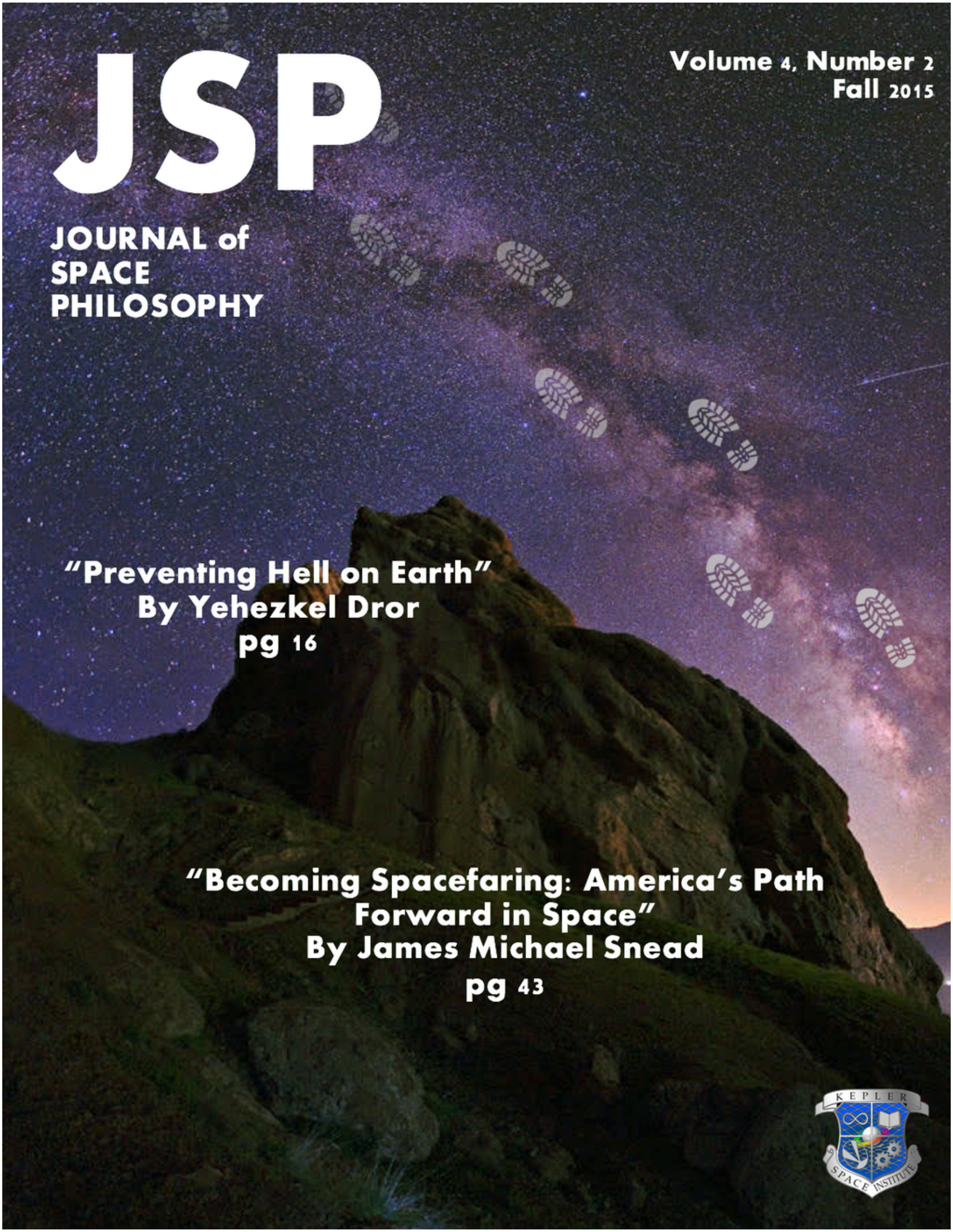


JSP

JOURNAL of SPACE PHILOSOPHY

Volume 4, Number 2
Fall 2015

"Preventing Hell on Earth"
By Yehezkel Dror
pg 16

"Becoming Spacefaring: America's Path Forward in Space"
By James Michael Snead
pg 43

Kepler Space Institute

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

Dedication

The Kepler Space Institute Board of Directors dedicate this Fall 2015 issue of the *Journal of Space Philosophy* to the need for humankind to ensure Space becomes an environment for all to live, flourish, and survive in harmony and peace.

Kepler Space Institute

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

Preface

We continue to develop the presentation of the *Journal of Space Philosophy*, and we again thank Isabelle Ramirez and Naté Sushereba in our Florida Office for their ongoing creative work. There are two main foci in this issue. The first is on ensuring ethical behavior on Earth and in Space. Our first feature article by Yehezkel Dror, on preventing Hell on Earth, addresses the problem of the oppressive behavior that is likely to develop following the harsh transition crises we can expect to encounter as technology develops and humans move into space. In our second feature article, Mike Snead points the way forward into Space, introducing the second focus on productive uses of space. George Robinson contributes an assessment of the current state of Space law and in particular the absence of any explicit universal rights. Stephanie Thorburn offers some progressive etudes on consciousness. Terry Tang explains some key determinants for experimentation in space. William Mook offers some thoughts on the production and uses of positronium.

We are proud to offer readers this seventh issue of the Journal of Space Philosophy. 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; they do not necessarily reflect the 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*

JOURNAL OF SPACE PHILOSOPHY

Vol. 4, No. 2, Fall 2015

CONTENTS

Access to the Journal of Space Philosophy and free downloading of its articles is available at bobkrone.com/node/120.

Anyone on Earth or in Space may submit an article or Letter to the Editor to BobKrone@aol.com.

PRESS RELEASE

December 11, 2015

By Naté Sushereba

The Kepler Space Institute, Inc. (KSI) closes out its publications for 2015 with the seventh issue of the *Journal of Space Philosophy.* It is dedicated to the need for humankind to insure Space becomes an environment for all to live, flourish, and survive in harmony and peace; and has a Board of Editors composed of forty-two professional Space Community members.

The KSI Chairman of the Board of Directors, Gordon Holder introduces this issue as follows:

> **The leaders of Kepler Space Institute might best be described as dreamers – envisioning a not-too-distant future in which humans expand our world-wide civilization into extraterrestrial Space. There is a wide body of science and technology behind a global movement toward that end today, and it will continue to increase rapidly into the future.**
>
> **Kepler Space Institute is dedicated to providing an educational forum for today's young professionals to become tomorrow's leaders, and aims to combine disciplines and studies into an educational program. We are also exploring domains with other scientists where scientific advances are providing new, exciting areas of research that will complement our ventures into the current unknown of Space. Our ultimate goal is to enhance and enable those that seek to develop this adventure.**

The two featured articles address the serious problem of "Preventing Hell on Earth" by Professor Yehezkel Dror, the Co-Founder of the Policy Sciences, and America's Spacefaring future by James Michael "Mike" Snead, one of the world's leading researchers in that area.

The co-editors of the *Journal of Space Philosophy*, Dr. Bob Krone and Dr. Gordon Arthur, continue the Journal's history of the capturing of Space knowledge and research in this issue with articles by Dr. George S. Robinson, Stephanie Lynn Thorburn, Dr. Terry Tang, and Professional Space Engineer, William Mook.

The directors of KSI are proud to announce in this issue the forthcoming special issue of the *Journal of Space Philosophy*, which will contain a major science paper by Dr. Louis H. Kauffman and Dr. Joel D. Isaacson titled "Recursive Distinctioning."

Readers will find the subject in the Joel Isaacson article, "Nature's Cosmic Intelligence," published in the Fall 2012 issue of this journal, and in the "Letter to the Editors" article in the Spring 2015 issue, titled "Recursive Distinguishing" by Joel D. Isaacson and Louis H. Kauffman, April 28, 2015.

Space Educators will find the seven published issues of the *Journal of Space Philosophy* to be a unique professional research source for their classes and publications.

A Note from the Chairman of the Board

By Gordon Holder

The leaders of Kepler Space Institute might best be described as dreamers – envisioning a not-too-distant future in which humans expand our world-wide civilization into extraterrestrial space. There is a wide body of science and technology behind a global movement toward that end today, and it will continue to increase rapidly into the future.

This is an extremely interesting and maybe unique consideration given that our board has a quite diversified membership. For example, we have a retired Air Force officer with a PhD, a true scientist with a PhD, a former newspaper columnist, a retired engineer and US Air Force technical sergeant, and a retired Navy Vice Admiral with a specialty in surface warfare. Our other board members are in the supporting roles that allow us to highlight our desires for development and exploration of the space. The unifying aspect of all of these folks is the desire to prepare our future leaders to continue the expansion of space exploration and work on defining and refining those items that are not the province of NASA or other private space exploration agencies. It is most interesting that today's television science fiction deals ever more with extraterrestrials and suggestions that there is life beyond our earth. We want to ensure that our future leaders are ready to deal with the unknowns that will be presented.

There is also a tremendous amount of study and thought about the multiple ramifications of this movement – on economics and governance, international relations, on the human mind and body, and even on our spirituality. Kepler Space Institute is dedicated to providing an educational forum for today's young professionals to become tomorrow's leaders, and aims to combine these disciplines and studies into an educational program. Not only are we working to facilitate this education, but working with other distinguished scientific leaders, we are also exploring domains with other scientists where scientific advances are providing new, exciting areas of research that will complement our ventures into the current unknown of space.

Our ultimate goal is to enhance and enable those that seek to develop this adventure. We will accomplish this through online courses that will be certified in the State of Florida. The *Journal of Space Philosophy* is our first document, and great credit belongs to Colonel Bob Krone, PhD, USAF, Retired, for being the advocate, leader, and creator of the journal. Like our intent with our future educational programs, the journal is an online document, and easily accessible at www.bobkrone.com/node/120. I invite you to review the journal and its back issues, and to add your voice to ours to ensure our future in this great, vast area.

Journal of Space Philosophy 4, no. 2 (Fall 2015)

Letters to the Editor

We invite readers of the *Journal of Space Philosophy* to send us letters referencing any past publication, to suggest subjects for future publication, or to submit information from anywhere in the Global Space Community. ***Bob Krone and Gordon Arthur***.

****

Energetics

By Mike Snead, November 16, 2015

Dear Editor,

The Atlantic recently published an interview with Bill Gates under the title "We Need an Energy Miracle."[1] Gates publishes his own blog on topics of interest to him. On July 29, 2015, he published a blog with the title "We Need Clean-Energy Innovation, and Lots of It." This blog entry gives more insight into his views than the interview.

Gates's primary focus/concern is anthropological climate change and the alleged harm this will bring to the world's poor. As I discuss in my paper "Becoming Spacefaring: America's Path Forward in Space," the key to being non-poor is to have an elevated standard of living. To achieve an elevated standard of living requires technology and energy. The technology needed to enable a non-poor standard of living is readily available. The energy needed to apply this technology and to produce the goods and services required by a non-poor standard of living is not readily available and, because it is based primarily on fossil fuels, we are running out of it. Without concerted, effective action by the United States – its government and private sector acting together – Americans will experience energy poverty later this century.

