).

book The Moon: Resources, Future Development and Settlement (1999), published by John Wiley and Sons and second edition by Springer/Praxis in 2007.
He is the invited author of the chapter “Living on the Moon” in the Encyclopedia of Aerospace Engineering, a major reference work published by John Wiley and Sons in 2010 and the on-line second edition updated in 2012. He is a member of the USC team that won the NASA NIAC Phase I award in 2011 and Phase II award in 2012. He is a former AIAA officer, having served as Vice Chair for Education in the Los Angeles section.

Editors' Notes: Madhu Thangvelu is a strong advocate for articulating the philosophy of space. He states:

> Scientists and Engineers (in particular) have a tendency to get lost in the tools and toys they make, though some of us do arrive at philosophy for the meaning of what we do and why, via the long route of experience. By then, alas, for the most part, our life's work is done. It is a good idea to set us all a solid foundation in space philosophy, so we can all have a steady handle on our works, as nature reveals her secrets slowly, ever so slowly, but surely.

He is a member of the Board of Editors for the *Journal of Space Philosophy*. His latest projects may be found at denecs.usc.edu/hosted/ASTE/527_20111. His graduate students at USC do professional research – he and some of them will be presenting at the ISDC-2014 Conference in Los Angeles, 15-18 May 2014. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

The Space Option: Our Cosmic Choice

By Arthur Woods

If one believes that other technological civilizations have appeared throughout the cosmos, then one can speculate that they must have faced a similar choice to the one that confronts humanity at this particular moment in its history. Did these distant civilizations decide to use their technology and knowledge to extend their civilization beyond their home planet in order to perpetuate their species or did they misuse their technology and knowledge and let their civilization decline and their future be destroyed? This situation is called the *cosmic choice* – a decision that any technological species must make about its future at a critical point in its evolution – most specifically when Space technology has appeared.

Here on Earth, human civilization has reached such a point in its development where it has evolved the means to leave its home planet and to begin operating in the environment beyond its atmosphere. Optimistically, this development may enable humanity to utilize this technological capability to harness the infinite resources located off Earth in order to improve the well-being of the population as well as improving the chances that its current civilization can continue to prosper in the decades and centuries ahead – both on Earth and eventually in other places in the solar system. On the other hand, this same capability could also be used in a negative manner in order to exert tyrannical control over a majority of the population, thereby limiting prosperity to a select few or, in the ultimate worst case, it could be used to destroy civilization and humanity's only chance of expansion into the cosmos.

Gerard K. O'Neill once posed the following question:

> Is a planetary surface the right place for an expanding technological civilization?[1]

This question concisely encapsulates the idea of a *cosmic choice*. An evolving technological species existing on a planet with finite resources is faced with the ultimate challenge of maintaining its development and the viability of its civilization before it reaches the threshold of unsustainability and/or the possibility of collapse. In order to meet this challenge, it will need additional resources beyond those that are available to it on its home planet as well as an expanded environment that will stimulate the further development of its technological capabilities.

---

[1] Stewart Brand, "Is the surface of a planet really the right place for an expanding technological civilization?" interview with Gerard O´Neill, in *Space Colonies*, ed. Stewart Brand (Harmondsworth, UK: Penguin, 1977), 22-30.

Of all the options available to humanity at this moment, the Space option presents our species with a cosmic opportunity to meet the basic and anticipated needs of human civilization through the utilization of extraterrestrial resources and to apply these resources for use on Earth so that humanity may survive and thrive in an eventual era of peace and prosperity. The process of accessing and harnessing these resources will in turn create an infrastructure beyond the atmosphere upon which further expansion of the human civilization can be anticipated. Consequently, if human civilization can be established beyond Earth, then the chances for its ultimate survival will correspondingly increase. However, by not embracing the Space option, the possibility that humanity will be overrun by one or more of the many threats to its survival will increase and, likewise, its chances of ever becoming a spacefaring species will diminish. Therefore, today, we find ourselves in precisely this a critical situation – one that constitutes our *cosmic choice.*

Most people intuitively assume and fundamentally believe that terrestrial problems must have terrestrial solutions. This is obviously due to a lack of understanding about our interconnectedness and interdependence with the rest of the cosmos. As a terrestrially evolved organism, it is in our genes to adapt to our immediate environment as we have over millions of years. Only recently have we begun to become aware of how celestial events affect our lives. We now know that such events have been critically important to the evolution of life on Earth. Impacts of comets most likely provided a young Earth with the necessary water and perhaps even the necessary genetic materials for life to appear. Subsequent impacts by large asteroids are believed to have resulted in mass extinctions of life at various times in the history of our planet. The cycles of the sun have resulted in a number of cold periods or ice ages where life had to struggle to survive and numerous warm periods where life has blossomed and spread. And now, in recent times, human civilization has become increasingly dependent on technological assets located in Space. Removing these Space assets would pose dire consequences for the functioning of our complex technological society. Thus, in all aspects, humanity's future on Earth is irrevocably linked to its future in Space. So choosing the Space option as an optimistic pathway to securing our future would appear to be a logical choice to make.

Table 1 lists a number of problems, issues, and challenges currently confronting human civilization that are paired with possible solutions that can be found through the utilization of Space resources and technologies.

Table 1. Earth Problems and Space Solutions

EARTH PROBLEMS	SPACE SOLUTIONS
Increase of CO_2 in the atmosphere.	Space-based solar power replaces hydrocarbon fuels
Meeting future energy needs	Space-based solar power and lunar Helium-3 fusion supplies unlimited energy
Global warming	Solettas and sun shields could block sunlight and permit cooling

Global cooling	Solar power satellites and Space mirrors to raise the temperature
Cosmic threats from asteroids and comets	Space infrastructure for planetary defense
Population pressures	Population stabilized through higher standard of living
Industrial pollution of the biosphere	Moving polluting industries into Space
Ground transportation	Space-based solar power supplies necessary energy
Desalination of water	Electric and hydrogen-fueled vehicles powered by energy from Space
Economic crisis	Millions of new jobs in the Space tourism, Space mining, and Space power industries
Declining prosperity	Importing wealth from Space instead of depleting the remaining resource wealth of Earth
Government planned and regulated economies	New free and open markets and entrepreneurship opportunities
Increasing creation of debt	Wealth creation through expanding economies in Space
Worthless fiat money	An extraterrestrial commodity-backed currency
Lack of habitable room	Creation of new habitats and colonies throughout solar system
Political repression and control	Individual freedoms and creativity
Resource wars on Earth	Harnessing infinite extraterrestrial resources for use on Earth
Empire-oriented governments	International cooperation to develop Space
A small and elite ruling class	Educated, prosperous, and democratic self-determining societies
Geopolitical conflicts	Aggressive human tendencies redirected to conquering the Space frontier
Development of the technologies of death and destruction	Development of the technologies for promoting peace and life
Increasing sense of despair about the future	Increasing a sense of human purpose and hope about the future

Loss of bio-diversity	Renewed reverence for all life
Vulnerability of life on Earth	Resilience of life on and beyond Earth
Ultimate extinction of life on Earth	Survival and perpetuation of humanity and all terrestrial life throughout the cosmos

Each of these issues and the accompanying Space solution could and should be addressed in much more detail. It would surely be an interesting study to take each issue and compare the terrestrial and extraterrestrial options that are proposed as solutions. This list shows us that by considering the solutions imbedded in the Space option concept, humanity may be able solve some – if not most – of its many pressing issues simply by thinking beyond the limits of a finite planet. If it applies these solutions responsibly, then its future chances of survival will increase.

Most of these problems can be traced to the ever-expanding activities of the human species that has resulted in it occupying every available niche and exploiting every available earthly resource for living, working, and maintaining society. This process has led not only to the development of our technological society and its many advantages, but also to the disadvantages of having such powerful technologies available to be used in an irresponsible and dangerous manner.

It could be argued that the most critical issue facing humanity, the one that will most likely determine its ultimate success or failure as a species, is its propensity to wage war. Since the beginning of human history, war has been the method most often chosen to resolve conflicts of interests among nation-states or communities through the use of violence. Mostly, such conflicts and the resulting wars were about gaining control over populations and resources accompanied by the lust for power over others. The concept of *right* expressed through *might* is still widely practiced by societies of the 21st century. With the invention of nuclear weapons, the development of missile delivery systems, and the willingness of governments to use such technologies for solving terrestrial problems or exerting their power, humanity has lived on the brink of making its *cosmic choice* for more than a half a century.

In 1932, Albert Einstein was contacted by the League of Nations and was asked to invite someone (the choice was up to him) to reflect on a pressing problem or question in a series of public letters. Einstein question was “Is there any way of delivering humankind from the menace of war?” and he selected Sigmund Freund as his interlocutor.

Einstein’s views were mostly practical and political and he spoke of power and right or violence and law. He called for a world in which law would supersede violence and urged the international community to create a legislative and judicial body to which all nations would ascribe to and unreservedly accept its judgments that would settle every conflict without violence.

In a subsequent letter dated April 26, 1932 to Arnold Kalisch, editor of the magazine *Die Friedensfront*, Albert Einstein wrote:

> As long as all international conflicts are not subject to arbitration and the enforcement of decisions arrived at by arbitration is not guaranteed, and as long as war production is not prohibited we may be sure that war will follow upon war. Unless our civilization achieves the moral strength to overcome this evil, it is bound to share the fate of former civilizations: decline and decay.[2]

Freud's reply to Einstein explained that humans are torn between a drive for *eros* or connection, and a drive toward *thanatos*, death or aggression. The eagerness to engage in war is a product of the drive toward aggression, which itself is always embedded in political, social, and economic contexts. Freud argued that one can bring *eros* into play against *thanatos* in that whatever leads us to share important values also produces a sense of community: "Anything that encourages the growth of emotional ties will operate against war."[3]

In his book, *The Overview Effect*, Frank White's reflections on war and Space exploration appear to echo Freud's insights closely:

> 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.[4]

Whatever the justifications for war – the victor in most such conflicts is usually the one with the superior technological advantage and Space technology is deeply embedded in today's military arsenals.

Carl Sagan wrote in *Cosmos*:

> The choice is stark and ironic. The same rocket boosters used to launch probes to the planets are poised to send nuclear warheads to the nations. The radioactive power sources on Viking and Voyager derive from the same technology that makes nuclear weapons. The radio and radar techniques employed to track and guide ballistic missiles and defend against attack are also used to monitor and command the spacecraft on the planets and to listen for signals from civilizations near other stars. If we use these technologies to destroy ourselves, we surely will venture no

[2] "Why War? - Albert Einstein and Sigmund Freud." from *The Einstein-Freud Correspondence* (1931-1932).

[3] Diane Jonte-Pace, "Freud, Einstein, and Upaya: Contemporary Reflections on the Question 'Why War?'" chabrieres.pagesperso-orange.fr/texts/whywar.html; see also *"Why War?"* www.public.asu.edu/~jmlynch/273/documents/FreudEinstein.pdf.

[4] Frank White, *The Overview Effect: Space Exploration and Human Evolution* (Boston: Houghton Mifflin, 1987), 126.

> more to the planets and the stars. But the converse is also true. If we continue to the planets and the stars, our chauvinisms will be shaken further. We will gain a cosmic perspective. We will recognize that our explorations can be carried out only on behalf of all the people of the planet Earth. We will invest our energies in an enterprise devoted not to death but to life: the expansion of our understanding of the Earth and its inhabitants and the search for life elsewhere. Space exploration—unmanned and manned—uses many of the same technological and organizational skills and demands the same commitment to valor and daring as does the enterprise of war. Should a time of real disarmament arrive before nuclear war, such exploration would enable the military-industrial establishments of the major powers to engage at long last in an untainted enterprise. Interests vested in preparations for war can relatively easily be reinvested in the exploration of the Cosmos.[5]

Thus, the first and most important *cosmic choice* a technological civilization must consider making is choosing between *more war* or *more Space*.

In his book *Collapse – How Societies Choose to Fail or Succeed*, Jared Diamond, a geologist, examines a number of ancient societies that have collapsed, including Easter Island, the Mayan culture, and the Norse settlements in Greenland. He then turns his focus towards the present and future by examining societal catastrophes such as what happened in Rwanda and then he looks at modern societies like China and Australia, whose futures may be mortgaged by environmental degradation and/or overpopulation.[6]

Extrapolating from Diamond's subtitle, *how societies choose to fail or succeed*, by putting it into a contemporary global context we may consider *how civilizations choose to fail or succeed*. Here, Diamond's description of the mysterious story of Easter Island has particular significance for the Space option.

Easter Island, an isolated island in the South Pacific, once had abundant 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 and one that produced enormous stone statutes. This society was not murdered or wiped out by invasion; it was not decimated by a pest or by another natural catastrophe. Its 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 to move the statues from the building site to the erection place. Larger statues gave them a higher rank and over time the Easter Islanders cut down each and all of their trees one by one. This did not happen overnight. Any Easter Islander who tried to warn about the dangers of progressive deforestation would have been overridden by the vested interests of the stone carvers, the bureaucrats, and the chiefs, whose jobs depended on continued deforestation. In the end, they committed

[5] Carl Sagan, *Cosmos* (New York: Random House, 1980), 339-42.
[6] Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (New York: Viking Penguin, 2005).

suicide. They no longer had the one resource – trees – necessary for building fishing boats and for their only means of escape.

When Diamond gives this lecture his students ask the obvious question: "How 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]

The fact that Easter Island was also quite isolated in the South Pacific made the possibility of emigration to another locality very difficult. Easter Island is located 2,000 km from the coast of Chile and 1,400 km from the nearest inhabited island to the west. Thus, Easter Island is as alone in the Pacific Ocean much as our planet Earth is alone in Space. If we compare the geographical situation of Easter Island to the cosmological situation of planet Earth, then an insight emerges that may have relevance to the survival of our own civilization.

Today, our modern societies have developed quite a complex infrastructure to deal with changes in the global system in order to regulate the economy, manage resources, respond to threats to national security, etc. Yet there is also the inherent problem that group dynamics that characterize our decision-making processes are not always effective and often fail because of competing interest groups and competing priorities. The systemic failures of the world community to manage major problems are numerous; how our governments responded to Hurricane Katrina both before and after the storm, the Gulf oil spill, Fukushima, the financial crises, and the rising tensions first in the Middle East and now in the Ukraine[8] are clear examples of how such modern systems can and do fail.

Like the natives of Easter Island when they cut down the last tree, we must therefore ask ourselves the following: *Why do our governments continue to invest vast resources into the technologies of destruction rather in the technologies that promote survival, peace and prosperity?*

It is a moral and philosophical dilemma. Either we are more afraid of each other than we are of the real threats to our existence or is it embedded in our character to live in a state of denial and to project our aggressions onto others. The obvious solution would be simply to ban any war of aggression in any form and for whatever purpose.

---

[7] Jared Diamond, "Easter Island's End," *Discover Magazine*, August 1995, www.hartford-hwp.com/archives/24/042.html; Malcom Gladwell, "The Vanishing," New Yorker Magazine, January 1, 2005, www.newyorker.com/critics/books/articles/050103crbo_books?050103crbo_books: "in *Collapse*, Jared Diamond shows how societies destroy themselves".

[8] Editor's note: This article was written before the Russian invasion of Crimea.

As Robert A. Heinlein succinctly stated in 1970:

> It may take endless wars and unbearable population pressure to force-feed a technology to the point where it can cope with space. In the universe, space travel may be the normal birth pangs of an otherwise dying race. A test. Some races pass, some fail.[9]

As our technological civilization continues to develop on an isolated planet with finite room and finite resources our species is indeed rapidly approaching that moment of ultimate decision – *humanity's cosmic choice*. If one believes that economic and technological development are necessary preconditions for peace, then one has to arrive at the conclusion that significant resources are necessary (a) to fuel development and (b) to reduce tension. By embracing the Space option, humanity could provide the necessary new and sufficiently abundant resources for this purpose. This tension-reducing potential is perhaps the greatest contribution of the Space option to peace and security on Earth.[10] As such, it offers a plausible solution to Einstein's question: "Is there any way of delivering humankind from the menace of war?" The answer is "Yes, it must choose the Space option!"