Understanding that Gates's public musings are likely just exposing the tip of his thinking on these topics, I find it troubling that his quantitative understanding of the world's energy situation appears to be non-existent. Energy is a very quantitative topic. To live at a certain standard of living requires X energy per person on average. Multiply this by the population's size and the product is what that population needs in terms of annual affordable energy supplies to have the desired standard of living. Sum this product for Y years into the future – say to the year 2100 – and the total energy needed by that population can be reasonably estimated. If the energy supply is substantially non-sustainable – as is the case of the United States and most of the Western world – the required total can be compared to the estimated supply of affordable fossil fuels. If the tally sheet shows a positive value in 2100, then we are in good shape at this time. However, if the tally sheet shows a negative value in 2100, then energy impoverishment is coming within the lifetime of American children and grandchildren. The tally sheet for

[1] www.theatlantic.com/magazine/archive/2015/11/we-need-an-energy-miracle/407881/.

the United States shows a substantial negative value. (I discuss all of this quantitatively in my paper.) If the United States's energy security is bad, so is the rest of the world's.

As public awareness of America's precarious energy insecurity sets in, political concerns about any environmental impact of energy extraction and anthropological climate change will disappear. Coal is a dirty and smelly fuel compared with wood. Yet, when wood fuel supplies ran low in England starting in the 1200s, and in America in the mid-1800s, and coal was available, did folks prefer to keep warm with coal in the winter or be cold without dirty, smelly coal? Nearly 800 years of coal mining tells the answer.

As discussed quantitatively in my paper, there is but one sustainable energy solution for the United States and most of the world – space-based power. This is where I see a great failure in Gates's remarks. He writes as if terrestrial renewable energy will be able to lift the world's standard of living to that developed nations in a practical manner when fairly simple quantitative analysis shows this not to be the case. The only "lots of" clean, sustainable energy will be what we build in space, probably in geostationary orbit.

Many view this turning point in human civilization with alarm. There have always been those overwhelmed by circumstance and wanting to crawl into the nearest hole to hide. I view this turning point with great excitement. To maintain our standard of living, substantial new sustainable energy sources must be brought into operation. To undertake the space-based power solution to secure our energy future, the United States must become a true human commercial spacefaring nation. As a nation, we must boldly go forth to open the Earth-Moon system and much of the central solar system to routine human commerce. As we do this, the rest of the world will be able to exploit this new energy capability as well giving the world's poor the energy they will need to raise their standard of living – a goal we can all endorse. If Americans accept this challenge, this century will be quite exciting rather than the dismal existence the worrywarts want us to believe will happen. If Gates cannot now identify any comparable terrestrial solution that can be practically implemented at the scale of power production needed to replace fossil fuels, he should then be open to and endorse the space-based power solution.

Mike Snead, PE
President
Spacefaring Institute LLC
Beavercreek, OH

Journal of Space Philosophy Sponsors

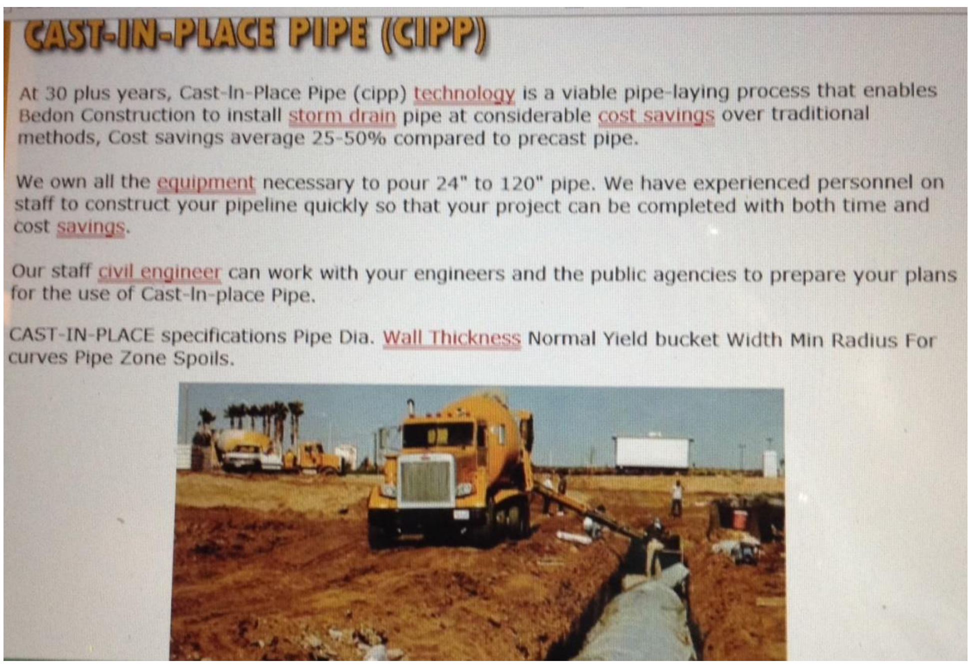
By JSP Editors

The Board of Directors of the Kepler Space Institute recognizes the generous donations of the following companies and individual to finance the Journal of Space Philosophy:

- Bedon Inc., Construction Company, Temecula, California, Don Parker, President
- Automotive Repair, Singapore, Hosain Bahari, President
- Dr. Sherry Bell
- Dr. Bob Krone and Salena Gregory Krone
- Smart Fleet, Inc. Joseph Sobodowski, CEO.

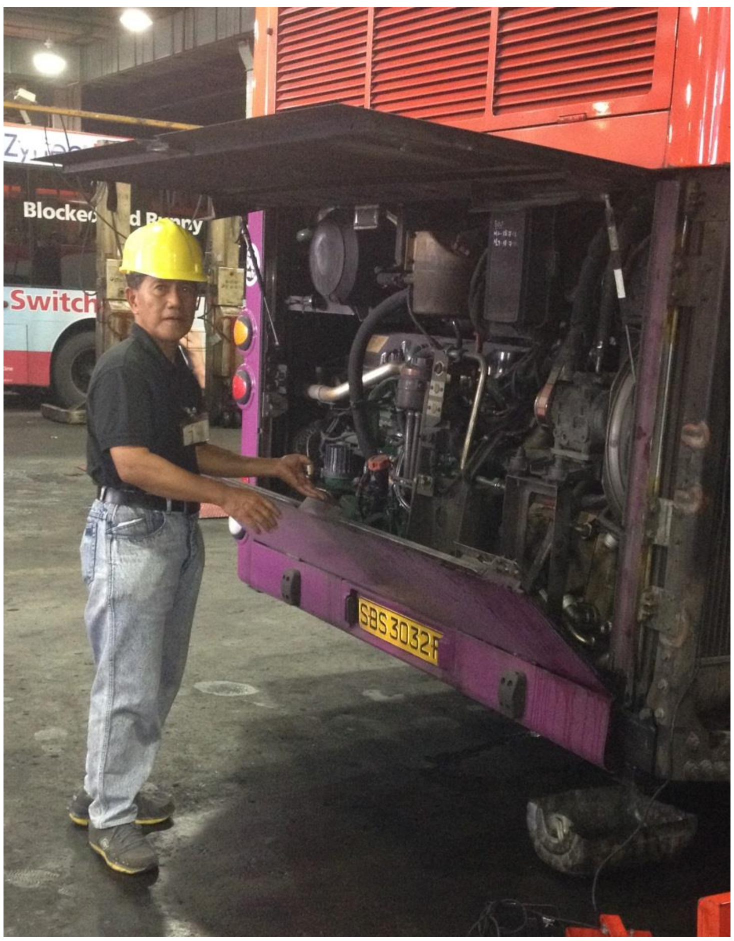
See information in the following pages

- **Bedon Inc., Construction Company, Temecula, California, Don Parker, President**



- **Bedon Construction, Inc.: Today on Earth – Tomorrow in Space**

- **Automotive Repair, Singapore, Hosain Bahari, President**



- **Dr. Sherry Bell**

Dean of Psychology at Kepler Space Institute and long-time ISDC planner with the National Space Society

- # Dr. Bob Krone and Salena Gregory Krone

- **Smart Fleet, Inc. Joseph Sobodowski, CEO.**

Preventing Hell on Earth[1]

By Yehezkel Dror

Journal of Space Philosophy Introduction

Professor Yehezkel Dror is the co-founder and leading scholar of the Policy Sciences, having published fifteen books aimed at improving public policymaking globally. His works will be critically important for the design of governance in future Space settlements.[2]

His "Preventing Hell on Earth" article alerts the global Space community to the human factors issue of future potential pathological behavior and leadership that could prevent successful Space settlements and even destroy humanity on Earth before that settlement can occur. The Kepler Space Institute (KSI) will sponsor a panel at the 2016 International Space Development Conference (ISDC 2016) in Puerto Rico that focuses on this issue that has existed throughout human history on Earth. The research question will be "How can we prevent failures in Space flowing from human pathologies?"

****

Abstract

To fulfill its mission, a human-centered paradigm as envisioned by the World Academy of Art and Science should combine optimism with pessimism. It must avoid the bad, in addition to achieving the good. Realistic assessment of humans is a must. An appropriate, phased time horizon of 10 to 80 years should frame the paradigm. Evaluation of emerging science and technology with very dangerous potentials, such as those posed by synthesizing viruses and radical "human enhancement," followed perhaps by human cloning and deep genetic engineering, is essential. Thinking ahead realistically on alternative futures of humanity and its drivers is a must, giving due weight to dangerous propensities as well as the virtues of humans. Only a small minority of humanity and its political leaders have the understanding essential for coping with the fateful choices increasingly facing humanity. It is also essential for a strict global regime headed by a duly constituted circumscribed global authority to regulate dangerous research and technologies. Better political leaders within redesigned democracy are essential. No human-centered paradigm should ignore such requirements. All this leads to my suggestion to focus the paradigm on the most important and urgent, what Dag Hammarskjöld called appropriately "preventing Hell on Earth."

---

[1] Adapted by permission from CADMUS 2, no. 4 (April 17, 2015): 57-68, www.cadmusjournal.org/article/volume-2/issue-4-part-1/preventing-hell-earth.

[2] *Journal of Space Philosophy* Editor-in-Chief, Dr. Bob Krone's first description of Yehezkel Dror's works was in Robert M. Krone, *Systems Analysis and Policy Sciences: Theory and Practice* (New York: John Wiley & Sons, 1980). Subsequent ones can be found at www.bobkrone.com, in Bob Krone's article, *"Policy Sciences for the Space Epic"* in the Spring 2015 issue of the *Journal of Space Philosophy*, and in Harold D. Lasswell, "The Policy Orientation," in *Policy Sciences*, ed. Daniel Lerner and Harold D. Lasswell (Stanford, CA: Stanford University Press, 1951), Chapter 1. This is considered the beginning of Policy Sciences as a new discipline. In 1971, his book *A Pre-View of Policy Sciences* (New York: Elsevier) was published. That year Yehezkel Dror founded *Policy Sciences: An International Journal*. He has continued to 2015 as a co-founder and major scholar for the policy sciences. Other references to his work can be found in the Spring and the Fall 2014 issues of this Journal.

Introductory Note

This essay is a contribution to discourse on a human-centered paradigm, or set of guiding principles. It is largely based on my books *Avant-Garde Politician: Leaders for a New Age* (2014) and *The Capacity to Govern: A Report to the Club of Rome* (2001), which also detail most of the sources on which the present paper is based. But this essay focuses on preventing Hell on Earth, including averting the self-destruction of the human species, which is at the center of concerns.

Realistic Vision

The conceptual framework for a human-centered paradigm, which is being developed by the World Academy of Art and Science (WAAS), aims at guiding action directed at assuring, as far as humanly possible, a better future for humans and humanity as a whole. Accordingly, it belongs to the category of realistic visions, in partial contrast to "realistic" in the narrow incremental sense of "the art of the possible," but also in contrast to counter-factual utopian visions.

To fulfill its action-guiding aims, a realistic vision must meet three main criteria: (1) directed at well-considered and explicated values; (2) accepting constraints imposed by rigid features of reality; and (3) dealing with clarified time horizons phased according to the natural time cycle of the relevant issues.

It seems to me that the WAAS discourse on a human-centered paradigm meets the value criterion of advancing the good, as accepted by the best of contemporary moral discourse and global declarations. But it misses an essential meta-value, namely avoiding the bad, as distinct in many respects from achieving the good, despite some logical and operational overlaps. Also, most of the discourse ignores very vexing issues of judging what endangers the welfare and perhaps existence of humans or enhances them, including emerging technologies that will be useable both for the better and the worse. Artificial Intelligence (AI in short), synthetic biology, and human enhancement illustrate such domains of science and technology in respect to which salient values are missing or at best underdeveloped. The question to what extent and under what conditions novel science-and-technology provided processes and tools are likely to advance human welfare or endanger it, and what to do about it, remains wide open.

Also missing is an overriding imperative that guides specific human-serving values and helps to establish action agenda. Preventing Hell on Earth, with a continuously developing scope, is proposed as an overriding imperative, as expounded in this essay.

Moving on to the realistic aspect, I have grave doubts on crucial assumptions concerning human beings, as well as unavoidable power structures, which nearly all discourse on a human-centered paradigm takes implicitly for granted. I discuss these below.

Furthermore, as far as I understand the publications and declarations dealing with the human-centered paradigm, the time horizons dealt with are not clarified. This undermines their essential realism by permitting "mental time travel" into undefined futures, which are far beyond maximum foresight abilities, and thus make the vision, at least in part, more an exercise in fantasy than creative but action-oriented contemplation. Therefore, I start my substantive discourse by proposing a phased time horizon.

Phased Time Horizon

The time horizon which I suggest for the paradigm is between the near future, say ten years, and a maximum of about eighty years, divided into phases to fit specific domains under consideration.

Publications on expectations for the 20th century written around the end of the 19th century were completely wrong. All the more so, outlooks presuming to cover the rest of the 21st century are at least very doubtful, and most likely largely mistaken, because of the accelerated rate and the steeper degree of non-linear and contingent change, and also some phase jumps, adding up to the beginnings of a largely opaque metamorphosis of the human condition.

Still, an effort, however provisional, to engage in thinking about the future, preferably in the form of more or less possible and in part likely alternative futures and their drivers, is of critical and perhaps fateful importance, because of emerging dangers in addition to novel opportunities that require proactive creative adjustments, most of which have to be radical rather than incremental.

Cascading into metamorphosis with habits, institutions, and frames of mind largely fixated on rear mirrors is very dangerous. But dreaming of a never-never future will not help. Therefore, I adopt a time horizon long enough to encompass radical transformations foreseeable in part as in-between possible and likely (to use multimodal logic terminology), but short enough, taking into account the longer life expectancy of humans, not to get lost in too much speculation. Thinking and acting in time frames of between about 10 and 80 years probably meet more or less these criteria.

Even within this relatively short time horizon range, presently inconceivable events and processes are likely, resulting in harsh transition crises. Gearing up for them and for using the crises as opportunities for necessary radical innovations that are not feasible without reality-undermining events is essential and should be included in all humanity-centered paradigms. Thus, a mass-killing conflict using mutated viruses may clear the way for setting up a strict global security regime.

However, a longer time horizon is a must when we move from a human-centered paradigm to a human species-centered paradigm. This adds the long-term imperative to prevent any action that endangers the very existence of the human species, together with being very cautious about human enhancements that may change basic features of the human species.

Emerging technologies are likely to provide tools that may result in the end of humankind in one way or another (as studied, inter alia, at the Oxford University Future of Humanity Institute), in addition to the continuing possibility of nuclear self-destruction and escalating damage to the environment. Therefore, I suggest that these imperatives be added with absolute priority to any human-centered paradigm.

Rigid Realities

I have serious doubts about underlying assumptions on human beings on which the proposed WAAS paradigm seems to rely, however un-explicated. As a mood-setter, let me take up for a critical look a widely accepted recommendation that illustrates a dangerous neglect of stubborn facts that should be regarded as rigid, at least within the proposed time horizon.

The idea of a global parliament elected democratically is often discussed as if feasible in the foreseeable future. But to demonstrate the illusionary nature of such thinking for at least the next 80 years and probably much longer, it is enough to mention the demographic fact that a global body elected according to the democratic principle of one person – one vote would be completely dominated by a few Asian countries. China, India and Indonesia alone add up to about 40 percent of humanity! This clearly would not be acceptable to most of the global powers, rightly so given present and foreseeable states of being of large parts of humanity, in addition to undermining the pluralism of composition in terms of civilizations needed in a global parliament.

Mobilizing massive grass-root support for measures essential for the welfare of humans is important and perhaps essential. Limitations on both nuclear weapons and climate-changing activities have benefitted from bottom-up pressures, however inadequately so. But most of the emerging dangers to humans and the species as a whole are very complex, as are the required countermeasures. Thus, the potential dangers of AI are hotly debated and what can be done about them is far from clear, all the more so as AI can provide enormous benefits for humankind. The same is true, *mutatis mutandis*, for synthetic biology and, most challenging of all, for human enhancement.

It is hard to imagine that large parts of humanity will understand the complexities of such domains, which tax to the utmost the capacities of the minds of outstanding philosophers, scientists, and other highly qualified thinkers. Mass petitions and referenda on them cannot, therefore, make sense within the proposed time horizon. This illustrates critical issues on which only a very small percentage of humanity can express plausible opinions; and, much worse, on which politicians who lack any real understanding of the issues and what is at stake will have to make decisions impacting on the future of generations to come.

Critical for crafting human-centered paradigms are foundational assumptions on human beings. In particular, it is very dangerous and perhaps fatal to base a realistic vision on much too optimistic views on human beings while ignoring or underrating dangerous propensities built into them, as revealed throughout history and exposed by many psychological and sociological studies.

Without underrating the great importance of altruism, artistic creativity, advances in widely accepted humanistic values, and other achievements of humanity over its history, which has its own ups and downs, let me focus on seven examples of very disturbing cardinal proclivities of the vast majority of human beings, as individuals, groups, and societies:

1. Human beings have a dangerous propensity to regard it often as their moral duty to kill other humans, and also sacrifice their own lives in order to do so. "True believers" and fanaticism demonstrating this propensity are an integral part of human history and show no sign of disappearing or at least abating.
2. Human beings seek power and superiority, wanting to be the chosen and special, while being envious of others who do so and often hostile towards them.
3. Greed for more of what one or others like is a very strong attribute.
4. Tribalism, in the sense of distinguishing between "us" and "others," frequently accompanied by hostility to different others, is widespread.
5. Humans seek leaders, look up to them, and follow them in doing good and often evil.
6. In collectives, mass psychology phenomena take over, many of them full of dangerous potentials. Hopes that social networks and other Internet collectives will reduce collective vices have not been realized, the opposite being just as likely.
7. Even the most civilized of groups and societies seek enemies to blame and show signs of barbarism when put under pressure. The reaction of some of the European countries regarded as the most liberal of all to the influx of Moslem immigrants is just a relatively small indicator of how thin the veneer of civilization often is.

I do not presume to go in this short essay into the deeper layers of such features and their causes, as discussed, but not satisfactorily explained, by evolutionary psychology, genetics, depth psychology, and so on. Most probably they are animalistic features built into humanity by evolutionary processes, which can also metaphorically be viewed as a kind of original sin. But one point needs emphasis: efforts to change such basic propensities into what is regarded in different periods and places as better ones by education have not proven themselves. Even totalitarian efforts to produce a "new human being" have failed dismally.

It would be too pessimistic to conclude that dangerous human propensities are immutable. During about 800 to 200 BCE there occurred in China, India, and the Occident the so-called Axial Age, which transformed human self-understanding and transcendental views in ways still dominating most civilizations. It may be that a second axial age is in the making, driven by the capacity of humanity to destroy or transform itself, hopefully together with future peak value creators, transforming relatively rapid human self-understanding for the better, though this is far from assured. But this is too much of a speculation to serve as a basis for a new human-centered paradigm.

Alternatively, human enhancement by chemical or genetic engineering, with all its dangers, may enable reengineering that reduces dangerous human propensities, though the risks of doing so are surely very high. But as long as human propensities are as they have been throughout the history of the species, and as they surely will be within the proposed time horizon and probably for much longer, all proposed paradigms must take them seriously into account. This is not done in most human-centered paradigms, which therefore suffer from a lot of wishful thinking, which makes them at least partly into nice utopian fantastic visions but not reliable foundations for action.

Priority to Preventing Hell On Earth

The considerations above lead to the need for much humility in proposing human-centered paradigms, which should limit their ambitions and concentrate first on what is most important. Accordingly, I propose as a top priority for human-centered paradigms what Dag Hammarskjöld called "preventing Hell on Earth."

Human history is full of examples of Hell on Earth, taking the forms of mass slaughter, slavery, extreme deprivation, forced conversion, and eliminationism. Luckily, as mentioned, this is only one side of the ledger. Altruism, cultural and scientific-technological creativity, rising standards of human development, and progress in acceptance of some humanitarian values also characterize human development. Therefore, there is hope that human history may be progressive in some sense and will spontaneously produce a better world, aided by selective human interventions and, unavoidably, also be very painful transition crises. But this is far from certain, dismal futures being no less likely.

Still, one might feel relatively sanguine about the future of humanity were it not for some drivers of the future that are very likely to increase Hell on Earth unless counteracted with quite stern and, in part, painful measures. Paradoxically, it seems that despite all their enormous blessings it is science and technology that are the likely drivers of more Hell on Earth, accompanied by malignant value transformations driven in part by science-and-technology-caused disruptions and crises.

Let me provide a few illustrations:

- Synthetic biology and soon quantum biology will enable engineering of viruses, including mass-killing ones likely to be used by fanatics or to get loose by accident. Comparable in results, autonomous killer robots are likely to become widely available, taking in part the forms of drones that easily reach everywhere, enabling targeted assassinations and also impersonal mass slaughter.
- AI-equipped robots together with molecular engineering will break contemporary employment patterns leaving most of humanity without work, in contrast to all of human history. Even if economic consequences are mitigated by minimum assured income and a basic universal personal allowance, the results of mass leisure time are unknown. Hopes that it will be used for cultural creativity, or at least harmless virtual lives on computers, have no stronger basis than apprehensions that with more time to think on the certainty of death humans will seek beliefs providing contents and meaning to life, which may well be in part fanatic ones.
- Human enhancement may prolong high-quality life expectancy, but may also enable production of super-humans devastating all ideas of human equality. Super-warriors may increase mass killing. And, should life be

> synthesized artificially, basic religious beliefs and many values based on human dignity may be undermined, together with other inconceivable moral and immoral consequences.