By accepting this realization, any military activities in Space including the use of conventional weapons and/or Space-based military systems and technologies would have to be banned as such activities are a detriment to achieving peace on Earth. If this can be accomplished, then the reduction in military expenditures and eventual worldwide disarmament on Earth could begin in earnest. In this context, the primary contribution of the Space option to end our species' propensity to engage in war resides in the fact that it carries with it an authentic hope, a challenge, and a potential that may be able to compensate for the confusion, despair, and misery of the philosophy of the finite world expressed in the practice of war, which is our main obstacle to becoming a spacefaring species. Apparently, the cosmos does not welcome self-destructive and irresponsible behavior.

****

About the Author: Arthur Woods is a Swiss/American artist. He studied psychology, art and literature at Mercer University in Macon, Georgia. After graduation in 1970 and completing U.S. military service he began his art career in California in 1972 before moving to Switzerland in 1974 where he now lives and works.

Arthur Woods's involvement with space activities began over fifty years ago when he personally witnessed the beginnings of the U.S. space program while living in the immediate vicinity of Cape Canaveral and the Kennedy Space Center (1959-1970).

[9] Robert A. Heinlein, *I Will Fear No Evil* (New York: Putnam, 1970).
[10] Marco C. Bernasconi and Arthur Woods, *The Space Option – A Précis*, www.thespaceoption.com/the_space_option_a_precis.php

During the summers of 1967-1968 he worked at the space center during the Apollo program. In the mid-1980s he initiated a number of art-in-space projects including the spaceflight of his Cosmic Dancer sculpture (1993) and Ars ad Astra – the 1st Art Exhibition in Earth Orbit (1995) – both projects realized on the Mir space station. In 1990 he founded the OURS Foundation, a cultural and astronautical organization dedicated to introducing, nurturing, and expanding a cultural dimension to humanity's astronautical endeavors.

He has been a member of the International Academy of Astronautics (IAA) since 1995 and served as co-chair of the IAA sub-committee on the arts and literature from 1996-2003, where he was involved in the planning of the IAA sessions related to the arts and humanities held at the annual International Astronautical Congress. He has co-organized and managed several European Space Agency (ESA) and IAA studies including the design and maintenance of the related websites. Presently, he is actively promoting the concept of "The Space Option" via a website he launched in 2013 including the development of the *Space Option Star* and *Send Our Seeds* projects.

Websites:
www.arsastronautica.com
www.cosmicdancer.com
www.arsadastra.com
www.thespaceoption.com
www.ours.ch

Full biography: http://www.thespaceoption.com/arthur_r_woods_biography.php

List of publications: http://www.arsastronautica.com/arthur_woods_publications.php

Editors' Notes: We are delighted to add Arthur reflections from his fifty years of involvement in the Space Community to the *Journal of Space Philosophy.* ***Bob Krone and Gordon Arthur.***

The Happiest 20 Seconds of Our Lives

By Leo K. Thorsness

Introduction by Bob Krone
American prisoners of war during the Vietnam War were the longest imprisoned in the history of the United States. They experienced torture, isolation, abuse, and absence of needed medical care. Their communications with family varied from none to one letter every two months. They were denied any news about the war or about the United States. Many died and many experienced more than six years of cruel imprisonment before their release in March of 1973.

One of those POWs was Leo K. Thorsness, Colonel, USAF (retired), Medal of Honor recipient. He spoke to Space professionals attending the International Space Development Conference, 2011, at Huntsville, Alabama. His three-minute description of how the Hanoi prisoners learned that Americans had landed on the Moon is a classic story for the Space Community. Fortunately his talk was filmed.

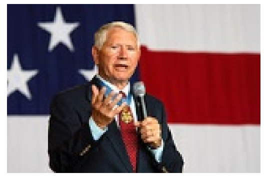
His statement that the 20 seconds it took for prisoners to use their tap-code to share the discovery that Americans had landed on the Moon was "The happiest 20 seconds of our lives," exposes both the character and patriotism of those Americans suffering day after day and the global significance of Neil and Buzz stepping on the Moon on 20 July 1969.

Here is Leo:

www.youtube.com/watch?v=tDjDKc1LaGU&feature=youtu.be

****

About the Author: Colonel Leo K. Thorsness, USAF (retired) had a distinguished career as a jet fighter pilot when he was selected in 1967 to be the commander of the F-105F Wild Weasel Squadron flying over North Vietnam. The Wild Weasels were tasked with attacking the North Vietnamese Air Defense system – the most sophisticated one since Allied airpower fought in World War II. He and his backseat Electronic Warfare Officer, Captain Harry Johnson, was shot down on his 93rd mission a week after flying a dramatic mission that earned him the Medal of Honor. They survived six and a half years in North Vietnamese prisons. See his Surviving Hell: A POW's Journey (New York: Encounter Books, 2008). In 2010 he was elected to be the President of the Medal of Honor Society. For his bio and the story of his Medal of Honor Mission go to en.wikipedia.org/wiki/Leo_K._Thorsness.



Editors' Notes: People all over the world watched their television sets in suspense on July 20, 1969 as Neil Armstrong and Buzz Aldrin piloted Apollo 11's Lunar Module to a landing. It was months later that our Vietnam Prisoners discovered that Americans had been on the Moon. Leo's short report of their emotions and pride is a unique and special story about that historic event. Kepler Space Institute takes pride in sharing the story with global readers of The Journal of Space Philosophy. ***Bob Krone and Gordon Arthur*.**

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Asteroid Mining: Why and How?

By Michael Buet, CTO – KESE, LLC and Robert Frantz, PhD, CFO – KESE, LLC

The development of Space Industrialization and large-scale human tourism, habitation in orbit and in space, is hampered by the high cost of launching materials into low Earth orbit (LEO) using existing launch vehicles (@ ~ $10,000 per kg). Even using the next generation of launch vehicles from Space X, Boeing, and Sierra Nevada, we still look at ~ $5,000 per kg. Consider that payloads are only about 5% of the entire mass of a rocket on the launch pad and that 80% of the propellant in that rocket is expanded during the first 80 seconds of flight, just to extract the 5% of that initial mass out of Earth's gravity well into LEO! At that cost, putting a pioneer family into orbit with a ton of supplies would cost more than $7 million each, many orders of magnitude higher than the pioneers paid two centuries ago to come to America or to go "conquer" the West.

Although the Moon appears to be the logical first goal for space mining, basic thermodynamics tells us that it is actually more difficult and more costly to go in and exploit Moon-based materials than asteroids. In space, all that really matters is energy expenditures from a limited source (no re-fueling stations in space yet): that is called changes in velocity (Delta-V or ΔV), and the Moon, even though it is only 1/6th of Earth's gravity (1/6th g), still exerts a significant gravitational pull that is large enough to require fuel and specialized motors and equipment to land and take off. For most Near-Earth Orbit asteroids (NEOs), that adds up to more ΔV than is needed for asteroid exploitation, which makes asteroids a better choice, particularly because we already have all the technology to do so now, vs. the necessary huge new technology development efforts needed to do the same from the Moon.

The solar system's asteroid belt is essentially an inexhaustible source of all the metals, minerals, water, gasses and organic compounds we need to support life in large human colonies in outer space within the solar system (Figure 1).

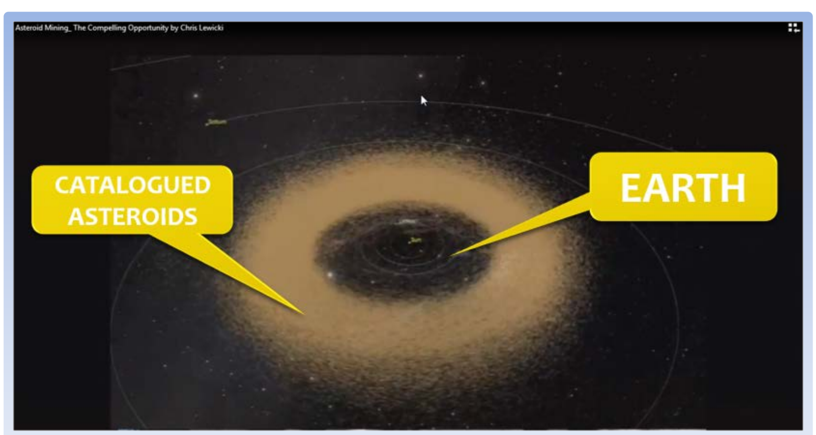


Figure 1: Earth Sits at the Center of a Vast Ocean of Resources

At present, there are three companies dedicated to asteroid mining and to jump-start the 21st-Century industrialization of space:

1. Planetary Resources is headed by an ex-JPL engineer and is supported by several multi-billionaires, including a Google founder, Microsoft founder, and Warren Buffett. Their business model is to send thousands of small, inexpensive reconnaissance Arkyds Cubesats (Figure 2) and land them on the asteroids they deem the most valuable, hence claiming sole mining rights to these asteroids for their exclusive billionaire funders "club". They estimated the Wall Street value of a 1-km-wide metal-rich asteroid at approximately $1 trillion.

Figure 2: PR Arkyd Cubesat

Planetary Resources then plans to tow these most valuable asteroids and place them in orbit around the moon for later exploitation (Figure 3). This will also require extensive new space-tug and propulsion technologies development to achieve and mandates a return to manned expeditions to the Moon, with manned space stations in orbit around the Moon, ~400,000 km away from Earth, way outside the Earth's protective Van Allen magnetic belts, fully exposed to deadly cosmic radiation and solar flares.

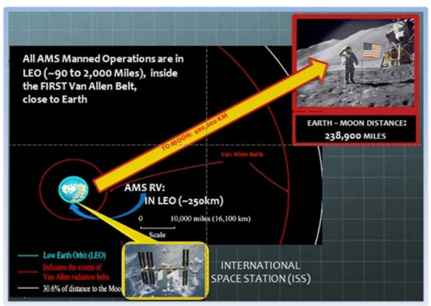


Figure 3: PR Cis-Lunar Captured Asteroid Orbit vs. AMS

2. Deep Space Industries is headed by a very knowledgeable Australian mining and radioactive materials industry expert and PhD in Asteroid Mining, Dr. Marc Sonter. DSI is supported by Australian mining concerns and private funding: it plans to do essentially the same thing as Planetary Resources (Figure 4).

Figure 4: DSI 's Asteroid Tug

3. Kepler Energy and Space Engineering (KESE) is headed by several veterans of the Aerospace Industry. It aims to return ~ 40 metric tons of raw asteroid regolith to LEO (250 km from Earth, the same as the ISS) by the end of the decade using the "keep it simple" principle: KESE plans to make full use of existing proven space technologies and hardware from the Dawn, Hyabusa, and Rosetta Missions, which can be very easily adapted to Cornucopia (Figure 5).

Figure 5: KESE 's Asteroid Mining System

The KESE spacecraft system architecture and proposed hardware components (Figure 6) will result in a complete robotic asteroid mining system (AMS) that is named "Cornucopia," for the mythic Horn of Plenty. Cornucopia is specifically designed to return large amounts of marketable materials from near-Earth asteroids into LEO as quickly as possible. The goal is to energize the Space Industrialization in LEO by providing enough raw materials for the development of in-space manufacturing, producing building materials, propellants, radiation shielding, etc. The goal is also to extract valuable minerals like rare earths, gold, and platinum group metals (PGMs) for Earth consumption. Based upon our very large analytical database from meteorites, which are pieces of asteroids that landed on Earth, all these valuable basic compounds are found in abundance in asteroids and will provide the significant revenue stream needed to support the entire enterprise.[1]

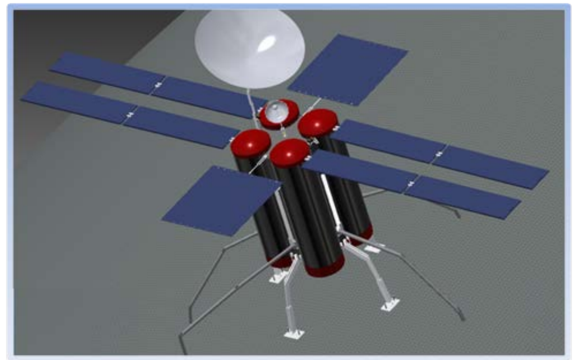


Figure 6: KESE 's "Cornucopia"

Several technology developments in many different fields have all come together to make it possible now to begin the development of asteroid resources for space development. The Japanese Hayabusa spacecraft mission[2] to the Apollo asteroid Itokawa demonstrated the basic capabilities needed for asteroid mining. The NASA Dawn mission demonstrated long-term space operation of advanced ion rockets. Advances in solar cells driven by terrestrial applications have greatly increased the efficiency of using solar power and asteroid regolith has been transformed into useful forms needed for space manufacturing using solar power and additive manufacturing.

Recent additive manufacturing/3D printing experiments have already demonstrated the capability of generating structural material directly from unrefined regolith, as shown in Figure 7. Therefore, it may not even be necessary to refine the raw regolith material to create the basic building blocks of space structures in space. A simple interlocking building block design may be all we need to create a massive basic habitat with a radiation-protective shell, made of raw regolith in orbit.

[1] Brad Blair, "The Role of Near-Earth Asteroids in Long-Term Platinum Supply," EB535 Metals Economics, Colorado School of Mines, May 5, 2000.
[2] Hitoshi Kuninaka et al., "Hayabusa Asteroid Explorer Powered by Ion Engines on the way to Earth," IEPC-2009-267, 31st International Electric Propulsion Conference, Ann Arbor, MI, 20-24 Sep 2009.

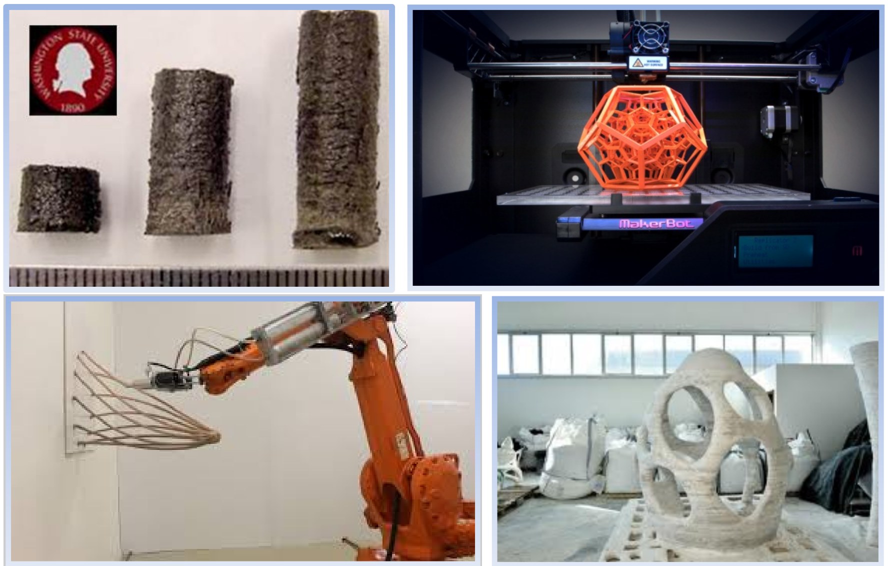


Figure 7. 3D-Printed Tubes Directly from Raw Lunar Regolith Simulant + 3D Printers

The Cornucopia mission plan has the goal of returning several tons of marketable asteroid regolith by the end of the decade, at a projected cost of less than $400 million. An unexpected potential application is that the in-orbit ore-processing system can also be used to recycle the thousand tons of high-grade aluminum in upper stage debris in LEO.[3] This material is worth at least the current launch cost of $5,000 per kg, or $5 billion.

During the 1970s, NASA supported many studies[4] on space colonies and organizations such as the L5 Society (a precursor to the National Space Society), which developed plans for large space colonies at the Earth-Moon L5 Lagrangian point. But building colonies for 10,000 people using Earth and even lunar materials would be prohibitively expensive and is not within the technical capabilities of NASA or the private industry, even to this day, unless we first start bringing raw materials to LEO to build those space structures and spacecraft from space-based materials.