Even under very optimistic assumptions, serious and in part probably quite catastrophic transition crises are probably unavoidable. As shown by historic case studies, such crises and their accompanying traumas, disorientations, and feelings of being lost and having no control over one's life, tend to produce new value systems, often aggressive ones that seek the guilty. These, in turn, increase the likelihood of mass killings using new slaughter technologies creating more Hell on Earth.

Essential Counter-Measures

Given the growing potential for more Hell on Earth, effective counter-measures are a must. They are all the more essential because what may be at stake is not only the welfare of humans, but also the very existence of humanity as a species. Enough to consider the low probability, but fateful impact of a sect believing that humanity should be eliminated so as to let nature and Mother Earth take over, and of such a sect including an outstanding bioengineer synthesizing a virus likely to kill most of humanity, in order to realize that stern counter-measures are essential. Less fateful but still disastrous Hells on Earth, quite likely to come, can be handled with less extreme measures. But fatal contingencies endangering the survival of the human species must not be ignored in any human-centered paradigm.

Let me add an example of a very problematic plausible possibility, though probably beyond the proposed time frame: Humanity may develop the capability to "create" a *Homo superior* species, even if long-term consequences are inconceivable and may include elimination of *Homo sapiens* in its present forms. This illustrates that, thanks to human ingenuity in science and technology, what was considered as impossible may become a real option, but an option that human values, institutions, and leaders as now constituted, and also most of the reforms being proposed, are totally unqualified to consider seriously. Returning to my time horizon, let me illustrate some essential measures of what I call humanity-craft (in distinction from statecraft) for taking care of what is critical for "raison d'humanité" (overriding raison d'état) focused on preventing Hell on Earth.

- Limitations on research and technologies that can be used for mass-killing and related atrocities, and on the diffusion of their findings and tools.
- Inhibition of alleged prophets and other leaders advocating acts producing Hell on Earth, such as attacks on non-believers.
- Restriction of possession of mass-killing instruments and other means of large-scale violence to global authorities subjected to strict supervision.
- Arbitration and, if necessary, imposed solutions of intractable conflicts which have the potential to produce Hells on Earth.
- Obligatory transfer payments between countries and a global progressive capital tax to help eliminate extreme deprivation worldwide.

- Global surveillance to identify humanity-endangering activities, while otherwise preserving privacy.
- Universal obligatory two or three years of humanity-service by all 18 to 22 year olds, to help and build a global sense of communality.

To be added, as mentioned, is extreme caution on human enhancement, with much more attention given to it than in most discourses on a new human-centered paradigm. At the very least, and as a preliminary step, strictly enforced global regulation of all human enhancement research and activities is essential, together with prohibition of work dealing with explosive subjects such as human cloning, till a widely agreed global ethical code on human enhancement can be formulated and strictly enforced, subject to periodic revisions.

Enforcement

Such essential measures require imposition of laws, rules, regulations, transfer of resources, and surveillance, often on the unwilling. Therefore, what is needed is the establishment of a circumscribed global power structure able to enforce essential measures, subject to strict oversight against misuse.

Let me emphasize: we cannot rely upon willing compliance. Scientists may agree to follow an impressive code of professional ethics, but a few are sure to break it. Countries may sign a global covenant to follow agreed humanity-craft norms, but some of them are likely to seek a secret advantage by developing powerful mass-killing weapons or dangerous high-value technologies. Companies may agree not to market risky knowledge and tools, but some are sure to seek an extra profit by doing so. Therefore, an effective global enforcement regime is essential.

In the best of cases, the essential global enforcement regime will be headed by bodies reflecting (but not representing in the democratic sense) main civilizations, continents, and states, and will enjoy broad grass-roots agreement. But, unavoidably, within the postulated time horizon only a global authority composed of the main powers, headed by China and the United States (I put them in alphabetic order) may become feasible – probably as a result of substantive, but hopefully not too devastating, calamities.

With time, the global authority can and should be based on a coalition of the willing, in line with Kant's perpetual peace proposals. And, in a future beyond the proposed time horizon, a more representative composition of some organs of the global authority should be instituted, including some experimentation with novel approaches – such as selecting globally members of an organ, advisory at the beginning, by lot, so as to reduce the prevalence of power-hungry, manipulative, low-grade politicians. But this is far beyond the proposed time horizon.

Neither obsolete conceptions of sovereignty and equality of states, nor resistance by the unwilling, whether states or non-state actors, nor grass-root opposition must be permitted to hinder establishment of the required global authority as soon as possible, and effective action by it. Measured but decisive application of force by the global authority, after due warning, to enforce main humanity-craft measures globally is essential. Reliance on good will, public pressures, bottom-up support and so on, however desirable, is an illusion unless backed by overwhelming enforcement.

Upgrading Political Leaders

Proposals to reduce the impact of the few on the future of the many are another of the delusions accompanying parts of the deliberation on a novel human-centered paradigm. Leaving ways to achieve such a transformation of human societies to some unspecified *deus ex machina* adds nothing to the credibility of such ideas.

Unless a quasi-anarchistic form of living together can be designed for the billions of humans populating the world, which is very unlikely for *Homo sapiens*, though perhaps possible for a hypothetical *Homo superior*, power hierarchies, with all their dangers, are essential for maintaining safety, law, justice, and other conditions of civilized existence and for the overall thriving of large scale civilizations.

Throughout human history, very few persons have had much impact on the future of multitudes in art, science, the economy, war and peace, religions and ideologies, and governance. This is sure to continue, at least within the proposed time horizon, and very likely for much longer. But a crucial question must be faced: who among the relatively very few shaping large parts of the future of the very many have the legitimacy to do so, especially with respect to radically innovative and necessarily controversial humanity-craft measures. The answer, for better or worse, is political leaders. It is political leaders who are the extremely few, within the very few who impact most on the future of humans, who, despite all their dangers, are crucial for preventing Hell on Earth.

To avoid catastrophes, including much Hell on Earth, and to increase the likelihood of pluralistic human thriving, it is absolutely essential to assure a much higher level of moral, mental and volitional qualities of political leaders.

This is not only a stubborn fact. In terms of political philosophy, only duly selected political leaders have the legitimacy and also duty, within elaborate safeguards, to make the humanity-craft critical choices impacting most on the future, including preventing Hell on Earth. Their freedom in making decisions is shaped and limited by a variety of social actors. But, still, political leaders are the agency having very large and often determinative weight in impacting on the future, as far as depending on deliberate human choice.

However, if we ask ourselves if political leaders as presently constituted are qualified to make such choices wisely, the answer is a loud and clear “No!” With very few exceptions, they are clearly very underequipped morally and cognitively to do so.

This leads to a far-reaching conclusion: To avoid catastrophes, including much Hell on Earth, and to increase the likelihood of pluralistic human thriving, it is absolutely essential to ensure a much higher level of moral, mental, and volitional qualities of political leaders.

Therefore, I find the lack of attention to the fateful importance of politicians and the need to upgrade radically their qualities in nearly all discourse on human-centered paradigms not only disturbing, but also very dangerous. No talk and no daydreaming will make politicians less important for shaping the future within foreseeable time horizons. On the contrary, because of the increasingly critical and also fateful portent of many collective choices, political leaders are sure to become more important as future-impacting actors. Ignoring them because much of actual politics causes nausea is understandable, but inexcusable. It imperils the future of humanity.

This leads to the key question of what can and should be done to upgrade the salient qualities of political leaders significantly. While my writings include a number of concrete proposals, they are inadequate. Available literature, as far as I have checked, includes even less. Clearly needed is focused, creative thinking on ways and means to upgrade political leaders. WAAS and related groups, such as the Club of Rome, should set up a number of thinking groups, with carefully selected membership having diverse life experiences, multidisciplinary knowledge, and pluralistic creativity, to ponder ways to upgrade the quality of political leaders worldwide, in private, without premature mass media exposure. At the same time, all public discourse on human-centered paradigms and related subjects should have on its agenda as a central theme the need to upgrade the quality of political leaders radically, so as to build up public support for concrete action when good ideas on how to do so and opportunities to realize them emerge.

The prime responsibility for being a high-quality political leader and developing necessary qualities is yours, not that of your genes and environment.

To stimulate such endeavor, let me shift gears and conclude with some relevant ideas in the form of a Code of Ethics for Political Leaders (excerpted, with some changes, from my book on avant-garde politicians).

But, first, let me emphasize that spiritual leaders are not less and often more important, though in other ways. They require separate consideration, which is beyond the scope of this essay.

Code of Ethics for Political Leaders

1. Regard being a political leader as a calling, destiny, mission, and engagement of central importance for all of your life and personality. Preventing Hell on Earth and creating a better future for humans worldwide are at the core of your extraordinary mission, together with the ordinary missions of political leaders at your time and place. In particular, the extraordinary mission makes your political leadership into an exalted endeavor of profound significance. It is far better to resign or lose your position than betray it.
2. Your missions require outstanding qualities. Their constant development, evaluation, and upgrading are an absolute duty of yours. This requires constant soul searching, permanent learning, and a lot of contemplation, much of which is possible only when you are alone.
3. As a political leader, you are constantly exposed to many corruptive influences and temptations, mainly stemming from possessing power. Accordingly, you must engage in constant self-monitoring and self-restraint, however demanding and painful.

4. In all activities relating to your missions, do not let personal considerations intrude.
5. Behave in your personal life in ways fitting a political leader in accordance with the highest standards of morality accepted in your society, without claiming privacy rights and personal privileges not necessary for your missions.
6. The strictures above apply also to your family. All of you have to be above suspicion.
7. Your mind is what makes you a political leader. You should focus on it and its upgrading so as to acquire and constantly to improve its core qualities essential for your missions. Remember, the prime responsibility for being a high-quality political leader and developing necessary qualities is yours, not that of your genes and environment.
8. Pondering, deciding, and acting are at the core of political leadership. Focus on them instead of trivia.
9. A critical facet of your mind is your conscience, including your values with special attention to raison d'humanité, as adjusted to your concrete circumstances as evolving with time, in part as a result of your endeavor. They should operate as a kind of second self in your mind, what Socrates called his daimon, whom you constantly consult.
10. To acquire and maintain the power essential for your missions, you have no choice but to behave according to a public-interest version of Machiavellianism. But you have to keep such behavior to the essential minimum and take great care not to enjoy it.
11. You are a social animal, largely shaped by your location in space-time. But you can and should strive for maximum autonomy of your mind, as needed for thinking and acting as an innovative political leader.
12. You are duty-bound to engage in your missions to the best of your ability and on your responsibility. You should take public opinions into account on their merits, but not be enslaved by them.
13. Have the courage of your convictions, willingly risking your position and also your life if this becomes essential for your missions. "Here I stand, I cannot do otherwise" is the principle that should guide you in your mind and behavior when critical issues are at stake.
14. If illness or other causes impair your qualities as a political leader, as judged by your physicians and spiritual advisors, you have to leave your position, temporarily or permanently as the case may be.
15. If, for political reasons, you cannot implement critical parts of your missions, you should resign rather than cling to power.
16. Do not let your family, friends, and acquaintances interfere with your missions. Resist and reject any emotional pressure they may put on you.
17. Be very careful while selecting knowledgeable and reliable advisors and encourage them to remonstrate with you. Seek ideas from creative persons. Consult on difficult moral dilemmas carefully chosen spiritual

advisors, however called. But insist on confidentiality and keep away all engaged in much ego-promotion.

18. Consider carefully the many tragic choices you face, but do decisively what is necessary to prevent Hell on Earth and improve the state of humans.

19. Accept full responsibility for your errors and failures, by feeling and showing shame, and making a maximum effort to draw lessons from them.

20. Learn from criticism directed at you, without hostility towards the critics.

21. You should do all you can to influence other political leaders to improve themselves constantly and to accept prevention of Hell on Earth and improving the state of being of humans worldwide as an extraordinary mission, in addition to their ordinary ones.

22. It is your absolute duty to act against evil politicians and to get rid of them.

23. Cultivating political leaders for the future is an important task of yours, both while you are in office and afterwards. Remember that you can die or be incapacitated without advance notice, so mentoring worthy successors should not be delayed.

****

***About the Author*:** Yehezkel Dror is Emeritus Professor of Political Science and Wolfson Chair Professor of Public Administration, Emeritus, The Hebrew University of Jerusalem. yehezkel.dror@mail.huji.ac.il.

Editors' Notes: Yehezkel Dror's career as a co-founder of The Policy Sciences and its most distinguished scholar has produced fifteen books and a huge set of professional journal articles on the improvement of public policy making. His publications include book chapters and journal articles on governance for humans in Space. This article is part of a trilogy of articles in this Fall 2015 issue focusing on the pathologies of human behavior throughout Earth's history and the need to prevent those human behavior failures from destroying human exploration, development and settlement in Space; the other two articles in that trilogy are those of Stephanie Lynne Thorburn and George S. Robinson. Dror here provides both description and prescription for a human-centered paradigm for Earth that avoids the bad while achieving the good, His realistic assessment of humans on Earth will be important for leadership designing Space futures. His identifying the need for an overriding imperative that guides specific human-serving values and helps to establish action agenda should be a priority for Space planners. ***Bob Krone and Gordon Arthur.***

Journal of Space Philosophy 4, no. 2 (Fall 2015)

Becoming Spacefaring: America's Path Forward in Space

By James Michael "Mike" Snead

Abstract

Fundamental to a nation's national security is energy security. The United States is substantially energy insecure, and this energy insecurity is growing. A barrel of oil equivalent (BOE), representing the energy content of 42 US gallons of oil, is a convenient measure of energy resources, production, and consumption. In 2010, with a population of 309.3 million, the United States consumed 18 billion BOE of energy, with 85% coming from fossil fuels. By 2100, with a likely population of 617.5 million, the United States will need 31 billion BOE of energy. Fossil fuels cannot meet this demand. Hence, the United States must switch to sustainable energy. This will take decades and cost tens of trillions of dollars. The only practicable option is space-based solar and nuclear power, most likely from geostationary Earth orbit, and transmitted to ground receiving stations. To become energy secure with sustainable space-based power, the United States must begin a spacefaring industrial revolution and become a true, human, commercial spacefaring nation. A substantial, airline-like spacefaring infrastructure must be built throughout the Earth-Moon system to support this new and substantial space-based power industry. The presidential policy changes needed to pursue space-based power and the spacefaring industrial revolution are discussed.

Keywords: United States, energy security, immigration policy, technically recoverable fossil fuel resources, White's Law of Cultural Survival, standard of living, space-based power, space solar power, spacefaring, space policy

I. Introduction

America's energy security and national prosperity is in very serious jeopardy. As everyone understands, affordable supplies of oil, coal, and natural gas are the lifeblood of America's prosperity—providing about 85% of all the energy consumed in America. Yet, these are non-renewable energy sources, as everyone also understands. While the Earth has large amounts of these fuels, only that portion that can be recovered safely can be used. This technically recoverable portion is called the endowment—recognizing that it is a gift from nature. The US Geological Survey (USGS) has estimated the remaining technically recoverable endowment of known and yet-to-be-discovered oil, coal, and natural gas and this is far less than what is needed to sustain America through the end of this century.

This shortfall creates a serious American energy security crisis that is foolish to ignore. The era of affordable fossil fuels will end this century during the lifetimes of our children and grandchildren, placing their security and wellbeing at great risk. Despite a half-century of national political awareness of our fossil fuel insecurity, there is no rational national program underway to develop sufficient practicable sustainable energy replacements before affordable fossil fuel scarcity takes hold. This is alarming! Clearly, new sustainable energy sources must be found to replace fossil fuels. The cost will be in the tens of trillions of dollars. This is fundamentally a political issue regarding priorities, policies, and allocation of resources. America's political leaders largely do not even understand that there is an energy security issue with unavoidable serious consequences. In short, with respect to national energy security, America is dangerously in the dark.

Our ability to harvest fossil fuels is a function of technology and market price. When our technology is no longer able to extract fossil fuels at a price and in the quantities needed for a healthy economy, serious consequences follow because affordable electricity and fuels are the lifeblood of any modern civilization. The coming end of the era of affordable fossil fuels means that serious strife is in America's future unless we undertake significant steps to replace fossil fuels with new, sustainable energy sources and do this rapidly enough to have a smooth economic transition. Achieving this smooth transition will not be easy, quick, or inexpensive. It will take generations and will require a significant percentage of the gross domestic product throughout the remainder of this century. Most importantly, it will require that the United States become a true, commercial, human spacefaring nation, as the only practicable source of sustainable energy in sufficient quantities will be from space-based sustainable power systems.

The purpose of this article is to explain quantitatively why the era of affordable fossil fuels is ending, what the consequences will be if no effective transition plan is undertaken, why space-based power is the only real solution, and what initial policy steps should be undertaken by the next president to begin to resolve this crisis.

II. The Vital Importance of Affordable Energy Security

The abundance of energy in America, particularly inexpensive gasoline, has made Americans unappreciative of the importance of energy security. A reasonable person understands that ignoring vital needs has serious harmful consequences, but this is exactly what most people do with respect to energy security. They take for granted that they will have electricity, natural gas, and gasoline at prices they find affordable. Thus, the appropriate starting point to understand the need for space-based sustainable energy is to establish the importance of affordable energy security. Everyone understands the vital need for water security, food security, and shelter from the weather. Everyone now needs to understand firmly why energy security is also vital.

A. How Energy Influences How We Live

Anthropologists study how people live or have lived. They seek to find out what makes civilizations work or fail. This research now shows that the affordable availability of energy plays a major role in civilizations surviving or collapsing. Without sufficient food (human-consumed energy), the population will starve. Without sufficient electricity and fuels, a modern industrial society will collapse. White's Law of Cultural Survival is at the center of America's energy security crisis and its future cultural survival. Yet, few understand its significance or have even heard of it. Hence, to understand the central premise of this paper of the need for America to address its energy insecurity politically, it is very important to understand White's Law. Fortunately, it is easy to grasp.

Using his studies of ancient civilizations, the fundamental energy-related paradigm of modern civilization was defined by American anthropologist Leslie White in the 1940s. He defined what is referred to herein as While's Law of Cultural Survival. This law defines the paradigm—a society's rules for success—relating energy and technology to the society's standard of living.

The starting point is to understand clearly what White means by "culture". He defined culture as the "tools, implements, utensils, clothing, ornaments, customs, institutions, police, rituals, games, works of art, language, etc."[1] In other words, culture is our standard of living. A civilization ascending is increasing its standard of living; a civilization in decline is losing its standard of living. Think of the decline of the Roman civilization where, in a very short time, the Romans lost the "how to" knowledge and capacity to function in ways that they had developed over centuries.

Now for his use of "energy." Energy, as White uses this term, is "the capacity for performing work."[2] White uses this term in a very general way. For most of human history, the work he speaks of was derived from the muscles of humans and animals. Food was the source of this energy. Today, it is modern fuels and electricity.

White's research into ancient civilizations found a critical relationship between the level of culture of a civilization and the availability of affordable energy. He established that "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 technology.

This is summarized in 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.

White's Law is expressed in the form of a symbolic relationship:

$$\textit{Energy}_{\textit{per capita}} \bullet \textit{Technology} \rightarrow \textit{Culture or standard of living}$$

White's Law is not a true mathematical relationship. The symbol "•" does not signify multiplication but only "interaction." The law indicates that the use of suitable forms of energy, using appropriate technologies, produces the civilization's culture. Especially in modern times, White's Law is essentially the law of cultural survival governing all modern

---

[1] Leslie White, *The Evolution of Culture: The Development of Civilization to the Fall of Rome* (New York: McGraw Hill, 1959), 3.

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

[3] White, *Energy and the Evolution of Culture* (New York: Grove Press, 1949), 111.

civilizations, including America. As will be discussed, it often determines if a nation goes to war.

As seen in White's definition, energy per capita—how much energy is used per person per year—is the proper metric to which attention must be paid. The standard of living is an expression of how well the average person lives. Hence, White's Law is related to how much energy is used directly and indirectly by the average person.

A good way to look at White's Law is by rewriting it incrementally, relating how changes in energy used per capita and changes in the technology available produce changes in the standard of living.

$$\Delta E_{per\ capita} \bullet \Delta T \rightarrow \Delta C_{standard\ of\ living}$$

Using White's Law, the relationship between energy, technology, and warfare can be examined.

B. Taking the Threat of Future Fossil Fuel Wars Seriously

Throughout most of human history, the ability of a civilization to ascend against its rivals was closely tied to its ability to produce sufficient excess food to sustain its army and, in times of peace, to undertake government construction efforts, increasing the standard of living. Egypt became a leading nation five thousand years ago as it harnessed the vast food production capability of the Nile River valley to provide food wealth to its rulers. This was used to develop a powerful nation, fielding strong armies and undertaking vast building programs. Later civilizations clearly understood the importance of having large, secure food resources by conquering Egypt first in order to use Egypt's grain production to feed their armies. Alexander the Great did this, as did the Romans. In those times, an army literally traveled on its stomach.

In the 1800s, the technology of steam power ushered in the industrial age. Steam power freed human civilization from the limits of muscle power or water power, enabling greater economic or military output per unit of human effort. After a fairly brief period where wood was the primary fuel, affordable supplies of wood fuel were soon exhausted and the world transitioned to fossil fuels to power the industrial age—first coal, then oil, and finally natural gas. Using White's Law, the increasing per-capita use of fossil fuels and improving mechanical powered technologies is expressed as:

$$\Delta E_{fossil\ fuels} \bullet \Delta T_{mechanical\ power} \rightarrow \Delta C_{standard\ of\ living/military\ capability}$$

Unfortunately, the distribution of fossil fuels is based on the growing conditions on continents hundreds of millions of years ago. What the transition to fossil fuels meant was that most of the world's developed nations—historically having existed in locations favorable to pre-industrial agrarian cultures—were suddenly in the wrong place. Nations wishing to modernize and industrialize found themselves domestically short of the modern energy and other natural resources necessary to become technological nations embracing the new ΔE and ΔT. What they needed, they soon realized, was to be elsewhere or, more accurately, to extend their political and military control elsewhere. In short, they needed empires. This situation became especially acute when oil became the primary fuel for transportation, making mechanized land and air warfare common in the early 1900s. Nations going to war on horses—as had been done for thousands of years—were easily dominated by nations having oil and mechanized warfare capabilities. Oil and mechanized warfare elevated the military culture of some nations while leaving the have-nots at their mercy.