The methods for utilizing those materials "in-situ" were not as advanced as they are now: Today, we have at our disposal modern carbon fiber composites and in particular, additive manufacturing/3D printing. Using advanced propulsion, solar power, miniaturized and highly reliable electronics, and simple mining techniques, we believe

[3] J. Pearson, E. Levin, and J. Carroll, "Affordable Debris Removal and Collection in LEO," IAC-12-A6.6.7, 63rd International Astronautical Congress, Naples, Italy, 2012. www.star-tech-inc.com/papers/Affordable_Debris_Removal_IAC_2012.pdf

[4] John Billingham, William Gilbreath, and Brian O'Leary, eds., "Space Resources and Space Settlements," NASA SP-428, technical papers from the Ames 1977 summer study (Washington, DC: NASA, 1979).

that it is now possible to retrieve asteroid materials at a low enough net cost to make possible the large-scale space industrialization in Earth orbit.

We must start building in space for space from space-based materials if we are to start colonizing space.

****

About the Authors: Michael Buet has a long career track record in cutting-edge aerospace, high tech semiconductors, and manufacturing technologies. His career spans from AT&T Bell Labs in fiber optics and other high-tech aerospace and undersea technologies development, to LORAL Electronics, MESA-TEK Instruments, Harvard Custom Manufacturing of satellite and rotary aircrafts wiring harnesses, to DeCrane Aerospace and Global Aeronautica (Alenia/Boeing alliance) on the initial efforts for the Carbon Fiber Reinforced Polymer (CFRP) body and electrical assembly of the new Boeing 787 in Charleston, SC. Michael also holds five USPTO patents ranging from chemicals recovery to semiconductor manufacturing tools. Michael has the breadth of experience and skills needed to apply his lifelong experience at creating and developing new ideas and fostering new technologies, then successfully transitioning R&D into production. Michael will be heading the technical staff of the Alternative Energy and Aerospace Research Center (A.E.A.), the high-tech incubator portion of the Japsers Crossings Project (see www.jasperscrossing.com).

Robert L. Frantz has completed multiple careers. Serving in the United States Marine Corps for 20 years, he was a combat veteran of the Vietnam War, where he served as a fighter pilot. Following this career, he flew as a commercial pilot for United Airlines and retired after 16 years as a Captain. In his third career he served as a university administrator and as a professor in business administration, specializing in distance education, both as a professor and as an online administrator. He served for ten years on the board of the Distinguished Flying Cross Society (.org) where he held positions of President and COB. He is also the COB for Ashburn Institute (.org) and has promoted international integration through the organization's graduate-level scholarship endowment.

His 22 years of nonprofit work has also included extensive volunteer work in Africa in technology infrastructure development and education delivery through distance learning. Additionally he volunteered for nine years at the Smithsonian Air and Space Museum working in fundraising/development and nine years at the same time with the Airline Pilots Association (on loan from United Airlines), where his duties included serving on the President's Commission for Airline Safety.

His education includes a BA, University of Minnesota and an MS, University of Southern California. He completed his doctoral course requirements and comprehensive exam at a Virginia business international graduate school earning the distinction of ABD (all but dissertation). He then transferred his doctoral work to Kepler Space University in

California and successfully defended his dissertation receiving a Doctor of Philosophy in Earth and Space Science. He is about to complete a second PhD with American University Girne, a European-accredited university located in North Cyprus. He co-founded Kepler Space Institute, a U.S. nonprofit corporation, along with Dr. Bob Krone and Walter Putnam. He is currently the Director for Strategic Planning for Intrepid Sports Development, which is developing 265 acres at Exit 8, I-95 in South Carolina, along with the Alternative Energy and Aerospace Research Center in close cooperation with Michael Buet (see www.jasperscrossing.com). He is also a co-founder of Kepler Energy and Space Engineering, LLC, which will be the key component of A.E.A.

Editors' Notes: This second paper on mining asteroids develops on the authors' previous contribution in the Fall 2013 issue of the *Journal of Space Philosophy* (Article # 13). We are again grateful for the combined skills of Dr. Robert Frantz and Michael Buet, which have led to the further development of their proposals for capturing the resources of asteroids for Earth needs*. **Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

The Evolutionary Impulse to Expand Beyond Earth

By Steven Wolfe

> The purpose of human space exploration cannot be found in human desires and ambitions alone, but must be viewed as a phenomenon actively encouraged by universal forces.[1]

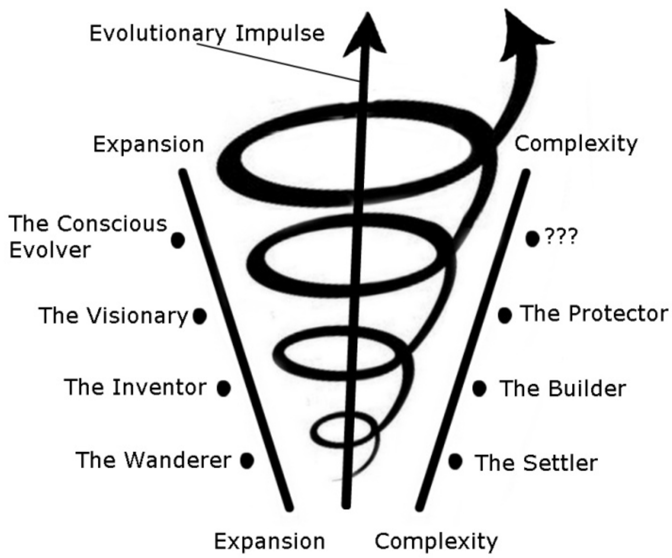


Figure 1. The Endowments.

Introduction

What is it that drives many in the space arena relentlessly to push the boundaries of human space flight? Those who feel this drive often speak of it as a *calling*. They are drawn to it beyond their own ability to articulate fully why they are so driven. Skeptical observers have compared this passion for space to religious fervor. They may be right. President George W. Bush put it well when he said that space exploration and discovery is “a desire written in the human heart.”[2]

I call this difficult-to-define desire the *evolutionary impulse*, which is at the heart of the philosophical perspective that I present in my book, *The Obligation*.[3] The evolutionary impulse, however, is much more than the desire to expand into space. It is a universal force that applies to all things in nature and the cosmos.

---

[1] Frank White, *The Overview Effect: Space Exploration and Human Evolution* (Boston: Houghton Mifflin, 1987).
[2] George W. Bush, “A Tribute to the Crew of the STS-107,” NASA Lyndon B. Johnson Space Center, Houston, TX, February 4, 2003.
[3] Steven Wolfe, *The Obligation* (New York: Smashwords, 2013) www.theobligationbook.com.

The essence of my understanding of the evolutionary impulse comes from the spiritual teacher, Andrew Cohen. He writes, "The evolutionary impulse is the energy and intelligence that burst out of nothing, the driving impetus behind the evolutionary process, from the big bang to the emerging edge of the future. The evolutionary impulse is felt as a sense of tremendous urgency, an ecstatic urgency. At the level of consciousness, it is experienced as a sense that something unthinkably important must occur NOW."[4]

To understand how the evolutionary impulse applies to the human drive for space, we should first consider its role in the context of all of creation.

Universal DNA and the Evolutionary Impulse

Carl Sagan famously said, "We're made of star stuff, we are a way for the cosmos to know itself."[5] We know that every particle in our bodies existed 13.8 billion years ago at the moment of the big bang. The complex chemicals that make up our bodies were forged in the furnace of long dead and distant stars. Origins of life scientists focus their attention on what sparked the chemicals in the primordial soup to assemble into the first living organism. But I feel it's more appropriate to view the phenomenon of life as the result of a process that includes all of cosmic history.

There are two ways to think about cosmic evolution. Either it is the result of random occurrences, or it is a designed process that has a beginning, middle, and end. I state in *The Obligation* that the universe is similar to any living organism on Earth in that everything about the cosmos was determined prior to its very inception. This is not a statement of theology; it is a statement of probability. By design, there was a very good probability that the galaxies, stars and planets like ours would evolve the way they have. Just the way an oak tree, by design, has a very good probability of creating acorns. In this regard, I am suggesting that evolution, as defined by Charles Darwin, is not an altogether random process. Instead, it is an integral part of the dynamic unfolding of a universal DNA code.

The muscle, or labor force, of creation are the competing forces of *expansion* and the tendency toward greater *complexity* with the help of gravity. These two qualities, *expansion* and *complexity*, are the resonating poles between which all of creation is takes place. It is where the creative force of the evolutionary impulse is at work in accordance with the universal DNA. They represent the yin-yang polarity described in Chinese philosophy.

These complementary forces of expansion and complexity play out over and over throughout all of creation. In this way, the evolution of life on Earth is a process of expanding outward to fill all available space and at the same time becoming ever more complex. The evolutionary impulse guided these forces and created the beauty and wonders of the natural world. Eventually our young living world emerged out of the cold,

---

[4] Andrew Cohen, *Evolutionary Enlightenment: A New Path to Spiritual Awakening* (New York: Select Books, 2011).

[5] *Cosmos* [TV Series documentary hosted by Carl Sagan], Episode 1, 1980.

dark void of space, green and wet, just as such a world was intended to from the beginning of time. Once that living world had fully matured, a unique species emerged that was destined to fulfill a very important obligation.

Gaia Hypothesis

It is the relationship between the Earth and humankind that is central to the philosophical perspective articulated in *The Obligation*. In the previous section, we discussed the essential forces that act upon the whole living cosmos. As we focus on our own species and its place in the biosphere, we will see how those same forces are at work right here and now.

It starts with James Lovelock's Gaia Hypothesis,[6] which explains in great detail how the biosphere can be viewed as a single organism. All of the life systems, plants, mammals, sea life, oceans, and atmosphere—all of it—are parts of a living whole. In much the same way that billions of cells in our body cooperate to give us a sense of a single life form, so it is with the Earth as a whole—as it is also with the cosmos. Every living thing on this planet is an integral part of the living biosphere.

Beginning four billion years ago, the world evolved from single-cell organism to a planet filled with lush forests, teeming oceans, and species of every kind coexisting on an ecologically balanced world. Everything was great. The world, Gaia, had matured. She was now ready to do something that every one of her constituent species took for granted: reproduce.

Gaia's reproductive system required the emergence of an agent species capable of manipulating the planet's resources to build seedpods suitable to carry life to hospitable locations beyond this Earth. That species turned out to be *homo sapiens*; that strange biped that was really good at throwing rocks.

At some point, the universal DNA markers awakened in human consciousness essential capacities, which I call the *Endowments* (discussed in detail below). Since the introduction of these Endowments, humanity has been on a 50,000-year-or-more march to get up to speed on how to build the seedpods to carry the planet's life stuff to other worlds—and thereby fulfill our reproductive *obligation* to the planet that gave us life. Driving us forward, of course, is the evolutionary impulse, which first alighted in our consciousness the moment one of our ancestors looked to the heavens and wondered what was up there.

This idea of humanity as the agent of the planet's reproductive system can be difficult to get your head around. We think of ourselves as special, unique in the world. And we are. We are self-actualized and capable of fabulous achievements, as well as acts of monstrous destruction. But, there is nothing about who we are—or *think* we are—that precludes the possibility that we may have a critical role to play as part of our ecosystem. We are like the bumble bee that buzzes from flower to flower gathering pollen for her hive to make honey, oblivious to the critical function it plays in the

[6] James E. Lovelock, *Gaia: A New Look at Life on Earth* (Oxford: Oxford University Press, 1979).

reproductive system of the flowers. Until now, we too have been oblivious to the fact that our march into space has been fulfilling an essential function for the organism of which we are a part. Did we actually think we were given this world with nothing expected of us in return?

But acquiring the ability to build interplanetary seedpods has put a huge strain on Gaia. The planet is at risk and few will argue that humankind isn't at least in part to blame. Some people say we are a parasite or a cancer on the planet. However, I think it is more accurate to say we are like an embryo in a mother's womb. As the fetus grows, it puts stress on the host mother. As humanity has built the requisite industrial capability to make space travel possible, it has similarly put a strain on the mother Gaia.

Fortunately, and perhaps not surprisingly, as space technology achieves maturity and our first formative steps are taken off this world, the planet is beginning to heal itself. Many are driven to be part of environmental restoration with a sense of urgency equal to what it took to develop space technology. In this regard, I believe there is no coincidence that the environmental movement went into overdrive at the same moment we were touching the moon. The child's birth gives way to the mother's healing.[7]

The Six Endowments

To understand the Endowments, let us come back to the question posed at the beginning of this essay: What is it that drives many in the space arena to push the boundaries of human space flight relentlessly? As discussed, at a basic level we are driven by the *evolution impulse*. Yet practically speaking, space activists are more likely to point to a range of more familiar motivators to explain their interest in space migration. Distilling and examining these motivators provide evidence about the specific traits needed to fulfill the space migration obligation. The Endowments, there are six, are the essential human characteristics that have allowed our species to thrive and take full command of the planet and all her resources. It is also these same Endowments that have enabled us to evolve into a spacefaring species. The following are the Endowments with a brief description of each:

The Wanderer: Humanity has an innate desire to know what is on the other side of the hill or mountain or ocean. Hostile terrain has never stopped us. The expanse of the ocean did not intimidate the earliest explorers either. Neither did the frozen tundra or deserts. Now that every square foot of the globe has been surveyed and partitioned, owned or protected, the only way our desire to wander can be adequately satisfied is by looking upward. The Wanderers among us today yearn to go to the Moon and Mars and beyond.

The Settler: The Settler is always looking for a good spot to rest and make a home. At first in caves and huts and later in towns and cities, we have been very successful at building barriers that separate us from the many threats in the natural world. Though this inclination has desensitized us to the environment—which has created an

[7] Marsha Freeman, *Krafft Ehricke Extraterrestrial Imperative* (Burlington, ON: Apogee Books, 2009).

imbalance that we must now address—it also has served to prepare us to build off-Earth cities that will protect us from the unforgiving conditions in space.

The Inventor: The Inventor wanders in the abstract confines of her own mind ever looking for unique ways to understand and utilize the resources of our environment, primarily for her own productivity, comfort, and pleasure. Each invention led to other inventions and over millennia this Endowment has brought us to the point where our understanding and ability to manipulate the physical world is nearly limitless. The Inventor has taken us to the Moon and back and is now at work to bring us into space permanently.

The Builder: The Builder is the artisan. Once the new tools and new ways of doing things have been developed by the Inventor, they are ready to be replicated. It is by reproducing invention that systems become complex. The light bulb is a marvel as much for its simplicity as for its function. Put into universal use, however, the electric light represents enormous complexity. The builder will take the prototype space habitat and refine and replicate it thousands of times throughout the solar system.

The Visionary: The Visionary is an evolved form of the Inventor. She is more than a problem solver. The Visionary envisions potential futures based on real or imagined conditions. We celebrate the Visionaries who act on their dreams and are successful. The Visionary is the one most responsible for the advanced civilization we live in today. It is only with the Visionary Endowment that we will be able to envision a multi-planet existence that we will one day create.

The Protector: With the Protector Endowment, we have the ability to conduct environmental assessment with the purpose of threat avoidance. Like the Visionary, The Protector has enormous capacity to envision all possible futures. However, the Protector's visioning is oriented toward protecting and preserving a given population or even the species as a whole. The Protector realizes that we had better take decisive action or there will be dire consequences. As we become ever more aware of the dangers that threaten human existence—from asteroid impact to bio-terrorism to pandemics to global climate change—we sense the survival imperative to do something before it is too late. In addition to the preventive measures we can take on Earth, the Survivor recognizes the need to diversify the population into space to guard against the real possibility that some planetary catastrophe might result in a total loss of human life. Ultimately, space settlement as an insurance policy against extinction will be one of the most powerful motivators for expanding into space.

Taken at face value, there is not much to disagree with regarding the descriptions of the Endowments. This list of human traits pretty well summarizes the capacities that have allowed us to evolve to a high level of civil and technological order.

Now let us return to our earlier statement that humankind is obligated to colonize space, not only for our own survival, but on behalf of all life that emerged on this planet. We see that the Endowments dramatically brought civilization to the threshold of space. The inventors who lived 10,000 years ago may not have given space travel a single thought, yet they were as integral a part of building the bridge into space as any NASA engineer. The fact that these Endowments appeared in human consciousness is an indication, if not proof, that human migration into space was a strong probability long before we had any idea how to accomplish such a thing.