As World War I (1914-1918) unfolded and the advantages of oil-fueled warfare became clear, those without oil quickly recognized their weakness. Beginning with World War II, the military control of oil has become the central theme of military hostilities. Control the oil and your military has its hand at the throat of all the other nations dependent on that oil supply. Germany, with limited domestic oil resources, understood this. Its military invasions of North Africa and Russia early in what became World War II were aimed at seizing the oil fields of the Middle East and southern Russia. By controlling the oil, Germany could have forced other nations, such as Britain and Russia, to suffer the consequences of dramatic ΔE decline, directly impacting their ability to wage war. Even though these nations still retained the mechanized warfare ΔT, this was just junk without oil. Germany tried to use White's Law of Cultural Survival as a tool of warfare. Millions of lives were lost in this attempt.

Japan, also with few domestic oil resources, as well as most other needed industrial natural resources, undertook military conquest of the Pacific to secure the needed oil and other resources. Japan, which did not begin to modernize until the 1860s, quickly recognized its natural resource shortcomings. By the early 1900s, to the surprise of many, it had become the preeminent modern military force in the western Pacific by defeating the Russian military in two decisive land and naval engagements.

Japan's attack on Pearl Harbor was directly tied to its need for oil. In the 1930s, the United States was the world's primary exporter of oil, supplying the bulk of Japan's oil. Cutting off Japan's oil was a measure used by President Roosevelt to try to force Japan to curtail its military conquests, especially after brutal attacks in China. Instead, what this oil embargo accomplished—most likely unavoidably—was an expansion of war in the Pacific, as the then highly militaristic Japan was unwilling to cede to these demands. Japan hoped that a quick strike on the US Navy, then stationed at Pearl Harbor, would cripple US military capability in the Pacific, giving Japan the upper hand. The attack failed because the US Navy's aircraft carriers were out to sea at the time of the attack. Millions died in the Pacific theater as Japan, driven by White's Law of Cultural Survival, tried to secure its vital oil and other vital industrial resources.

With the end of World War II, Middle East oil became a central focus of the Cold War between the United States/NATO and the former Soviet Union. By the end of World War II, the United States recognized that Middle East oil would be needed to replace declining domestic oil resources. The Soviet Union, even though it had substantial oil resources and is a major oil exporter today, also recognized that by controlling the Middle East politically it could control/influence the countries becoming increasingly dependent on these immense oil resources, including the United States. From the 1950s on, although often cloaked as religious conflicts, much of the turmoil in the Middle East has really been about the control of oil and the world political power this enables. Millions have died in the various wars and conflicts that have taken place in the Middle East. In a region of the world that has little industry, oil is the foundation of national and individual wealth and political power.

The anticipated US need for Middle East oil, dating back to World War II, came true in 1970. That was the year when domestic oil production peaked—as projected by American geochemist M. King Hubbard in the 1950s. He introduced the concept of "peak oil". This is when locating and exploiting new oil and gas deposits lags behind supplying a growing domestic oil demand due to an increasing population and an increasing oil-fueled standard of living—two-car households, suburban living, better cars, interstate highways, etc. Although the United States had been importing Middle East oil into some markets since the 1950s, domestic production was still then increasing. After domestic production peaked in 1970, the imported percentage of total oil consumed rose dramatically—from 9% <u>of total fossil fuel use</u> in 1970 to 18% in 1973, just three years later. For the first time in their history, Americans were substantially energy insecure, bringing White's Law quickly into play.

In 1973, as the third Arab-Israeli war broke out, Arab oil-producing countries used the growing US dependency on imported Middle East oil to punish the United States for supporting Israel following the surprise Arab attack. The United States initiated a massive arms airlift to replenish Israeli stocks of arms. Within two days, Arab oil producers, using the same rationale as did President Roosevelt when he embargoed oil to Japan, placed an embargo on exports of oil to the United States, creating a domestic oil supply crisis. It is now fairly well understood that the rapid response of the United States to support Israel, when it was suffering early heavy losses, was undertaken to prevent Israel from using its nuclear weapons in its defense. The Arab countries, perhaps not understanding the seriousness of the situation, attempted to use White's Law of Cultural Survival against the United States by creating a significant ΔE reduction to harm the US economy. This brought substantial oil price inflation in the United States, long gas lines, the threat of gas rationing, and a temporary recession <u>just four years</u> after the United States had been substantially energy secure! The awareness that the US president decided to have the United States endure this to prevent the likely use of nuclear weapons has only recently come to light.

In 1979, Iran again came to center stage as the monarchy, supported by the Western countries, was overthrown by revolutionary forces supported by the former Soviet Union. American hostages were taken at the US Embassy, precipitating hostilities between the US government and the new Iranian government that have continued ever since. One consequence of the revolution was that Iranian oil production fell dramatically. As Iran was then a major world oil supplier, this created a worldwide oil supply shortage. In 1978, imported oil provided 24% of the total US fossil fuel consumed. To counter domestic shortages, price controls on domestic oil were lifted. The market price of oil rose 250% within two years, creating a major recession, high unemployment, high inflation, and high interest rates. The economic impact of the recession lasted nearly a decade. At the bottom of the recession in 1982, imported oil had fallen to 11% of total fossil fuel use, while total fossil fuel energy use declined 13% from 1978 to 1982. US unemployment rose to 11% in 1982 from just under 6% at the start of the crisis in 1979. The impact of White's Law on the US standard of living and nearly all American families was very much evident.

It is very important to understand the US economy's sensitivity to market-driven price increases resulting from even modest per capita ΔE reductions as the era of affordable fossil fuels ends. The oil supply crisis of 1979, as well as that of 1973, showed that White's Law is clearly negatively impacting an energy-insecure America. US per-capita energy consumption historically peaked at the start of both the 1973 and the 1979 oil supply crises. Per-capita energy use—a measure of economic health—fell immediately after the 1973 crisis as the recession and higher prices took hold. As the economy came out of that first recession, per-capita energy use had climbed back to just above the 1973 level when the Iranian crisis started a second recession. By 1983, as the second recession dragged on, per-capita energy use had fallen 13% from the 1979 peak.

The two oil-supply crises in America in the 1970s and the severe economic recessions they triggered are now largely forgotten. Recent Middle East conflicts in which the United States directly and substantially engaged are now viewed from the perspective of war and anti-war and not about the central political conflict to control vital Middle East oil resources. Most Americans simply do not understand that nations engage in deadly serious conflict to obtain or preserve their control of oil and that the history of past conflicts is a harbinger of what is to come as all affordable fossil fuels, not just oil, are exhausted in the coming decades. History ignored is often history repeated. It is obvious that any future fossil fuel scarcity will trigger warfare—perhaps nuclear warfare—as nations scramble to be among the winners controlling what available fossil fuels remain. The need for a better energy security "Plan B" is obvious.

C. Immigration Policy and Energy Security

Modern humans began to migrate from Africa as long as 100,000 years ago by some estimates. Australia was reached around 45,000 years ago and, by current understanding, the Americas were first reached perhaps as long as 40,000 years ago. Except for some small part of southern Africa that is likely our ancestral home, humans everywhere else are immigrants or the decedents of immigrants.

While human migration certainly came from an urge to explore, most previous human migration was likely undertaken in search of better security—improved protection from the weather and threats, potable water, and, especially, reliable food sources. Too many humans in one area extracted food at a rate exceeding natural replenishment rates. Soon hunger set in and everyone then had to migrate anew seeking new food sources. Eventually, humans became territorial, forcing those outside their tribe to migrate elsewhere to protect the tribe's food supplies. Elbow room to live was a survival instinct.

Three fundamental food-producing ΔTs enabled an increased population density—fishing, food animal domestication, and plant cultivation. These increased the per-capita food supply (ΔE) per unit of human effort. The increased ΔE enabled greater numbers of humans to live off a given area of fertile land, enabling an improved ΔC in the form of increased permanence and growing population size. With a rising per-capita food energy availability and greater security against famine, humans had the time to create more ΔT, enabling even more ΔC.

The key to any society's long-term success is a family with the ability to give birth to and raise the next generation. The amount of land necessary per family established the acceptable population density. To the extent of available fertile land, migrants were likely welcomed as they strengthened the civilization by increasing the number of people, total land area in food production, and diversity of skills. And, of course, highly skilled migrants—merchants, artisans, healers, warriors, etc.—were also likely welcomed because the improved food ΔT produced excess food enabling these skilled migrants to be fed in payment for their skills.

The invention of steam power, followed by electricity and the internal combustion engine, transformed human civilization because they enabled far greater food production per unit of human effort. The result was that the percentage of the population required to produce food fell dramatically. However, the "price" was the creation of an entire new energy dependency—that of the non-renewable fossil fuels necessary to fuel the engines. During the time when human and animal food powered civilization, this energy supply was renewable. The low population density, established by the annual food-production capacity of the land, also meant that obtaining wood for fuel was not generally an issue. However, with the advent of steam power, wood fuel became scarce, forcing the industrializing nations to transition to coal as a replacement.[4] Oil, in the form of kerosene for lighting and gasoline for engines, and natural gas for lighting and heating followed. For modern civilizations, the critical "food" supply became non-renewable fossil fuels. As discussed above, a world war was largely fought to control the preeminent fossil fuel—oil.

D. Migration Now Has a Negative Impact on Modern Civilizations

This change in civilization's "food supply" from human and animal food to non-renewable industrial fuel changed how migration impacts a society. Migration now adds demand for energy to an economic unit, such as a nation, without adding capacity to expand the non-renewable fossil fuel resources being used. This is an important difference from when human and animal food was the primary energy source. In other words, a modern new immigrant, unlike our immigrant ancestors, does not add to the nation's fossil fuel resources, but only increases the drawdown of these resources, creating a negative impact on the nation's energy security. This change in circumstance is not well recognized.

A corollary is the drought now severely impacting the western United States. Nature supplies potable water through rainfall and snow melt. These western states have historically had droughts, both short-term and long-term, due to weather changes. Some droughts have lasted for hundreds of years well before humans occupied these areas in significant numbers and well before the use of fossil fuels. Water engineering projects undertaken nearly a century ago created reservoirs, dams on distant rivers, and pipelines

---

[4] Britain, as an island nation with an increasing population, was an exception, switching to coal in the 1500s because of shortages of wood fuel well before it industrialized with steam power.

to redistribute water to enable short-term droughts to be covered. However, regional population growth, primarily through migration into the region, has increased the drawdown rate of the available storage, while insufficient rainfall and snowfall has failed to correct this situation. Drought, and the famine it generally causes, is a historical reason why civilizations collapse. Immigration during good times, which increases the local population, also increases the likelihood of turning an otherwise moderate drought into one with severe consequences for everyone. Hence. significant net immigration into such drought-prone areas is very clearly a poor policy for the simple reason that these new immigrants do not bring new vital supplies of water with them.

E. The Negative Impact of Immigration on US Energy Security is Substantial

Just as the western United States is seeing the negative impact of net immigration-driven population growth on the sufficiency of its engineered water supplies, the same is happening to the United States overall with respect to the decrease in the longevity of its non-renewable fossil fuel endowment.

White's Law stated in terms of per-capita energy use is:

$$E_{per\ capita} \bullet T \rightarrow C_{standard\ of\ living}$$

The standard of living is a function of the available affordable energy per person (per capita) per year. Obviously, the greater the total population, the greater the total annual energy needed by the nation to sustain its standard of living.

$$E_{per\ capita} \times population\ total = Annual\ energy\ needed\ by\ nation$$

For any country dependent on fossil fuels, population growth due to immigration increases its total future energy needs. Thus, for a nation primarily utilizing domestic fossil fuels, immigration creates a faster drawdown of the remaining non-renewable fossil fuel endowment, advancing the time when fossil fuels are no longer affordable. This will decrease the standard of living of everyone. The conclusion is drawn that the transition from an agrarian society to an industrial society switched the impact of net immigration from positive to negative in terms of energy security. This makes US immigration policy a national security issue.

F. The United States Has Limited Useful Fossil Fuel Resources Remaining

The Earth has extensive remaining fossil fuel resources. However, only that portion able to be recovered safely, legally, and affordably using available technologies counts towards satisfying White's Law.

The USGS tracks US natural resources and makes projections of how much known and <u>yet-to-be-discovered</u> oil, coal, and natural gas resources are accessible for recovery using available technologies. This is known as the "technically recoverable resources." In simple terms, this projection constitutes the natural endowment of fossil fuels available to meet America's future White's Law of Cultural Survival needs.

What about those people on TV saying that the United States has lots of fossil fuel? Yes, the United States has lots of fossil fuels. What it does not have, as will be seen, is lots of technically recoverable resources.

What about discoveries of additional fossil fuel resources? The USGS includes an expert assessment of yet-to-be-discovered resources in its estimate of technically recoverable resources. Hence, even though new discoveries are made, these are included already in the remaining endowment estimate.

What about improvements in fossil fuel recovery ΔT? Certainly, improved recovery ΔT will increase the size of the technically recoverable resources. Take, for example, the hydraulic fracturing (fracking) of oil and natural gas shale deposits. This technology, now deployed for less than a decade, has substantially increased the size of technically recoverable US oil and, particularly, natural gas resources. The first fracking of oil wells began shortly after World War II, but it was not profitable. It took nearly fifty years of research and development to bring this ΔT out of the lab into profitable commercial use. Therefore, it is reasonable to conclude that a comparable technology being started today may not see substantial commercial use for many decades. From a strategic energy security planning perspective, while new fossil fuel recovery ΔT should be pursued, it is not reasonable to "bet the farm" on it. Sound energy security strategic planning must have a reasonable confidence of success and most certainly must avoid presumptions that things will just work out. California's drought shows that things do not just work out.

In 2011, the Congressional Research Service published the USGS 2010 projection of the size of the domestic technically recoverable fossil fuel resources or endowment. (As this does not include the affordability of the fuels brought to the market, this is an optimistic projection of the size of the affordable fossil fuel endowment.) Per the USGS, in 2011 the United States then had 1,366.8 billion BOE of technically recoverable fossil fuels—just about 1.4 trillion BOE.[5] While this sounds like an almost unlimited supply, for a growing nation of over 300 million, it is not.

A BOE is a simple measure of energy representing the amount of thermal energy in 42 US gallons of oil. All energy sources, not only coal and natural gas, but also wind, solar, hydroelectric, nuclear, etc., can be expressed in terms of how many equivalent BOE they supply to the consumer.

Currently, the United States is consuming about 18 billion BOE of energy each year with about 85% or about 15 billion BOE coming from fossil fuels. At the current rate of fossil fuel use, assuming that all of this is taken from domestic sources, the total endowment of US technically recoverable fossil fuel resources would last 89 years—only to the end of this century.

$$18 \text{ billion/year} \times 0.85 = 15.3 \text{ billion BOE/year of fossil fuels}$$

[5] Carl E. Behrens et al., *US Fossil Fuel Resources: Terminology, Reporting, and Summary*, 7-5700, December 28, 2011 (Washington, DC: Congressional Research Service, 2011), Table 4, pp. 15-16.

$$1{,}366.8 \text{ billion BOE} \div 15.3 \text{ billion BOE/year} = 89 \text{ years}$$

Thus, the roughly 1.4 trillion BOE fossil fuel endowment—including resources not yet discovered and resources that are likely unaffordable to produce—will run out around 2100, provided the size of the US population does not increase and assuming the current standard of living is maintained. This is within the lifetime of today's children and grandchildren. Clearly, their future is **not** energy secure at today's standard of living and with a continued substantial reliance on fossil fuels. Assertions that the United States has lots of fossil fuels are clearly very misleading.

What about imports? As discussed above, the United States became substantially dependent on imported oil in the early 1970s and this has not benefited US national security. Fortunately, at least for a while fracking has substantially increased domestic oil and natural gas production, reducing natural gas and oil imports while lowering consumer prices. This has made the United States more energy secure. Why would it benefit the United States to increase its dependency on oil and gas imports in the future as the primary means of shoring up diminishing domestic supplies? Clearly, it would not.

G. Continued Immigration Will Dramatically Increase Energy Insecurity

In 1999, the US Census Bureau made several projections of the growth of the US population through 2100 based on various levels of immigration. Two cases are relevant to national energy security planning:

1. With the most likely fertility and mortality rates, but with zero immigration, starting at 274 million in 2000, the US population would likely climb to 377 million by 2100.

2. With the most likely fertility and mortality rates combined with the most likely net immigration using then current immigration policies, the US population would likely climb to 571 million by 2100.

The first case shows that the earlier ballpark estimate of an 89-year life of US technically recoverable fossil fuel resources is optimistic, because even with zero immigration, the US population will grow by about 27% by 2100. The second case is even more alarming. Likely net immigration substantially increases the population in 2100, making clear that America's fossil fuel endowment will last far less than a century. US immigration policy has a very significant impact on future US energy security and, consequently, US national security.

From 2008-2012 the Census Bureau updated its forecast, but only for 50 years. A private demographic analysis company used this data to create a model matching the Census Bureau projections and then used this model to extend the projections to 2100.[6] The starting point was the 309.3 million US population established in the 2010 census.

Six levels of net immigration were modeled with these results:

[6] Decision Demographics, Inc.

- With zero net immigration, the US population peaks in around 2050 at 358 million and declines to 343 million in 2100.
- With an annual net immigration of 500,000, the population in 2100 increases by 72 million to 415 million and continues to increase thereafter.
- With an annual net immigration of 1 million, the population in 2100 increases by 143 million to 486 million and continues to increase thereafter.
- With an annual net immigration of 1.5 million, the population in 2100 increases by 217 million to 560 million and continues to increase thereafter.
- With an annual net immigration of 2 million, the population in 2100 increases by 286 million to 629 million and continues to increase thereafter.
- With the Census Bureau's <u>most likely level of immigration of just under 2 million per year</u>, the population in 2100 increases by about 275 million to 617.5 million <u>and continues to increase thereafter</u>.

The Census Bureau's most likely 2100 population of 617.5 million is nearly twice the 2010 census of 309.3 million. This makes the <u>average</u> population from 2010-2100 1.5 times that of 2010. Thus, the corresponding increase in the rate of fossil fuel use means that the 1.4 trillion BOE of the US fossil fuel endowment will only last 60 years to 2070—a loss of 30 years—if today's standard of living is maintained.

$$(309.3 \text{ million in } 2010 + 617.5 \text{ million in } 2100) \div 2 = 463.4 \text{ million}$$

$$463.4 \text{ million} \div 309.3 \text{ million} = 1.5$$

$$1{,}366.8 \text{ billion BOE} \div (15.3 \text{ billion BOE/year} \times 1.5) = 60 \text{ years}$$

While not addressed so far in the public political debate on immigration policy, net immigration, both legal and illegal, significantly impacts the future population size of the United States <u>and must</u>, via White's Law of Cultural Survival, impact its future standard of living as the supply of affordable fossil fuels ends more quickly. In a free market, diminishing supply brings price inflation and economic recession as experienced in the 1973 and 1979 oil supply crises. *There is a price to be paid for irresponsible immigration policy and, with respect to energy security, that price is likely to be very costly and dangerous.*

H. The Impact of Energy Conservation is Likely to be Marginal

To keep from complicating the preceding calculations, the per-capita energy use was assumed to be constant through 2100. Measured in terms of BOE/year, US per-capita energy use peaked in 1979 at 62.1 BOE/year. From 2001-2007, when energy prices were fairly stable, just prior to the start of the current recession in 2008, the average was 58.1 BOE/year. At the 2010 population of 309.3 million, this comes to nearly 18 billion BOE/year of total energy consumption.

$$309.3 \text{ million population} \times 58.1 \text{ BOE/year} = 17.97 \text{ billion BOE/year}$$

The decline in per-capita energy use during times of economic prosperity has been slow. Over the nearly 30 years since 1979, the average per-capita energy use declined by only about 6% total—or only about 0.26% per year. This very minimal rate of reduction is especially noteworthy given the significant public and legal attention paid to energy conservation and improved energy use efficiency.

$$(62.1 - 58.1) \div 62.1 = 6.4\%$$

$$0.064 \div (2004\text{-}1979) = 0.26\%/\text{year}$$

While it is reasonable to expect further improvements in energy use efficiencies, at the same time the ΔT and ΔC of non-energy goods and services will require increases in per-capita energy use for larger cars, second cars, larger homes, second homes, travel, increased use of electronics and data handling, etc. Energy efficiency improvements are being converted into gains in the standard of living—exactly the same as has been happening since the start of the Industrial Age.[7]

With this in mind, per-capita energy use is optimistically assumed to decline steadily from 58 BOE/year in 2010 to 50 BOE/year in 2100. While there is uncertainty in this value, it must also be recognized that the Census Bureau's methodology-based projection of 617.5 million in 2100 is also uncertain. Both are, however, reasonable to use for this discussion.

I. Likely Net Immigration Will Double the Cost of Switching to Sustainable Energy

Modern civilization requires energy in two primary forms—electrical power generated to meet the immediate demand, called dispatched electricity, and a convenient and safe form of fuel for transportation, heating, and industrial processing. Thus, the new sustainable energy infrastructure replacing fossil fuels will need to provide on-demand dispatched electrical power and a fuel as well. The primary replacement for fossil fuels will be electrical power produced from sustainable solar and/or nuclear energy sources. Hydrogen, produced by the electrolysis of water using this sustainable electricity, will become the primary fuel.[8]

---

[7] The coming humanoid robotic revolution will likely substantially increase the human per-capita energy use. These robots will require energy for operation, transportation, housing, manufacturing, etc.