Our six Endowments can also be organized as emerging in evolving stages in alignment with either the expansion or complexity of universal forces mentioned earlier (see Figure 1). In the yin/yang context, expansion is the yang, masculine and aggressive, force. Complexity is the yin, feminine and nurturing, force. The emergence of each Endowment corresponds to a general evolutionary leap in our consciousness. The six Endowments fall naturally into three pairs, with one aspect aligning more closely with the expansion aspect of evolution and the other aligning more closely with the complexity aspect.

The first pair contains the Wanderer and the Settler Endowments. The Wanderer strikes outward, the expansion nature, and the Settler wants to find a good place to build a home, complexity.

The second pair includes the Inventor and Builder Endowments. The Inventor is expanding his view to solve problems; the Builder puts those inventions to use in ever more complex applications.

The final pair contains the Visionary and Protector Endowments. The Visionary sees an expansive future; the Protector sees future risks and wants to devise complex systems to ensure our safety and survival.

Organizing the Endowments in this way may seem tangential to the central tenet of the obligation perspective. However, I think it is important to see the unfolding of these capacities in a naturalistic context. By conforming to patterns seen throughout nature, the emergence of the Endowments in our own consciousness is recognized as logical and appropriate.

We are at the threshold of expanding into space, but by all measures we are still a long way from anything resembling an off-world civilization. The final impetus may in fact require something more than the six Endowments alone. To get us over the threshold I am convinced will require the emergence of a *Seventh Endowment*.

The Seventh Endowment

Frank White in *The Overview Effect* said, "Humanity has the singular opportunity to guide and shape its own evolution, working in conscious partnership with the whole."[8]

Earlier I said that we are like the bumble bee, oblivious to the reproductive role we play for the ecosystem we inhabit. We have been evolving our space technology for 50,000 years without any idea we were doing so. But, if space migration is an obligation written

[8] White, *Overview Effect*.

in the heart, why has our human space program been so stagnant for more than 40 years? Yes, progress has been made with the Space Shuttle and the International Space Station, but these can only be viewed as modest and very drawn out follow-ups to the potential envisioned during the age of Apollo.

As much as we are driven to expand out into space, there is an inertia that keeps us bound to the planet. The last thing a fetus wants to do is leave the comfort of the womb. As strong as the desire is for space travel, there remains an overwhelming planetary inertia that is holding us back. For this reason, in order finally to fulfill the obligation, it is necessary to become conscious of the reality that we are already active participants in the evolutionary process. Once we are conscious that evolution happens because of us, we must then decide to take an active role in guiding the direction of evolution. That realization is the emergence of the Seventh Endowment, the capacity to *Evolve Consciously*.

In her book, *Conscious Evolution*, futurist Barbara Marx Hubbard wrote, "We are an integral part of the evolutionary journey. In our genes are all generations of experience. In our genius is the code of conscious evolution. In our awakening lies the pattern of the planetary transition from our current phase to the next phase. Our mind is designed to know the design of evolution toward higher consciousness and freedom."[9]

If we do not wake up to this unfolding that is already taking place, then there is a high probability that we will not make it. We are an advanced civilization, but history teaches us that all great civilizations rise and then fall. There are plenty of indicators even now that our civilization is past its prime and in decline. Nineteen sixty-nine, when Armstrong and Aldrin walked on the Moon, might have been the high-water mark and it has been downhill ever since. True, our computing technology continues to improve exponentially, but the social framework of our global culture is certainly showing signs of serious wear and tear—particularly in the wake of the 2008 economic collapse. China is the only country with a stated mission to send humans to the Moon in the late 2020s, duplicating a journey that by that date will have taken place 60 years earlier. The point is the longer the delay in attaining a firm human foothold in space, the less our chances are of actually achieving it.

The demand to wake up and engage in the evolutionary process—to be a *Conscious Evolver*—is not just about space migration. Like all the Endowments, the need for the Seventh Endowment exists everywhere: in politics, in education, in healthcare, in corporate citizenship, planetary stewardship, to name a few areas. As I write in *The Obligation*,

> The *Conscious Evolver* helps us to see beyond the parochial interests. She sees things in evolutionary terms and is willing to act according to that larger context. Eventually, when the Seventh Endowment takes firm hold in our collective consciousness, there will be little tolerance for actions that

[9] Barbara Marx Hubbard, *Conscious Evolution: Awaking the Power of our Social Potential* (Novato, CA: New World Library, 1998).

> are taken for short-term, selfish gains. In this way we also recognize the Seventh Endowment as the Endowment of the 'we' and not of the 'I.'
>
> The Conscious Evolver is a masculine Endowment, an evolved version of the Visionary in that he is able to see vast possibilities for the future. The difference is two parts: first, the Conscious Evolver feels a strong sense of the holistic order that already exists in the yet unlived future, so it's not so much the feeling of being a kid in a candy store, which is how the Visionary can sometimes feel. The Conscious Evolver has a clear sense of how things should be in the future, and possesses a profound desire to bring that future into being. Second, the Conscious Evolver is interested in outcomes that benefit the whole. So we could say that Henry Ford was a visionary, but in the end his vision really had to do with selling lots of cars so that he could make himself rich and famous.[10]

We can also say that Conscious Evolvers have the potential to be directly aware of the evolutionary impulse. This perspective gives them an intuitive sense of the right direction that evolution must take. This recognition creates a tremendous sense of urgency. They feel fulfilled when their lives are acting in accordance with the evolutionary impulse and they feel depressed when it is not. Conscious Evolvers who can place themselves in the flow of the evolutionary impulse are extremely content people. Those who are unable to do so for any reason have a difficult time because they are not able to shut out the call that is constantly ringing in their ears.

The *Conscious Evolvers* are among us and have been. Martin Luther King, Jr. and Mahatma Gandhi would be obvious examples, but there are and have been many in all walks of life throughout history. They are among the prophets, scientists and enlightened thinkers of history. In our time the numbers are increasing dramatically. So much so that today's Conscious Evolvers do not necessarily stand out the way King or Gandhi did in their day.

The space arena has plenty of conscious evolvers, fortunately. People like Frank White, Rick Tumlinson, Peter Diamandis, Elon Musk, and Bob Krone, to name a few, have made it a life mission to usher in a future where the solar system is teeming with human life no longer bound to a single planet. They, and many others, are working hard against planetary inertia that throws up barriers at every turn. I believe they will achieve their purpose, but it will take hundreds and thousands more to step into the fray and be just as earnest in reaching for that goal on behalf of the whole. We need all the Conscious Evolvers to wake up and become active if we are going to become the multi-planetary species we are destined to be.

It seems very appropriate that human expansion into space is a selfless act taken on behalf of the whole. Not all space migrants will be Conscious Evolvers, but the fact that they are leading the opening of space will ensure that it is done with a high degree of care and responsibility. In other words, they will stay close to the evolutionary impulse

[10] Wolfe, *The Obligation*.

and assist in the evolutionary process, creating a future that is most in alignment with the universal DNA code.

For a lively fictionalized discussion of the principles presented in this paper and more, read *The Obligation* by Steve Wolfe, available at Amazon.com. *The Obligation* is a modern parable about a young Capitol Hill staffer who discovers that the seasoned congressman he works for is far from a typical politician. An obsession over a mysterious inscription on a plaque in the congressman's office sparks the young aide's initiation into a worldview that will challenge everything he thought he knew about space, evolution and humanity. Also visit www.theobligationbook.com.

****

About the Author: Steven Wolfe has been a writer, speaker, and advocate for the advancement of the space settlement concepts and related ideas for more than 25 years. He was a legislative aide for the late Cong. George E. Brown, Jr., where he served as executive director of Congressional Space Caucus. He served on the board of directors of the National Space Society, president of the New York Space Frontier Society, and Advocate of the Space Frontier Foundation. Steve drafted the Space Settlement Act of 1988 for Cong. Brown. The bill was signed into law by President Ronald Reagan as part of the NASA Authorization bill.

Editors' Notes: Steven Wolfe's exploration and development of the theory concerning the impulses that drive exploration of all kinds, and Space exploration in particular, are a welcome addition to the *Journal of Space Philosophy*. ***Bob Krone and Gordon Arthur.***

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Astro-Humanism: Space as a Spiritual Movement

By Walter Putnam

The space development movement has produced dedicated professionals in many disciplines – science, engineering, economics, and even philosophy – who believe deeply in the need for extraterrestrial expansion of human civilization. Yet, there seems to be a lack of the sort of political will necessary to propel that expansion. The vast majority of Earth's population is oblivious to the abundance of resources available in our solar system that could not only enhance life on this planet, but also support a flourishing civilization beyond it. Nor are most people aware of the perils that could cause extinction of the human race; or else they choose not to consider them seriously or believe that nothing can be done about them.

It may be the case that only a great spiritual movement can steer humanity toward a desirable outcome for Earth and its inhabitants. Our need is to find the proper form and direction that such a movement should take, taking into consideration a natural tendency to reject outside interference in matters of faith, spiritual wellbeing, and lifestyle choices. Any approach to persuading the masses to support human migration into space must be based on both reason and a deep emotional connection that goes to the core of what makes us human in the first place.

Other great advances of civilization have followed a similar course, albeit usually in a religious context. For all the criticism directed against them, Christianity and Islam together have been responsible for widespread migration of ideas that helped form cohesiveness of societies that allowed them to progress far beyond the spiritual realm. Humanism itself could be considered a sort of spiritual movement in that it champions the human spirit in aspiring for achievement and overcoming difficulties imposed by the natural world against both the individual and civilization as a whole.

Now, what we could call astro-humanism offers the chance to unify the human race – across national, ethnic and religious lines – toward the goal of advancing civilization into space and perhaps to spread the seeds of life and the best of human virtues and values throughout our solar system and beyond.[1]

A Crossroads

Still early in the 21st century, we are at a crossroads where humankind must decide what steps to take to avoid calamity on one or more of several fronts: overpopulation and overtaxed resources; destruction through environmental pollution and climate change; violent economic, social, and political upheaval; nuclear holocaust; super volcanic activity; and even the possibility of an asteroid strike.

---

[1] Astro-humanism is a common concept within Space Renaissance International, a global initiative to advance the cause of space development. "The Space Renaissance Manifesto," July 2009, recognizes scientists and philosophers such as Konstantin Tsiolkovsky, Krafft Ehricke, Gerald O'Neill, and others as "the fathers of the philosophical current that we call Astronautic Humanism."

When considering these threats it is important to recognize that we either have the technological capabilities to counter many of them or the scientific knowledge to develop those capabilities. But if science leads to knowledge and engineering provides competence to address human problems there still is a missing ingredient. Knowledge and competence are essential for success, but it is equally important to instill the spiritual impetus that will lead us into the future.

By “spiritual” we do not mean religious, at least as it applies to existing religions. They often not only fail to address contemporary problems, but also compete for the devotion of their human adherents and sometimes even conflict with the goals needed to solve the problems that are faced.

Instead, we have to look at the root of the word – spirit – to get the proper sense of the type of emotional attachment required to motivate people to achieve goals for the common good. On athletic fields, for example, it is easy to observe that team skills and experience are often not enough to win the game, especially when teams of equal abilities face each other. Usually, the ones with the proper spirit will prevail and sometimes even those with lesser skills have overcome the odds against winning because, as is often said, “They wanted it more.” In other words, they were inspired. Feeling was as much a key ingredient as thought.

A Matter of Unity

Even if everyone in the entire world was united in the goal of expansion into space, would we be able to advance without specific interests – corporate, nationalistic, or militaristic, etc. – undermining each other to further their own agendas?

Instead, we do not even have that unity. We have Protestants vs. Catholics, Indians vs. Pakistanis, Shia vs. Sunni, Arabs vs. Jews, liberals vs. conservatives, and so forth in an almost endless variety of schisms that impede practically any universal cooperation at all – much less space development.

In the past, nationalism has provided the kind of emotional push needed to propel such development. Americans old enough to remember the Apollo program recall the sort of patriotism stirred by the first landing on the Moon. However, that sort of national pride is not appropriate for a truly international movement. The people of the world must be united in the vision of one Earth, as described in Frank White’s *The Overview Effect.*

The promise of financial reward has inspired others to support space development. But that will not fulfill the inner desires or satisfy the physical needs of most people. Even if it can be demonstrated that Space Abundance will improve the lot of most people on Earth, there is still little emotional incentive to strive for vast profits for the few.

The two major competing economic systems of the 20th Century are no longer sufficient to meet the goal of space development. Socialism, where it has failed, has done so largely because of rejection of religion – “the opium of the people” – even though as an ethical system, it shares many of the same values. Conversely, capitalism is often criticized as being "soulless" because of its emphasis on the drive for individual accomplishment even at the expense of the less fortunate, yet it can claim a moral high ground for promoting the general welfare through that individual drive.

The Promise of Astro-Humanism

There needs to be a merging of the best ideas and values of both systems, along with a bonding of the most fundamental beliefs of all the world's religions – compassion, hope, and belief in a supreme being of which we all are important parts.

In *The Obligation*, Steven Wolfe writes of the inner drive, embedded in our DNA, to continue to spread the life that gave birth to the civilization that now stands on the edge of expansion beyond our native planet.

We can accomplish this through astro-humanism, which is not a system of beliefs in the ordinary sense but one that embraces ideas from all other belief systems that have led humanity to its present position. It is possible to take the best and reject the rest. That is the way forward.

We can recognize that we are all part of a greater, living entity – whether it is our Earth, God, or the Universe – and still champion individual rights and talents and the creative spirit that drives each of us to achieve and advance. We can continue our natural concerns for each other as human beings and for protecting our planet and other creatures on it, while still maintaining our individual interests.[2]

The key is to create awareness of the rational basis of space development, seeking the abundance of resources available outside the gravitational sphere, while giving people a reason to believe there is a higher purpose behind it. That is the sort of spiritual movement that will bring new birth to civilization, a new Renaissance – a Space Renaissance – to humankind.

And, it can be done without groups of people giving up whatever other beliefs they may have already. There is nothing inconsistent about pursuing one's faith in a supreme being and aspiring to reach closer to it by reaching out into the heavens. In fact, almost any religious practice already holds that as a goal.

Only a negative belief in pending doom for humankind can stand in the way of Space advancement. And even if a large percentage of the global population has adopted such a belief at one time or another, there is no reason to believe that it will prevail in the future. If we accept that there is a positive, creative force in the Universe then we must

---

[2] As Lawrence G. Downing, DMin, noted so succinctly and was cited in a previous issue of the *Journal*, "There is within the human frame a powerful presence that we cannot measure, precisely define, or empirically examine, but we recognize its existence and influence on our lives from the beginning of time. The ancient religious traditions speak of soul, spirit, space, and breath. Some suggest that by whatever term one may select to identify the presence that is an essence of our humanity, we confront a mystery."

let it follow a natural course, recognizing natural obstacles but working together as a global community to overcome them.

****

Editors' Notes: Walt Putnam's attempt to harmonize competing systems of thought is a welcome addition to an ongoing debate. Steven Wolfe's article on his book *The Obligation* is article 18 in this issue of the *Journal of Space Philosophy*. ***Bob Krone and Gordon Arthur*.**

Isaacson 1980 Aspirational Statement – Space Exploration

By Bob Krone

Dr. Joel Isaacson and I were members of the Space Exploration Team for the 1980 NASA/IEEE Summer Research at the University of Santa Clara, California. The research task was to define Advanced Machine Intelligence, then superimpose that definition over plans for future Space missions. As a Professor of Computer Sciences at Southern Illinois University and Founder of Isaacson Machine Intelligence he took a lead role in the definition subsequently used by the Study Group.[1]

I was going through my extensive files on the work of Dr. Isaacson because of our *Journal of Space Philosophy* publications of his discoveries in *Nature's Cosmic Intelligence*.[2] I found his hand written notes, dated July 14, 1980, at the University of Santa Clara and titled "Aspirational Statement – Space Exploration." It follows:

[1] The report from that 1980 Summer research is NASA Conference Publication 2255, *Advanced Automation for Space Missions*.

[2] Joel Isaacson, "Nature's Cosmic Intelligence," *Journal of Space* Philosophy 1, no. 1 (Fall 2012): 8-16, www.bobkrone.com/node/120.

Aspirational Statement - Space Exploration

Looking at the physical evidence, namely the number of galaxies in our universe, the size of our own galaxy, the number of stars in it, etc., etc... we must form the hypothesis that the single most prevalent "thing", or element, in the universe is not matter or antimatter, nor energy, nor other things of this sort; the single most prevalent element in the universe is... Intelligence and its various manifestations, including intelligence behaviour, communication and messages.

Our inability, so far, to comprehend OR detect that intelligence is, in our opinion, one measure of our inferiority as an intelligent race.

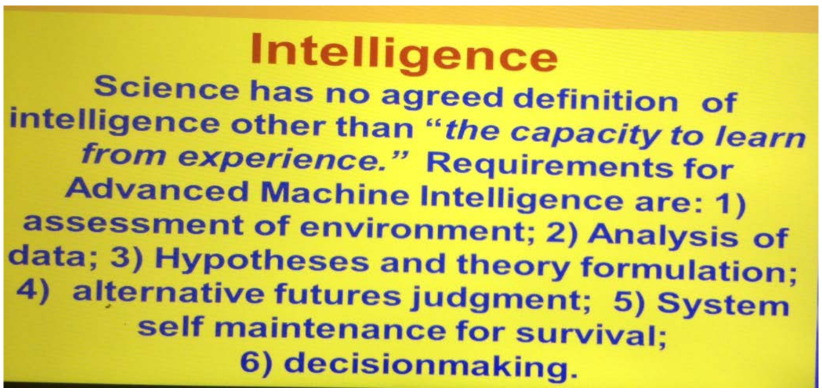
To the extent that we shall overcome that inability... To the extent that we shall become successful in harnessing true intelligence in our artifacts, to that extent we shall grow into a truly intelligent race. Our mission, therefore, to conceptualize, design, and construct truly intelligent machines is, in our opinion, coincident with our innate and deepest drive to transform ourselves into truly intelligent beings worthy of membership in the intergalactic community. We want to belong! We want to become full-fledged citizens of the universe!

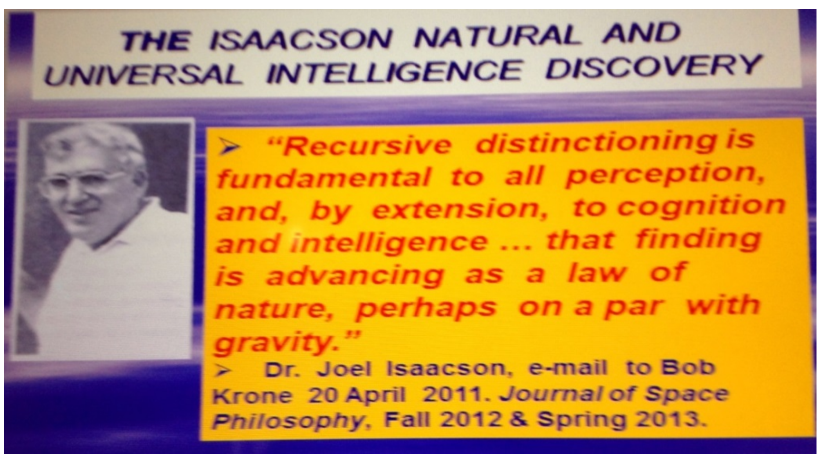
JDI / 071480

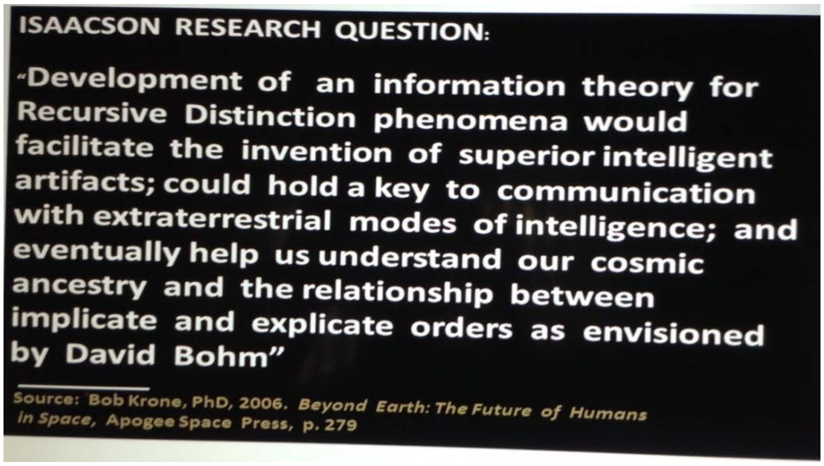
That is a truly remarkable statement made 44 years ago when what was known about the universe was mass, energy, gravity, and planetary motions – not intelligence. The search for extraterrestrial intelligence (SETI) had discovered nothing by 1980. And what is even more relevant is that Dr. Isaacson would not change a word of that *Aspiration Statement* today in 2014. His personal research and discoveries in the 1960s and 1970s formed those beliefs and convictions written in 1980.

Now readers have his publications beginning in 2006 that describe the science of Dr. Isaacson's discoveries and research over the past fifty years (see his "Nature's Cosmic Intelligence").

Following are some summary slides from past presentations or communications either by Dr. Isaacson or about his work:







****

About Dr. Joel Isaacson: Joel Isaacson has pioneered in RD Cellular Automata since the 1960s. Recursive Distinctioning (RD) was rooted in studies relating to the analysis of digitized biomedical imagery. Dr. Isaacson utilized NASA's computing facilities at the Goddard Space Flight Center in Greenbelt, MD for the initial stages of this research. His research has been supported over the years by DARPA, SDIO, NASA, ONR, USDA and a good number of NIH institutes. Isaacson is Professor Emeritus of Computer Science, Southern Illinois University and Principal Investigator of IMI Corporation.

He meets every criterion of scientific excellence. His first discoveries were at Goddard Space Flight Center in 1964. His patent was approved 25 August 1981, but he did not publicize it until 2006 because he continued to validate his discoveries and to have them confirmed by global information scientists. With his publications since 2006, Dr. Isaacson is beginning to make a huge contribution to Cosmos understanding. Mass and energy are well known. His discovery that our universe contains information and intelligence in a process that is basic also to human perception and cognition is a scientific knowledge paradigm shift.

About the Author: Dr. Bob Krone is the President of Kepler Space Institute and Editor-in-Chief of the *Journal of Space Philosophy*. Dr. Krone is on record stating his fortunate professional and personal rewards from his opportunity to be a colleague of Professor Isaacson beginning in 1980, when they shared a NASA Summer Research project, and continuing to 2014.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

A Planetary Defense Policy

By Al Globus

"If the dinosaurs had a space program, they would still be here." – Anonymous

Whereas,

1. Millions of Near Earth Objects (NEOs) large enough to cause significant damage to people and their work cross Earth's orbit.[1]
2. If we do nothing, very roughly 2% of these objects will eventually hit Earth.[2]
3. Many such objects have struck Earth in the past, inflicting damage ranging from trivial up to and including global catastrophe.
4. While if we do nothing a future large strike with catastrophic consequences is certain,[3] we do not know when it will happen; it could be in millions of years or 15 minutes.
5. Humanity has the technical capacity to discover, track, and deflect dangerous NEOs at very reasonable cost.[4]
6. NEOs represent vast resources that may be exploited to enable settlement of the solar system.[5]

Resolved,

1. I urge all spacefaring nations to devote at least 1% of their civilian space budget to planetary defense.

   1% is chosen because it is a sufficient for a first class program, even though the severity of the threat would warrant a much larger sum, the threat being anything from the destruction of a city to the complete extermination of civilization, if not humanity. A constant level of effort is chosen since while this threat can be minimized, it is extremely difficult to remove completely. Constant vigilance is the price of survival.

[1] National Research Council, *Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies* (Washington, DC: National Research Council, 2010).
[2] There are approximately 1,000 NEOs with diameters greater than 1 km. These objects are believed to have a lifetime of 10 million years. Furthermore, objects of this size are expected to strike Earth roughly every 500,000 years (NRC, *Defending Planet Earth*). This works out to 20 objects out of 1,000, or about 2%. Obviously, this number is not precise.
[3] It is common to describe major asteroid strikes as very unlikely. This is only true for relatively short time periods. While the chance of a large strike this year is small, in the long run such a strike is all but certain, absent our efforts. It should be noted that there was only a tiny probability of an asteroid strike in the year a NEO doomed the dinosaurs.
[4] NRC, *Defending Planet Earth*.
[5] Al Globus, "Paths to Space Settlement," *NSS Space Settlement Journal* (November 2012). http://www.nss.org/settlement/journal/.

2. The most important task right now is to find and track the NEOs large enough to cause damage on the ground, those about 20 meters in diameter or greater.[6] To this end,
   a. Current ground-based searches should continue, including the use of the Arecibo radio telescope.
   b. The Large Synoptic Survey Telescope (LSST) should be fully funded and encouraged to pursue NEO detection vigorously.
   c. The B612 Sentinel and the JPL NEOCam infra-red NEO space telescopes should be fully funded.

   All this can be done for well under 1% of the global civil space program budget; indeed it would be less than 1% of NASA's budget.

3. The threat from long-period comets should be studied.

4. Studies and tests of NEO deflection, including NEO characterization, should begin, although this is secondary to discovery efforts as one cannot deflect what one cannot see.

We face an existential threat. We can develop the ability to remove it. There is little or no benefit to waiting. Let us do it.

Discussion

On February 15, 2013 a NEO, the Chelyabinsk meteor, struck Russia and exploded. The blast damaged over seven thousand buildings and almost 1,500 people suffered injuries requiring treatment, mostly cuts from flying glass as windows were blown out. The Chelyabinsk meteor was probably about 20 meters in diameter. It is likely that there are millions of such objects that cross Earth's orbit.

The Chicxulub crater is 180 kilometers across. It was probably created 66 million years ago by a 10 km diameter NEO that exterminated most of the species on this planet, including the non-avian dinosaurs.[7]

It we do nothing, it is certain that similar impacts will happen in the future, but we do not know when. It could be in millions of years, or in 15 minutes. On average, we should expect city killers (> 20 m in diameter) on a time scale of many decades. Most should fall in the oceans or sparsely inhabited regions, but that is not guaranteed.

Every half a million years or so we should expect a devastating strike with global consequences (> 1 km diameter).[8]

---

[6] While the literature estimates 50-140 m diameter as the threshold for severe ground damage, the Chelyabinsk meteor, a 20 m object, recently struck Russia damaging thousands of buildings and injuring about 1,500 people. Olga P. Popova et al., "Chelyabinsk Airburst, Damage Assessment, Meteorite Recovery, and Characterization," *Science* 342, no. 6162 (November 29, 2013): 1069-73.

[7] Peter Schulte et al., "The Chicxulub Asteroid Impact and Mass Extinction at the Cretaceous-Paleogene Boundary," *Science* 327, no. 5970 (March 2010): 1214-18.

Unlike most natural disasters, we have the technology and knowledge to prevent nearly all major NEO strikes at very reasonable cost. We know how to build telescopes that can detect NEOs and we have identified a wide variety of approaches to nudging the offending rocks so they miss Earth.[9]

The funding allocated to planetary defense is tiny compared to the importance of the task. For example, in 2013 NASA spent approximately 0.1% of its budget ($20 million) on planetary defense. There are other missions, such as an asteroid sample return, that relate to planetary defense, but that is not the mission driver and from a planetary defense perspective these funds are not optimally spent. On the basis of importance one might argue that a quite large fraction of our civil space budget should be allocated to planetary defense. However, a very small part, around 1%, is sufficient to fund a first-class program.

The most important task is to discover and track the vast majority of NEOs that could impact Earth. If we do not see the next NEO coming, we cannot deflect it. Once a NEO is found with a date-certain impact, funding for deflection should be essentially unlimited.

There is a network of ground telescopes currently being used to discover and track NEOs and they have discovered around 900 (about 90%) of the most dangerous objects (diameter > 1 km).[10] Such objects will cause global damage when they impact Earth. We have found that less than 1% of the millions of the NEOs are large enough to produce significant damage on the ground.[11] The observations of these telescopes are sufficient to predict NEO location, including potential collision with Earth, for about a century.[12] **I recommend that the existing ground-based telescopic NEO searches be continued.**[13] This should include funding the Arecibo radio telescope for this mission, as it can obtain very good orbit and size data for NEOs within range.[14]

There is a new ground telescope particularly well suited to NEO discovery in development, the Large Synoptic Survey Telescope (LSST).[15] It is intended to support four major applications, one of which is NEO detection. **I recommend that LSST be fully funded and the NEO discovery function have a strong advocate within the LSST community.** This is essential to insure that the cadence of observations, when

---

[8] "Study to Determine the Feasibility of Extending the Search for Near-Earth Objects to Smaller Limiting Diameters," Report of the Near-Earth Object Science Definition Team, NASA. neo.jpl.nasa.gov/neo/neoreport030825.pdf

[9] NRC, *Defending Planet Earth*.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] NSS does not recommend construction of new ground telescopes for NEO detection (other than LSST), as we expect ground telescope NEO search to be phased out when space telescopes become available, with the possible exception of LSST. See also www.nasa.gov/pdf/467238main_20100415_NEOObservationsProgram_Johnson.pdf and neo.jpl.nasa.gov/programs/.

[14] See www.news.cornell.edu/stories/2009/09/report-calls-arecibo-capabilities-unmatched, neo.jpl.nasa.gov/neo/2011_AG5_LN_intro_wksp.pdf, and es.convdocs.org/docs/index-16822.html

[15] See www.lsst.org/lsst/.

and where observations are made, and data-processing resources are well tuned to NEO discovery. LSST is being funded by the National Science Foundation, totaling $465 million.[16]

Ground telescopes have large blind spots. They cannot see in the direction of the Sun, near the Moon, during daylight, or through clouds and the best frequencies to detect NEOs (infra red) are absorbed by the atmosphere. Thus, space telescopes are best for NEO discovery and tracking. The best place for such telescopes is inside of Earth's orbit so that NEOs in the sunward direction from Earth can be detected.

The Earth-orbiting WISE infra-red satellite telescope is being used for NEO discovery, but it was not designed for that task and will find only a tiny fraction of the threatening objects.[17] There are two space telescopes designed for NEO detection in the early stages of development, B612 Foundation's Sentinel[18] and JPL's NEOCam.[19] Sentinel is expected to cost $450 million[20] and NEOCam $600 million over a number of years.[21] Neither is funded for full-scale development. **I recommend that both Sentinel and NEOCam be fully funded.** The primary difference between the missions is the orbit chosen. The Sentinel is planned for a Venus-like orbit that is optimized for coverage and finding the most damaging NEOs well before they strike. NEOCam's planned orbit is at the Earth-Sun L1 point, locked to Earth. While less optimal for long-range detection, NEOCam has a better warning efficiency because it can see much smaller objects close to Earth, including just before impact. Also, NEOCam is able to detect small NEOs in orbits very similar to Earth's, which is important for asteroid mining. If both were built, spacecraft commonality should allow for significant cost reduction.

A vigorous planetary defense will discover and track essentially all NEOs above a certain size threshold. NEOs contain large quantities of water, metals and other materials that may be exploited. There are two basic strategies for mining them: removing part of a large NEO for return to cis-lunar space or capturing an entire NEO whole, which is only practical today for small NEOs (< 10 meters in diameter). The water can be processed to produce rocket propellant and the metals can be used for space construction. Thus, a catalogue of NEOs developed for planetary defense is also a map of resources that may be mined to provide fuel for settlement of the solar system. There may even eventually be a terrestrial market for NEO metals if the cost of delivery can be brought down sufficiently.

---

16 See www.nsf.gov/about/budget/fy2014/table.jsp.

17 WISE has found about 134 NEOs (neo.jpl.nasa.gov/stats/wise/) and may find about 150 more (www.spacedaily.com/reports/NASA_Spacecraft_Reactivated_to_Hunt_for_Asteroids_999.html).

18 See b612foundation.org/wp-content/uploads/2013/02/B612-Foundation-Sentinel-Space-Telescope.pdf.

19 See www.nasa.gov/mission_pages/asteroids/news/neocam20130415.html#.UuMfVbROk1I and neocam.ipac.caltech.edu/.

20 See www.spacenews.com/article/civil-space/34885b612-foundation-puts-a-price-on-asteroid-mission.

21 Lindley Johnson, "Near Earth Objects: Overview of the NEO Observation Program," NASA, June 21, 2013. In this talk NeoCAM is estimated at $500 million or less; we have added $100 million launch costs to total $600 million.

There is one class of NEOs that pass through the inner solar system, long-period comets, that Sentinel and NEOCam are not well suited to discover in time to avoid impact. LSST may be of some value. These objects spend the vast majority of their lifetime in the outer solar system, but some occasionally pass Earth's orbit and may exhibit spectacular tails visible to the naked eye. Approximately three per year pass near Earth's orbit. Unlike most NEOs, with current telescopes long-period comets cannot typically be discovered until a few months before impact, probably too late for deflection missions to succeed. While comets are much less dense than asteroids, impact velocities are much higher so damage is perhaps 30% greater than for the same diameter asteroid. Long-period comets are believed to be roughly 1% of the total NEO threat,[22] but this number may not be very accurate. Even if accurate, by the time the Sentinel and NEOCam missions are complete and 90-99% of short-period potentially dangerous NEOs have been discovered, long-period comets may represent a large fraction of the remaining threat and most, if not all, of the objects with globally catastrophic effects of collision. **I recommend that studies should be undertaken to understand the long-period comet threat thoroughly**. **LSST's capabilities for this task should be assessed and, if substantial, supported**.

It should be noted that NEO detection and tracking to protect the planet also has substantial scientific value. The knowledge gained will help understand the origin and evolution of the solar system.

The immediate recommended discovery and tracking actions: existing efforts, LSST NEO search, and funding Sentinel and NEOCam, do not require nearly 1% of the global civil space program budget. The remaining funds might be used for long-period comet detection, deflection research, including characterization of NEOs, and deflection missions to NEOs to practice with no chance of harming Earth.

In summary, **I recommend that the spacefaring nations of Earth devote at least 1% of their civil space program budget to planetary defense**. While the importance of planetary defense merits a much higher budget, 1% represents sufficient funds for a very robust program. Specifically, in the near term, NSS recommends that

1. Current ground searches continue.
2. The LSST receive full funding for NEO discovery.
3. The Sentinel and NEOCam space telescopes specifically designed for planetary defense be fully funded.
4. That the threat from long-period comets be assessed.
5. Any remaining funds be allocated to deflection activities, including characterization.

[22] G. Stokes, D. Yeomans, W. F. Bottke, S. Chesley, J. B. Evans, R. E. Gold, A. W. Harris, D. Jewitt, T. S. Kelso, R. McMillian, T. Spahr, and S. P. Worden. "A Study to Determine the Feasibility of Extending the Search for Near Earth Objects to Smaller Limiting Magnitudes." Report Prepared at the Request of NASA Headquarters Office of Space Science's Solar System Exploration Division (Washington, DC: NASA, 2003).

****

About the Author. In 1978 Al Globus read the space settlement issue of Co-Evolutionary Quarterly. It blew his mind. He had to build these things, so he went to work as a contractor at NASA Ames to work on the Hubble, ISS, X37, Earth observation, TDRSS, cubesats, lunar teleoperation, spaceflight effects on bone, aerospace computational fluid dynamics visualization, molecular nanotechnology, space solar power, asteroid mining, and space settlement. He founded and has run the annual NASA Ames Space Settlement Student Design Contest for 21 years.

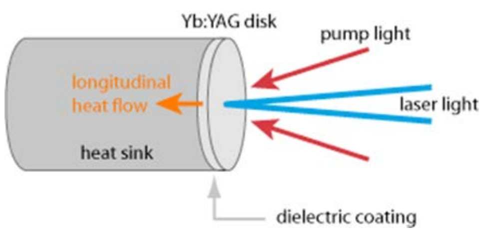
Editors' Notes: As one of the Space Community's thirty-five-year professionals, Al Globus's recommendations deserve, and have been given, attention by decision makers. He is a frequent expert participant for the Lifeboat Foundation web site discussions and produces documentation aimed at ameliorating or removing dangerous threats to Earth's humanity. If we fail in Planetary Defense, the majority of other priorities will be irrelevant. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Solar Power Satellites for a Sustainable Industrial Future

By William Mook

The thin-disk laser is a high-power solid state laser developed in the 1990s at the University at Stuttgart, Germany by Adolph Giesen. The gain medium is a thin disk much smaller than the diameter of the laser beam. This geometry allows heat to be extracted through one of the sides while laser energy is efficiently extracted through the other with a minimum of beam distortion. The cooled end reflects both the pump energy and the laser energy. For this reason thin-disk lasers can be thought of as mirrors equipped with a gain medium and are sometimes called active mirrors for that reason.



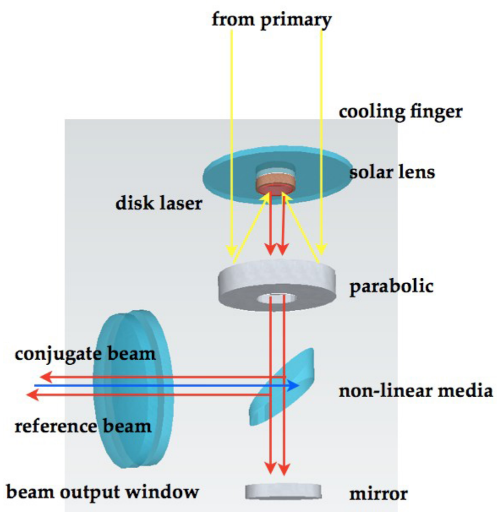
Conjugate optics are set up to recycle reflected pump light 16 times or more in what is known as a multi-pass system. In this way overall efficiency exceeds 80% near the wavelength of the laser's operation.

Multiple gain media layers permit the efficient conversion of solar radiant energy with an overall efficiency in excess of 55%. In this way a new sort of solar energy system may be contemplated, one that uses laser energy made directly from sunlight at high efficiency.

Laser energy created in this way when made to pass through a non-linear optical medium exposed to a reference beam from a power receiver creates a reliable link between generator and receiver. The reference beam interferes with the power beam so that a conjugate beam is produced that travels precisely to the receiver that originates the reference beam regardless of changes in orientation of the two systems. Furthermore, any object that traverses the power beam also intercepts the reference beam, cutting off transmission and thus acting as a safety fuse.

In this way a simple, safe, reliable, and robust space power system can be produced and launched at reasonable cost.

In the late 1950s, inflatable structures in tension were used for a variety of applications. Specific mass was less than 18 grams per square meter with life spans up to three years. Since that time, advances have reduced specific mass of very strong structures to 4 grams per square meter which remain rigid up to 30 years in space while optical quality has been vastly improved.

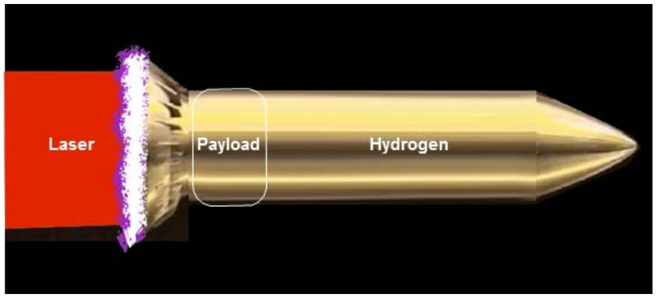


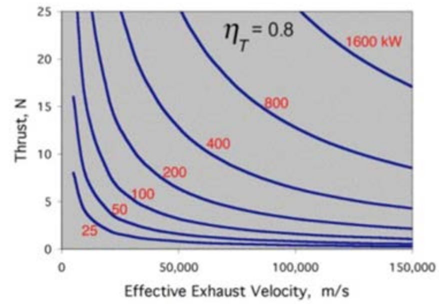
Using these ideas, I have designed a 6,000 meter diameter lenticular parabolic primary concentrator that focuses sunlight 1600x to a solar-pumped thin-disk laser equipped with a 6.6 meter diameter aperture to beam energy to two hundred 6.6 meter diameter receivers on Earth, simultaneously, over a distance of 40,000 km from geosynchronous orbit

This satellite, operating in a geostationary orbit, produces 18.7 billion watts of power delivering an average 90 MW of power continuously to 200 receivers anywhere visible to the satellite on Earth. Three such satellites spaced 120 degrees apart in this orbit are capable of delivering energy anywhere on Earth. At 8 cents per kWh the satellite produces $13.113 billion per year in revenue. Over 26 years at this price, each satellite earns $340.3 billion. At start up, this revenue stream is worth over $170 billion. A four-year program to develop the first satellite easily provides venture capital rates of return for early investors. The cost of a program to develop and orbit the first satellite could be as little as $1.28 billion and take four years. Each additional satellite is orbited at a cost as little as $0.63 billion.

Power Satellite Critical to Human Advance

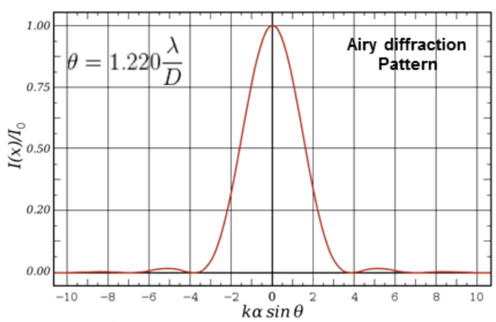
Achieving high living standards using off-world resources would reduce the impact of humanity on Earth's biosphere. Achieving space access for all requires that the present 9.02 TW grow to 45.10 TW. Maintaining a 9.5% economic growth rate to bring about this change quickly gives an 18-year window to achieve the increase described and scales the program. Using the satellites described here requires that we launch 2,400 satellites of this type in this period. This implies a launch rate of one satellite every 65 hours over this period. A fleet of seven vehicles with a 455-hour turn-around provides this capability. With launch center, fleet, supply chain for satellites, and replacement parts for launcher, there would be a $7 billion program cost with an $85 billion per year operating cost at the expected launch costs.

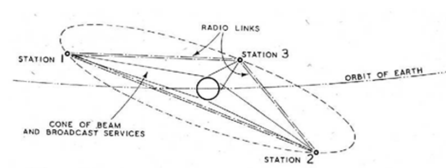




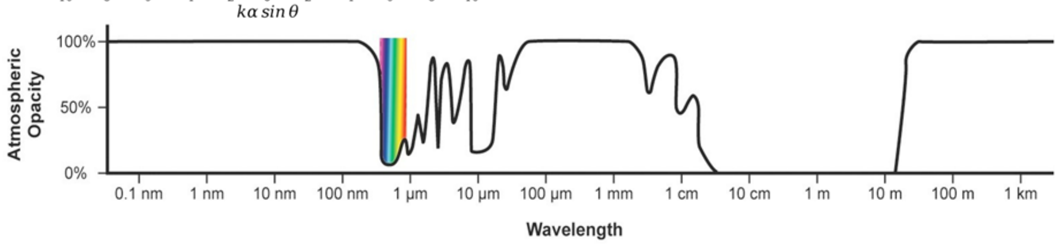
Laser Launch for Laser Power Satellite
Thrust vs. LSP at constant power (total efficiency eta = 0.8). AFRL and NASA researchers have attained 150,000 m/s exhaust speeds using ultra-violet laser beams and mixtures of hydrogen and helium gases. Four-wave mixing and efficient production of UV light on the multi-gigawatt scale are required to produce large, high-performance, laser-powered launchers.

Beaming Energy from Space





Geostationary Orbit

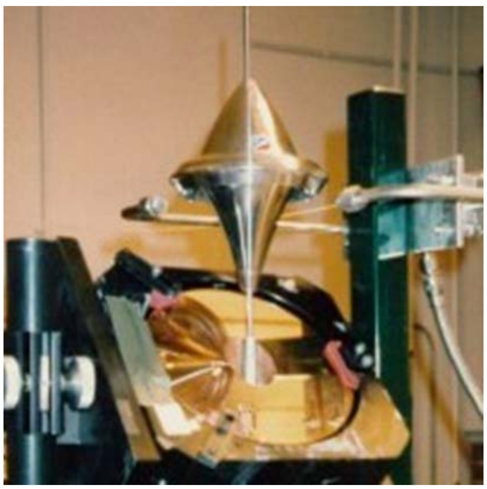


Short wavelength reduces mass on orbit. The Earth's atmosphere has sufficient clarity in the microwave, infrared, and visible portions of the spectrum to beam energy reliably from space. At a distance of 35,786 kilometers, the sizes of the transmitting and receiving apertures are fixed by the wavelength used. Using shorter wavelengths reduces aperture diameter and hence the size and mass of the satellite.

Geostationary Aperture Size and Mass

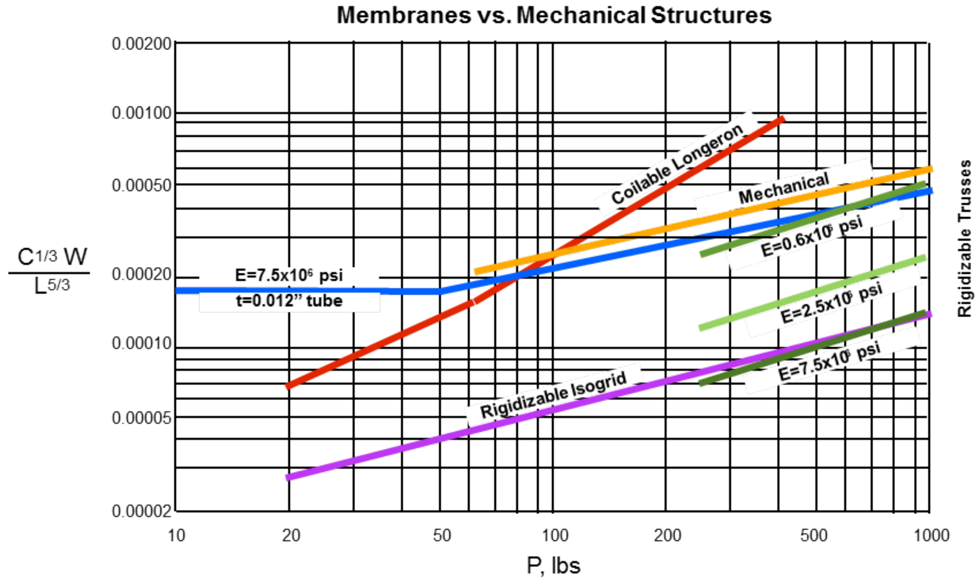
Wavelength	Aperture (meters)	Primary (meters)	Mass (tonnes)	GW	Type
100 cm	2,090 m	2090	27,446	2.8	Direct
10 μm	21 m	4200	887	10.1	Direct Concentrator
1 μm	6.6 m	6000	300	18.7	Indirect Concentrator
500 nm	4.9 m	9000	675	54.9	Indirect Concentrator

Low-Cost Laser Energy Used for Low-Cost Launch



Leik Myrabo and Franklin Mead at the Air Force Research Laboratory Propulsion Directorate proved it was possible to use laser energy to propel a spacecraft. Exhaust velocities in excess of 46 km/sec were achieved using hydrogen. A hydrogen-fueled spacecraft capable of attaining 9.2 km/sec exhaust velocity provides a means to attain orbit with a highly reusable single-stage launcher using minimum energy and power for a given payload mass, with the vehicle delivering 24.7% of its take off mass to low earth orbit, along with 12.0% structure fraction. A vehicle with 2,024.3 tonne take-off weight is capable of delivering 500.0 tonnes to orbit energizing 1,279.8 tonnes of liquid hydrogen with up to 140 GW of laser energy at peak acceleration.

Comparison of Mechanical and Inflatable Booms for Space Applications



Comparison of Mechanical and Inflatable Booms for Space Applications
C is the *column boundary coefficient*, **L** is the *column length*, **W** is the *weight*, **P** is the *load*. Industry standard 12-mil thick composite fabric and 7.5 MPSI modulus of elasticity were used throughout except where noted. Thin film structures have a mass of 1% or less of standard structures.

Lenticular Inflatable Parabolic Reflector

Echo 2 Communications Reflector

Complex membrane structures were flown in space 55 years ago and developed for terrestrial application 60 years ago. These structures massed 17.8 grams per square meter of surface area using 12-micron thick aluminum-coated off-the-shelf material. Today, 3.6-micron thick materials fabricated at a GBO film achieve 4.0 grams per square meter and less with improved optical and mechanical performance.

Cost of Energy vs. Economic Growth

Economics	$/barrel	$/MJ	$/kWh
	$250.00	24.4	$0.301
	$150.00	40.7	$0.181
	$100.00	61.0	$0.120
4% Decline	***$72.00***	***84.7***	***$0.087***
	$50.00	122.0	$0.060
0% Growth	***$36.00***	***169.4***	***$0.043***
	$25.00	244.0	$0.030
4.7% Growth	***$18.00***	***338.9***	***$0.022***
	$15.00	406.7	$0.018
9.5% Growth	***$9.00***	***677.8***	***$0.011***
	$5.00	1,220.0	$0.006
	$2.50	2,440.0	$0.003
	$1.50	4,066.7	$0.002
	$1.00	6,100.0	$0.001

The cost of primary energy determines the growth rate of an industrial economy. At present the world is undergoing a 4% decline each year in real terms because the cost of discovering and bringing to market a barrel of oil is at present $72. The cost of primary energy must be $36 per barrel or less to sustain economic activity. Historically, the inflation-adjusted cost of oil was $18 per barrel and this sustained an average growth rate of 4.8%. Large discoveries resulting in low-cost primary energy are associated throughout history with high rates of economic growth. Energy prices associated with double digit rates of growth were classified as “too cheap to meter” by Leo Strauss, AEC Chairman, in 1953.

Kardashev Scale

$$\left\{K = \frac{1}{10}\left(\frac{\log(P)}{\log(10)} - 6\right), p > 0\right\}$$

How Humanity Stacks Up

2012 AD	9.02 TW	K = 0.696
2089 AD	10.00 QW	K = 1.000 (at 9.5% growth)
2164 AD	10.00 QW	K = 1.000 (at 4.7% growth)
2342 AD	10^{26} Watts	K = 2.000 (at 9.5% growth)
2665 AD	10^{26} Watts	K = 2.000 (at 4.7% growth)

Rapid Growth Reduces Environmental Impact

2012	7.057 billion	$ 11,506/year	1,278 Watts
2089	18.892 billion	$4,763,921/year	529,324 Watts
2164	58.396 billion	$1,541,201/year	171,244 Watts

****

About William Mook, PE: Bill Mook has innovative science and technology ideas for more subjects than anyone you have met. Those subjects range from the rocket history to sustained industrial futures in Space. He approaches his subjects from a mix of engineering knowledge through financial analysis and imbeds them in philosophical rationale as a foundation to support his statement *"The heavens will open to humanity."* He has had management and fiscal responsibility on Fortune 500 R&D teams and provided analytic work for the White House during both the Clinton and Bush Administrations. He holds patents for ground-breaking product developments. He is a member of the Board of Editors for *The Journal of Space Philosophy*.

Editors' Postscript: We encourage readers to find the published work of Bill Mook on the Internet. His analyses of Earth and Space energy and Space resources are solid evidence within *the Law of Space Abundance* that the Kepler Space Institute formulated in 2009. ***Bob Krone and Gordon Arthur*.**

Space Art

By Bob Krone and Gordon Arthur

IN MEMORIUM – MRS. JANET BURGESS

This Journal of Space Philosophy inauguration of Space Art publications is dedicated to Mrs. Janet Burgess. Janet was the sixty-year partner of Professor Lowry Burgess, one of the world's pioneers and scholars of Space Art. Janet died on 8 March 2014.

Philosophy and Art have been forever related. With this issue, the *Journal of Space Philosophy* initiates a permanent Space Art component. The few images in this issue are simply representative. One artist has a long professional Space Art career. Another is an amateur who has just created his first Space painting. Others are from the European Space Agency and NASA. Future Journal issues will publish from any source.

****

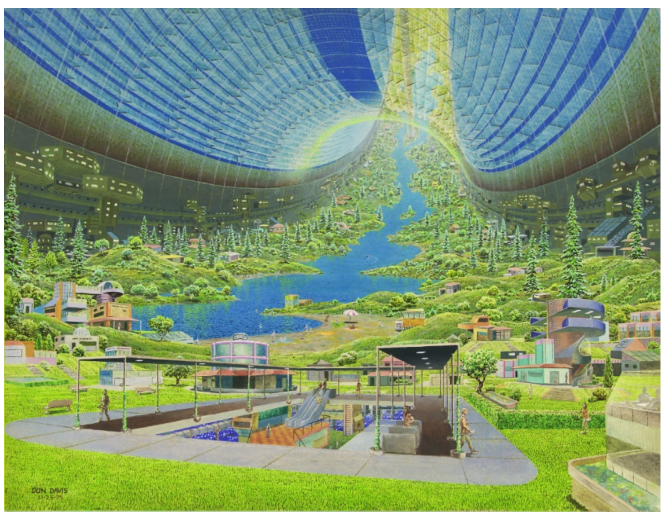
Don Davis

Double Sun Light

An Earth-like planet near a double star system, whose different colors create double shadows and reflections.

Center Vista

An overview of the Milky Way galaxy as it could appear from a vantage point well apart from the thin plane occupied by the spiral arms, looking toward the densely packed nucleus region.



Stanford Torus

Don Davis's interior concept for a 1.8 km wide wheel-shaped space colony that emerged from the NASA Ames 1975 Summer Study on space habitat design.

****

About Don Davis: Don Davis is a space artist and animator, as well as a photographer and writer. He has painted works for NASA, illustrating planetary exploration and visualizations of space colonies. He was on the team of artists for Carl Sagan's original *Cosmos* show, which was awarded Emmys by the Television Academy of Arts and Sciences. He created animations for the PBS shows *Planet Earth*, *Infinite Voyage*, *Space Age*, and two shows by Timothy Ferris, *Life Beyond Earth* and *Seeing In The*

Dark. Currently he produces animations of space subjects for modern planetariums that project high-resolution video. Don Davis is a member and fellow of the International Association of Astronomical Artists (IAAA) and has the rare privilege of having an asteroid bear his name – the *13330dondavis Asteroid.*

****

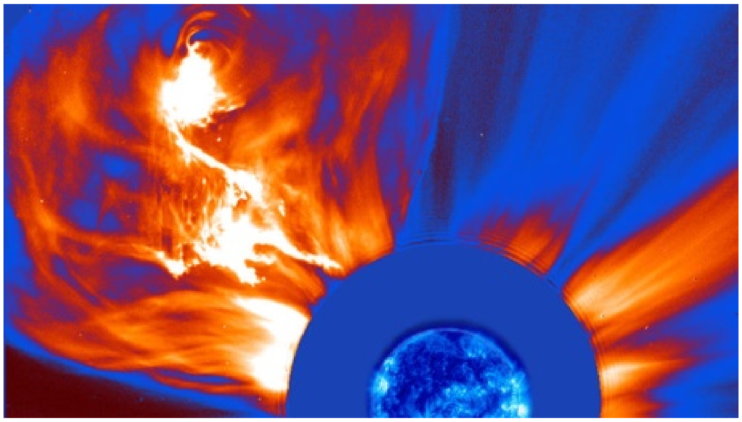
Henry Montanez, II

Deep Space

About Henry Montanez, II: Henry Montanez, of Beaumont, California, paints for fun and relaxation. His art signature is HMII. This is his first Space painting.

****

European Space Agency (ESA)



A fiery solar explosion: ESA Gallery

About the ESA: The ESA has created a world-class Space Art Gallery – real Space imagery equaling any artist's rendition.

****

Lunar Orbiter Image Recovery Project

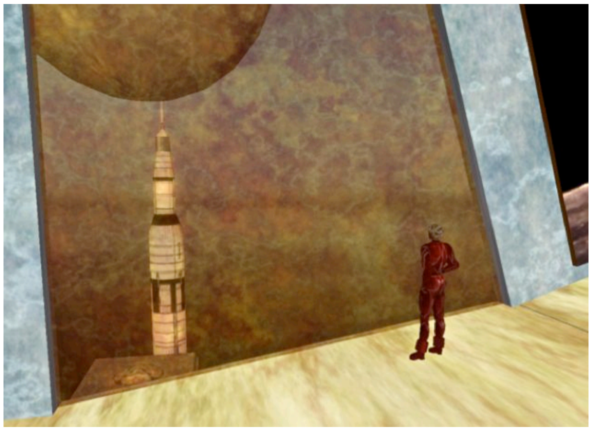
Earth Rising

This Earth rising image is the most reproduced NASA picture. The technology to capture it and its visual impact on all Earth's humanity were unprecedented. It is Space Art that everyone appreciates.

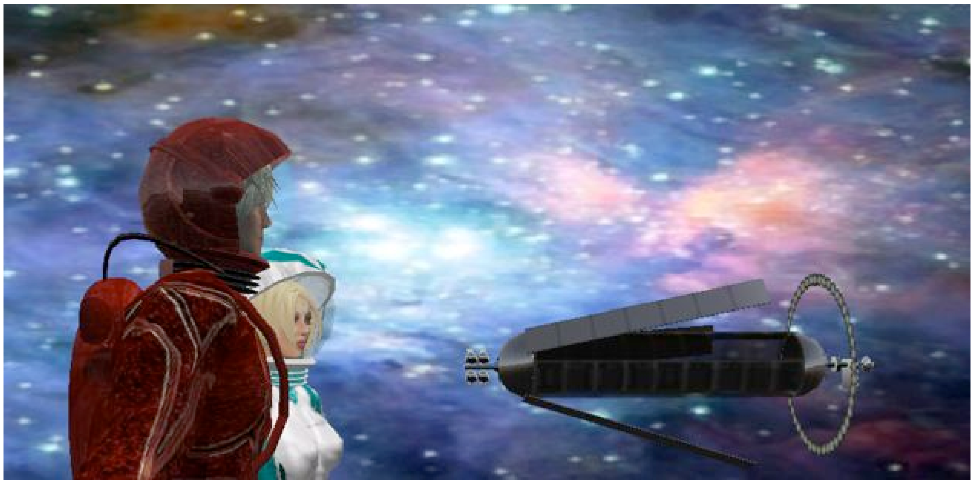
About the Source: The **Lunar Orbiter Image Recovery Project** (LOIRP), funded by NASA, SkyCorp Inc., SpaceRef Interactive, Inc., and private individuals, is digitizing the original analog data tapes from the five Lunar Orbiter spacecraft that were sent to the Moon in 1966 and 1967. This image comes from the NASA image gallery. For more details, see http://www.ask.com/wiki/Lunar_Orbiter_Image_Recovery_Project.

****

Kim Peart



Alone



Dreaming

About the Artist: Born in 1952, Kim Peart was raised in the Australian island state of Tasmania, where he trained as a visual artist, launched a Viking Society in 1975, and became a life-long space advocate in 1976 when joining the L5 Society. He founded the Southern Cross L5 Society in 1981, now the National Space Society of Australia, which was given its national launch in the Observatory at The Rocks in Sydney in early 1982.

After a journey to India in 1986, he became a human rights defender and urban environmentalist, gaining an entry among Tasmania's top 200 movers and shakers in 2007 at number 123. In 2006, he wrote the document "Creating a Solar Civilization," moved north to Queensland in 2007, and is currently director of Space Pioneers.

In March 2012, he worked with research scientist Dr. Jennifer Bolton, to identify a way to build a working model of an orbital space settlement in the virtual world, the virtual orbital space settlement (VOSS), which allows any number of people to be involved in a space-like virtual environment, as if in space. When they discovered that Second Life had activated the RayCasting function, it became possible for an avatar to walk around the inside of a torus space station, as if in space. Responding to this new potential, they built a torus space station above Nautilus in Second Life to develop their virtual space program further. They now look toward the potential of the Oculus Rift and the Omni to provide a more realistic virtual experience of space, as well as the development of a more advanced form of the virtual world by High Fidelity, where astronauts may train in a realistic virtual space environment and people can prepare for space tourism.

Over the past couple of years they have been working with members of the Overview Institute, seeking to develop a virtual experience of the Earth from space. They are also pleased to develop their relationship with the Kepler Space Institute, seeking ways to develop space studies in a global context in the virtual world.

They see a unique opportunity with the virtual world environment for people to meet globally and plan locally, toward building celestial futures. Kim Peart now lives in Mountain Creek on Queensland's Sunshine Coast with his wife and partner in space and virtual world development, Jennifer.

Starfarer in Second Life   Kim Peart in real life

****

Editors' Notes: Two unique human characteristics are the abilities to communicate through language, with the written word, and through the brain's creative cognition of images. Philosophy continues to do the former. Science is still penetrating the complexities of the latter. See the discoveries of Dr. Joel Isaacson in this, and previous, *Journal of Space Philosophy* issues – particularly his *"Nature's Cosmic Intelligence"* article in the Fall 2012 issue (accessed via www.bobkrone.com/node/120). Dr. Isaacson's identification of Recursive Distinctioning of Nature's Cosmic Intelligence being *"fundamental to all perception, and, by extension, to cognition and intelligence"* is a finding leading to the hypothesis that what happens in human brains with images is an application of Nature's Cosmic Intelligence. ***Bob Krone and Gordon Arthur***.

Research

By Gordon Arthur, PhD

The *Journal of Space Philosophy* was launched in the Fall of 2012 within the framework of Kepler Space Institute's vision and values. The Institute's two major functions are research and education under the umbrella of the *Law of Space Abundance*, formulated by the Institute's leaders in 2009 with the definition that *"Space offers abundant resources for human needs."*

The primary goal of this Journal is to capture the knowledge, ideas, and inspiration of global Space community professionals. Over time it will become a valuable Space research resource – a depository of future research ideas, suggestions, questions, and notes or conclusions on the remaining gaps in today's science, which can be consulted, analyzed, and used in the future for more focused inquiries in all aspects of basic and applied research in space and Earth sciences, including theory, data analysis, and modeling.

The first issue of our Journal (Fall 2012) focused primarily on the task of defining space faith and/or philosophy and their links with policy science, astrophysics, biology, and others. A number of pertinent research questions and hypotheses were proposed by the authors. They covered a large array of issues in space engineering, science, management, governance, and policy. The second issue (Spring 2013) discussed research theory. The third (Fall 2013) documented important hypotheses and research questions.

For this issue we provide for readers a brief video presentation by our Kepler Space Institute President, Dr. Bob Krone. Dr. Krone has taught graduate research at three universities, including being the principal supervisor for 43 successful doctoral candidates for the PhD and DBA between 1995 and 2010.

Click below for Dr. Krone's short presentation on research fundamentals.[1]

http://youtu.be/e8kAb4_Xqfw

About the Author: Gordon Arthur is the author of *Law, Liberty and Church: Authority and Justice in the Major Churches in England* (Aldershot, Ashgate, 2006); "The Development of Canonical Jurisprudence in the Roman Catholic Church and the Church of England", *Ecclesiology* 4 (2008): 308-25, and *On Frustrated Vocation* (Ilford: FeedARead, 2012) He gained a BSc in Physics from Birmingham University in 1984, an MA in Philosophy of Religion from King's College, London in 1998, and a PhD in theology, also from King's College, London in 2004. Gordon is Associate Editor of the *Journal of Space Philosophy*.

[1] Appreciation to our Technical Director, Alex Ssegujja, for professionally updating Dr. Krone's "On Research" video.

Journal of Space Philosophy 3, no. 1 (Spring 2014)

Global Decision Makers Alert: Leaders for a New Epoch

By Bob Krone and Gordon Arthur

Professor Yehezkel Dror, the Co-Founder and Leading Scholar for The Policy Sciences, has completed his classic study on leadership*: Avant-Garde Politician: Leaders for a New Epoch.*[1] It contains critically important analysis and recommendations for political leadership everywhere. Yehezkel Dror has previously published original articles on Governance for the Future of Humans in Space.[2]

Information and structure for his new book follows:

****

Avant-Garde Politician: Leaders for a New Epoch

By Yehezkel Dror

Publisher: Westphalia Press, imprint of the Policy Studies Organization, Washington, DC.

Availability: Estimated date of publication of soft cover book and e-book (Kindle) and availability at Amazon and other book outlets is April 2014.

On the Book

Humankind is cascading through radical changes comparable in significance to the invention of stone tools by proto-humans 1.5 million years ago. Emerging science and technology provide opportunities for unprecedented thriving. But they will also produce serious crises, up to fatal dangers resulting from humanity acquiring for the first time multiple capabilities to destroy itself, above and beyond the risks of nuclear weapons or climate change.

Rising sea levels and desertification, in part due to human action, will cause misery and mass population migrations. Molecular engineering, mass data processing, and quasi-intelligent robots will result in mass unemployment and further widen the gap between rich and poor. Synthetic biology, human enhancement, and cloning could easily run amok. And fanatic prophets and murderous dictators could unleash killer viruses.

---

[1] Yehezkel Dror, *Avant-Garde Politician: Leaders for a New Epoch* (Washington, DC: Westphalia Press, 2014).

[2] Yehezkel Dror, "Governance for a Human Future in Space," Chapter 5 in *Beyond Earth: The Future of Humans in Space*, ed. Bob Krone (Toronto, ON: Apogee Space Books, 2006). His Policy Sciences works were identified as the third component of the Kepler Space Institute's proposed *Philosophy for Space* published in the first issue of the *Journal of Space Philosophy* 1, no. 1, Article #8. The other two basic components were "Reverence for Life" and "Ethical Civilization." The Policy Sciences were selected as the best implementation methodology for the governance of future human Space settlements.

We are not equipped to handle what is sure to come and the vast majority of our political leaders are incapable of coping with unprecedented dangers and utilizing novel opportunities. Therefore we must change our ways. It is essential to have strict regulation of potentially dangerous or "human enhancement" science and technology, total prevention of dangerous fanaticism, enforced settlement of bloody conflicts, a Global Human Constitution setting up a strictly circumscribed "Global Leviathan" regime strictly limited to preventing "Hell" on earth, duties added to human rights, and strenuous efforts to advance social justice worldwide.

First of all it is vital to develop a new breed of what the author calls avant-garde politicians, willing and able to compose and implement human-centered policies, looking beyond our current tribalisms to a pan-human communality. No less essential are new modalities for pondering on novel challenges and improving unavoidable high-stakes fuzzy policy gambles.

Audience
Based on multiple disciplines and the author's experiences in "hot corridors" of power, this book evaluates dangers and opportunities, proposes humanity-craft policies, and explores the required qualities of avant-garde politicians. The result will be of interest to leaders, policy advisors, scholars, scientists, students, and, indeed, anyone concerned about the future of humanity.

Contents

****

About the Authors: Bob Krone, PhD, is President of the Kepler Space Institute, Founder of the *Journal of Space Philosophy* and its Editor-in-Chief. Gordon Arthur, PhD, is Associate Editor of the *Journal of Space Philosophy*. They were delighted to have the publication information of Professor Yehezkel Dror's latest work in time to announce in this Spring 2014 issue of the Journal. They urge widest distribution of ***Avant-Garde Politician: Leaders for a New Epoch****.* Humanity on Earth and as it spreads into Space will be vastly improved if global decision makers study and implement the prescriptions for leadership of Yehezkel Dror.

Journal of Space Philosophy (JSP) Board of Editors

Kepler Space Institute is honored to have 40 of the world's Space Community professionals as members of the Board of Editors for the Journal of Space Philosophy.

Dr. Elliott Maynard, our Journal of Space Philosophy Board of Editors colleague, has beautifully stated both the purpose and the style for our peer reviews:

"*This is such a hi-caliber group of leading edge thinkers and supercharged individuals, it should be natural for each of us to wish to provide a supportive and synergistic environment for the others. I have also learned always to have someone else proof read any material I write, as I have discovered that the brain tends not to "see" my own simple mistakes. Ergo, within the new Kepler context I feel editors should be there to support our writers in the most creative and positive ways possible*." Elliot Maynard, e-mail to Bob Krone, 23 March 2013.

The purposes of peer reviews of article submissions to the Journal of Space Philosophy are: (1) Determine relevance to the Vision and Goals of Kepler Space Institute; (2) Help the author(s) improve the article in substance and style or recommend references; and (3) Provide publication recommendations to the Editor-in-Chief.

****

1.

ARTHUR, Gordon, PhD, JSP Associate Editor,
Theology at King's College, London, UK.

For Bio Info: www.linkedin.com/in/gdarthur.

2.

AUTINO, Adriano, Founder, Space Renaissance International.

For Bio Info: www.spaceentrepreneurs.ning.com/profile/AdrianoAutino.

3.

BELL, Sherry, PhD, KSI Dean, School of Psychology.

For Bio Info: www.nss.org/about/bios/bell_sherry/html.

4.

BEN-JACOB, Eshel, PhD, Former President of Israel Physical Society; Founder Science of Bacterial Intelligence. Tel Aviv University.

For Bio Info: Google Eshel Ben-Jacob.

5.

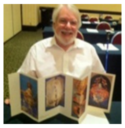
BLOOM, Howard K., Author, Scientist, Founder Space Development Group, Publicist, Author on Human Evolution, Science, Technology, and Space. Photo by Luigi Novi.

For Bio Info: www.en.wikipedia.org/wiki/Howard_Bloom.

6. 

BOLTON, Jennifer, PhD, Co-Founder Virtual Space Orbiting Settlement VOSS. Veteran and molecular biologist, Space Pioneers Science Officer.

For Bio Info: Google Jennifer Bolton.

7. 

BURGESS, Lowry, Professor. Distinguished Fellow at the Studio for Creative Inquiry, Center for the Arts and Society, College of Fine Arts, Carnegie Mellon University.

For Bio Info: See Issue 1.1, Article 13.

8. 

CLEMENTS, Douglas H., MD, American Board of Ophthalmology, *"Improving Human Vision for Space Exploration and settlement"*.

For Bio Info: Board Certified Ophthalmologist, University of Southern California Keck School of Medicine.

9. 

DOWNING, Lawrence G., DMin, Senior Pastor, Space Faith and Spirituality pioneer, University Professor.

For Bio Info: See Issue 1.1, Article 11.

10. 

HAYUT-MAN, Yitzhaq (Isaac), PhD, Architect for the Universe, The Jerusalem Dome of the Rock as a memory site for theology, philosophy and humanity past, present and future.

For Bio Info: Google Yitzhaq Hayut-Man.

11. 

HOPKINS, Mark, Chairman of the Executive Committee, National Space Society (NSS). Space Economics. Important in founding of the L-5 Society and collaboration of the NSS with the Kepler Space Institute.

For Bio Info: www.nss.org/about/hopkins.html.

12. 

ISAACSON, Joel, PhD, Nature's Cosmic Intelligence, pioneer of RD Cellular Automata since the 1960s.

For Bio Info: See Issue 1.1, Article 7.

13. 

KHOVANOVA-RUBICONDO, Kseniya, PhD, University of Chicago, Expert in Public economics, innovation, policy and urban planning. Consultant Council of Europe and European Commission, Proficient in six languages, Space International Economics.

For Bio Info: www.connect.tcp.org/profiles/profile.php?profileid=2296.

14. 

KIM, KEE YOUNG, PhD, Republic of Korea Senior University Academician and Administrator. Former President, Kwang Woon University; Former Dean of the School of Business and Provost, Yonsei University; currently the Chairman of the Board of the prestigious Samil Foundation, the oldest Korean institution to award and provide scholarships to high performing scientists, artist and engineers.

15. 

KIKER, Edward, General Engineer, GS-13, Office of the Chief Scientist, US Army Space and Missile Defense Command/Army Forces Strategic Command, Kepler Space Institute Chief Scientist.

For Bio Info: www.indeed.com/r/Edward-Kiker/45bd40a86c090f07.

16. 

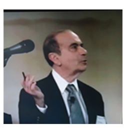
KRONE, Bob, PhD, Journal of Space Philosophy Editor in Chief, Provost Kepler Space Institute.

For Bio Info: www.bobkrone.com/node/103.

17. 

LIVINGSTON, David, PhD, Founder & Host, The Space Show.

For Bio Info: www.thespaceshow.com.

18. 

MARZWELL, Neville, PhD, Space Solar Power and Robotics Scientist. Career at JPL as Manager for Advanced Concepts and Technology.

For Bio Info: www.spaceinvestment.com/lcr2_bios.html.

19. 

MATULA, Thomas L., PhD, Business and Management Professor, Lunar Commercial scholar.

For Bio Info: www.trident.edu/dr-thomas-matula.

20. 

MAYNARD, Elliott, PhD, Founder, ArcoCielos Research Center, Sedona Arizona, www.arcocielos.com.

For Bio Info: www.fasiwalkers.com/featured/ElliottMaynard.html.

21. 

MITCHELL, Edgar Dean, ScD, Captain, US Navy (Ret), Apollo 14 Astronaut, 6th person to walk on the Moon, Founder Institute of Noetic Sciences.

For Bio Info: Google Edgar Mitchell.

22. 

MOOK, William P.E., Trained in aerospace engineering, 15 years in alternative energy, Space Commerce Technology.

For Bio Info: www.vimeo.com/user1527401.

23.  **O'DONNELL, Declan J., JD,** Space Law attorney, Fifty publications in Space Law and Policy, Publisher, Space Governance Journal, President, United Societies in Space, Inc.

24.  **OLSON, Thomas H., PhD, DBA,** Professor of Clinical Management and Organization, University of Southern California Marshall School of Business, Los Angeles, California, USA. Dr. Olson's specialty in research and consulting is on strategy, development, organization and human capital. He has authored four books and 100 professional articles.

For Bio Info: See http://www.marshall.usc.edu/faculty/directory/tholson

25.  **PALMA, Bernardino,** Historian, Portuguese Age of Discovery.

For Bio Info: See Issue 1.1, Article 8.

26.  **PEART, Kim,** Co-Founder, Virtual Orbiting Space Settlement (VOSS). Artist, Visionary, virtual worlds.

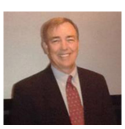
For Bio Info: www.independentaustralia.net/about/ia-contributors/kim-peart-bio/.

27.  **ROBINSON, George S., III, LLD,** Space Law Pioneer and International Space Expert. Smithsonian Institute Legal Counsel.

For Bio Info: See Issue 1.1 Article 14.

28.  **SCHORER, Lonnie Jones,** Kids to Space Author and Teacher. Architect, Aviator.

For Bio Info: See Issue 1.1, Article 17.

29.  **SCHRUNK, David, MD,** Aerospace Engineer, Founder, Quality Laws Institute, KSI Faculty.

For Bio Info: See Issue 1.1, Article 18.

30.  **SCHWAB, Martin, PhD,** International Space Author, KSI Faculty, Aerospace Technology Working Group.

For Bio Info: See Issue1.1, Article 21.

31. 

SCOTT, Winston E., American Astronaut, Vice President for Development, Florida Institute of Technology.

For Bio Info: www.en.wikipedia.org/wiki/Winston_E.Scott.

32. 

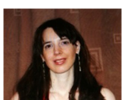
STEPHANOU, Stephen E., PhD, Emeritus Professor of Systems Technology, University of Southern California, Los Angeles, California, USA.

For Bio Info: See Issue2.2, Article 26.

33. 

TANG, Terry, PhD, KSI Director of Research.

For Bio Info: See Issue 1.1, Article 24.

34. 

THORBURN, Stephanie Lynne, Author, Astrosociology.

For Bio Info: See Issue 1.1, Article 12.

35. 

WERBOS, Paul, PhD, United States National Science Foundation, Space Scholar.

For Bio Info: See Issue 1.1, Article 19.

36. 

WHITE, Frank, MSc, Founder, The Overview Effect Institute.

For Bio Info: See Issue 1.1, Article 9.

37. 

WILKINS, John, PhD, Professor of Space Settlements.

38. 

WOLFE, Steven, Space Advocate and Author of the 2013 Space novel, *The Obligation.*

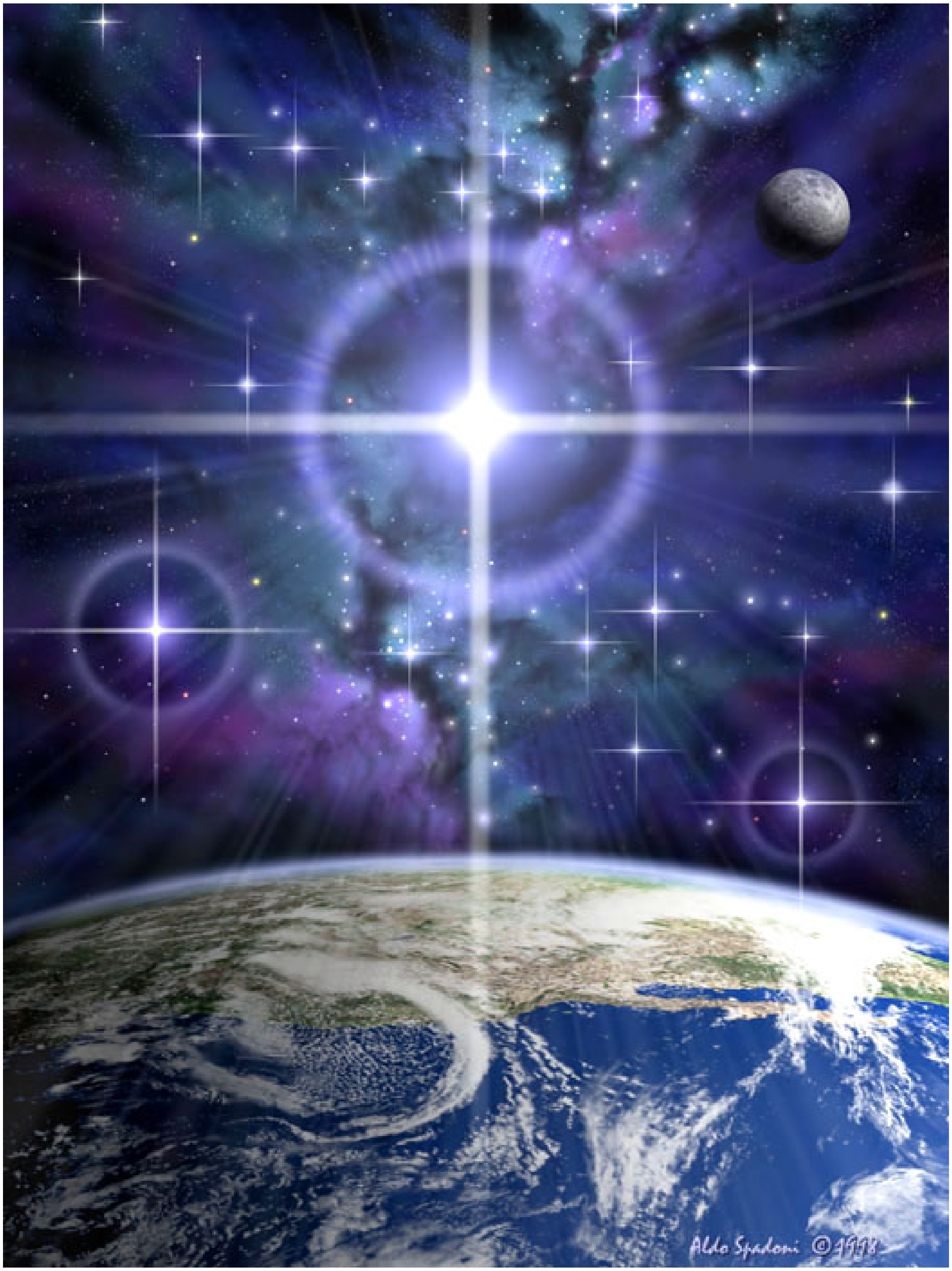
For Bio Info: See Issue2.2, Article 26.

39.  **YACOUB, IGNATIUS, PhD,** Founder and First Dean of the School of Business and Management, La Sierra University, Riverside, California. Currently Professor of Graduate Studies, Loma Linda University School of Social Work and Social Ecology, Loma Linda, California.

40.  **ZUBRIN, Robert, PhD,** President, MARS Society.

For Bio Info: www.en.wikipedia.org/wiki/Robert_Zubrin.

"The greatest use of a life is to spend it for something positive that outlasts it."
Dr. Max T. Krone, Dean, Institute of the Arts, University of Southern California and Founder, Idyllwild School of Music and the Arts, 1950


Aldo Spadoni ©1998