[8] Hydrogen is very difficult to store and handle in the general consumer market. It is quite likely that carbon will be extracted from the CO_2 in the atmosphere and combined with the hydrogen to produce methane, the primary component of natural gas. The technology for handling, storing, and using methane is well established. The carbon released into the atmosphere, from the combustion of this methane, will be recycled back into plants and more methane. It is quite possible that some of this artificial methane will be pumped back underground into depleted oil and gas wells for long-term storage, essentially returning to the

To help quantify this transition and the impact of immigration, a hypothetical all-nuclear energy infrastructure is modeled. A 1-GW nuclear power plant is typical of the size used by utilities. Such a 1-GW plant, operating 95% of the year, will generate 8,322 GW-hours (GWh) of electrical energy each year. This is equivalent to 5 million BOE/year.[9] This value is used to determine how many nuclear power plants would be needed to meet future US energy needs using only nuclear power.

$$\text{1-GW} \times 365 \text{ days/year} \times 24 \text{ hours/day} \times 0.95 = 8{,}322 \text{ GWh}$$

To establish a baseline, the US population in 2100 with zero net immigration will be used. With 343 million in 2100 using 50 BOE/year per capita, the gross energy need would be about 17 billion BOE/year. Note that this is less than the total US energy consumed in 2010.

$$343 \text{ million population} \times 50 \text{ BOE/year} = 17.15 \text{ billion BOE/year}$$

In 2100, 3,430 1-GW nuclear power plants would be needed to sustain a standard of living comparable to today. Each 1-GW plant would meet the needs of 100,000 people.

$$17.15 \text{ billion BOE/year} \div 5 \text{ million BOE/plant-year} = 3{,}430 \text{ 1-GW plants}$$

Now, using the Census Bureau's most likely net immigration assumption, for a US population of 617.5 million in 2100, the total annual energy need would be almost twice as large at 31 billion BOE/yr. Hence, 6,180 1-GW nuclear power plants would need to be operating in 2100—of which 2,750 would be due to immigration-driven population growth.

$$617.5 \text{ million population} \times 50 \text{ BOE/year} = 30.9 \text{ billion BOE/year}$$

$$30.9 \text{ billion BOE/year} \div 5 \text{ million BOE/plant-year} = 6{,}180 \text{ 1-GW plants}$$

$$6{,}180 \text{ 1-GW plants} - 3{,}430 \text{ 1-GW plants} = 2{,}750 \text{ 1-GW plants}$$

This most likely level of net immigration-driven population growth not only depletes the remaining US technically recoverable fossil fuels more rapidly, but it also nearly doubles, by 2100, the size of the sustainable energy infrastructure needed to replace these fossil fuels. This is another reason why US immigration policy is a key—but, currently missing—part of a national energy security planning.

---

earth what was extracted this past century. In this manner, a substantial portion of the "excess" carbon currently in the atmosphere can be captured and removed from the atmosphere—provided sufficient sustainable electricity is available to produce the hydrogen.

[9] Currently, the gross thermal energy equivalent used by the United States is about 18 billion BOE/year. Of this total, historically about 40% has been used to generate electricity, with the remainder being carbon fuels used directly for transportation, heating, etc. In the all-nuclear energy infrastructure, to meet the historical 60% fuel needs, the hydrogen fuel must be produced using nuclear electricity. Using projected future electrolysis efficiencies, around 0.002443 GWh will be needed to produce one BOE of hydrogen. Thus, for providing both nuclear electricity (directly) and hydrogen fuel (indirectly), it works out that each 1-GW nuclear plant provides the equivalent of 5 million BOE of gross thermal energy. About 85% of the total nuclear electricity produced each year by the nuclear power plant would be used to produce hydrogen.

J. Immigration Will Cost about $240 Billion per Year on Average

In 2013, the US Department of Energy estimated that the overnight capital cost to build a new nuclear power plant was about $5.5 billion per GW. To this amount, $1.5 billion is added for land, construction financing, hydrogen electrolysis and storage, etc. The ballpark cost is then $7 billion per GW. To build an all-nuclear energy infrastructure for 617.5 million in 2100 would cost roughly $43 trillion. The portion of this cost that is due to new immigration is about $19 trillion through 2100 or an average annual immigration premium of $241 billion each year from 2020 through 2100.

$$6{,}180 \text{ 1-GW plants} \times \$7 \text{ billion/plant} = \$43.26 \text{ trillion}$$

$$2{,}750 \text{ 1-GW plants for immigration} \times \$7 \text{ billion/plant} = \$19.25 \text{ trillion}$$

$$\$19.25 \text{ trillion} \div (2100 - 2020) = \$241 \text{ billion/year}$$

K. Terrestrial Nuclear Energy Is Not a Viable Solution

Uranium U-235-based nuclear fission has been commercialized since the 1970s. While the above discussion described the US energy needs in terms of a hypothetical all-nuclear energy infrastructure, replacing fossil fuels with thousands of terrestrial nuclear power plants is <u>not</u> a viable option for these reasons:

- The US only has sufficient U-235 to fuel about 135 1-GW nuclear reactors for the typical 60-year life of a new plant.

- Breeding the fissile U-238 isotope into plutonium Pu-239 would provide almost an unlimited amount of fuel.[10] However, Pu-239 is the plutonium isotope used to make nuclear weapons. Thus, a domestic Pu-239-based nuclear industry opens the door to easy foreign nuclear weapon proliferation when foreign countries implement their own plutonium-based nuclear energy industries.

- Breeding thorium into U-233, the other fissionable uranium isotope, would also provide an almost unlimited amount of fuel. However, U-233 can also be used to make nuclear weapons, just as U-235 and Pu-239. Hence, this is also a path to nuclear proliferation.

- Nuclear power plants are thermal power plants, meaning that about 70% of the nuclear energy released ends up as waste heat dumped into the terrestrial environment. This requires a large river, a large lake, or the ocean to provide the necessary cooling. Also, nuclear power plants must be located away from areas prone to earthquakes and tsunamis and located away from populated areas. It is unlikely that the United States

[10] While many elements and many isotopes of these elements are radioactive—meaning that they undergo spontaneous nuclear decay—only three isotopes are capable of being used in a nuclear fission reactor or weapon. These are uranium-233, uranium-235, and plutonium-239. "Breeding" is where another isotope is artificially transmuted, in a nuclear reactor, into one of these three fissionable isotopes.

has sufficient locations for thousands of nuclear power plants. It has only 104 GW of nuclear energy today.

- No acceptable nuclear waste disposal method has yet been identified and put into practice.[11] The federal government's effort to build an underground waste burial site in Nevada has been stopped, leaving extremely hazardous nuclear waste in temporary storage. Many of the waste radioactive isotopes must be safely contained for tens of thousands of years. Building large numbers of additional nuclear power plants without a disposal solution does not appear reasonable.

- Fusion nuclear energy is a possible future replacement for fission nuclear energy. The practicality of fusion energy has not yet been demonstrated. Also, fusion plants would still be thermal power plants needing large rivers, lakes, or the ocean for cooling. Hence, locating thousands of large fusion power plants in the United States will be difficult.

L. Wind and Ground Solar Power Are Not Politically Acceptable Solutions

The current focus on sustainable energy is with building wind and ground solar farms. Many people have been misled to believe that using these terrestrial sustainable energy sources to replace fossil fuels is quite practical. In reality, as shown in the following, the substantial land area needed for solar and wind farms to produce sufficient energy to replace fossil fuels likely makes these politically unacceptable solutions.

Wind Energy

Current commercial wind farms use wind turbines that stand nearly 500 feet tall at the tip of the turbine blades. With good wind speeds, these turbines will each produce 2.5 MW (0.0025 GW) of electrical power—the turbine's nameplate output power. Of course, as everyone understands, wind conditions continually vary at any location minute-to-minute as well as seasonally, and even year-to-year. This variability means that wind electricity cannot be a primary source of on-demand dispatchable electricity to supply power to a utility's grid. The method that has been adopted by utilities is to use wind electricity when it is available to substitute for electricity generated by other means, such as natural gas-fueled generators. The key point is that wind power, as it is now implemented, is not a reliable means of producing on-demand electricity.

The "capacity factor", expressed as a percentage, is the percentage of the wind turbine's nameplate output power generally available during a given period of time such as a month or year. The US Department of Energy reports that from 2009-2013, the average capacity factor for wind farms was 32%. Wind turbine performance is still improving, so a capacity factor of 40% is reasonable to use for future projections. Using this value, a 2.5-MW wind turbine can be expected to produce 8.76 GWh of wind-electricity each year on average.

[11] Nuclear reactor designs using nuclear waste as fuel are being developed. These generally involve breeding U-233 or Pu-239. This technology is in a very early stage of development, with China leading much of this effort.

$$2.5 \text{ MW} \times 365 \text{ days} \times 24 \text{ hours/day} \times 0.40 = 8{,}760 \text{ MWh}$$

$$8{,}760 \text{ MWh} \div 1 \text{ GWh}/1000 \text{ MWh} = 8.76 \text{ GWh}$$

This wind-electricity, of course, is variable electricity produced whenever the wind blows, not necessarily when the customer needs the electricity. The necessary engineering solution to be able to produce on-demand dispatched electricity is first to convert all of the variable wind-electricity into hydrogen fuel using electrolysis. The hydrogen fuel is then used, as needed, directly by the end consumer as a replacement for oil and natural gas and by utilities to fuel gas turbine generators to provide dispatched electricity.

As calculated previously, the likely US population of 617.5 million in 2100 will require 31 billion BOE of energy each year. This gross energy is divided into dispatched electricity and fuels. In 2007, before the 2008 start of the current prolonged recession, the US used 17.42 billion BOE of energy. Of this, 40% was used to produce 4.16 million GWh of dispatched electricity. Scaling this up, in 2100 the United States will likely need 7.4 million GWh of dispatched electricity.

$$4.16 \text{ million GWh} \times (30.9 \div 17.42) = 7.4 \text{ million GWh}$$

Using projections of the future efficiency of large-scale electrolysis, the conversion of variable wind-electricity into utility-dispatched electricity is estimated to be 46% efficient.[12] This means that it eventually takes 2.17 GWh of variable wind-electricity to produce 1 GWh of dispatched electricity.

$$1 \div 0.46 = 2.17$$

In 2100, about 16 million GWh of wind-electricity will be needed to provide 7.4 million GWh of dispatched electricity.

$$7.4 \text{ million GWh of dispatched electricity} \div 0.46 = 16.1 \text{ million GWh of wind-electricity}$$

Of the 30.9 billion BOE of gross energy needed in 2100, from US historical data, 60% would be used as fuel. This equals 18.5 billion BOE of hydrogen.

$$30.9 \text{ billion BOE} \times 0.60 = 18.54 \text{ billion BOE of hydrogen}$$

In this hypothetical all-wind energy infrastructure, wind-electricity is also used to produce the needed hydrogen fuel. Producing 1 BOE of hydrogen fuel (lower heating value) from electricity, using projections of future electrolysis efficiencies, is estimated to require 2443 kWh (0.002443 GWh).

$$2443 \text{ kWh/BOE} \times 1 \text{ MWh}/1000 \text{ kWh} \times 1 \text{ GWh}/1000 \text{ MWh} = 0.002443 \text{ GWh/BOE}$$

[12] The overall 46% efficiency takes into account a loss of 5% for the transmission of the wind-electricity to the electrolysis plants, a 20% loss for the conversion of the wind-electricity into hydrogen fuel, and a 40% loss for the generation of electricity using the hydrogen: $(1 - .05) \times (1 - .20) \times (1 - .40) = 0.46$.

To produce 18.54 billion BOE of hydrogen will require 44.61 million GWh of wind-electricity.

$$18.54 \text{ billion BOE} \times 0.002443 \text{ GWh/BOE} = 45.29 \text{ million GWh of wind-electricity}$$

To meet the energy needs of 617.5 million in 2100, the wind-electricity required to provide dispatched electricity and hydrogen fuel are summed to yield the total GWh of variable wind electricity needed. To provide 30.9 billion BOE of energy using wind power will require about 61 million GWh of wind-electricity.

$$16.1 \text{ million GWh} + 45.29 \text{ million GWh} = 61.39 \text{ million GWh in 2100}$$

With each 2.5-MW wind turbines producing 8.76 GWh of wind-electricity per year, about 7 million of these 500-foot-tall wind turbines would need to be operating in 2100.

$$61.39 \text{ million GWh} \div 8.76 \text{ GWh per turbine} = 7 \text{ million turbines}$$

The physics of extracting power from the wind places a cap on how many megawatts of nameplate power can be placed per square mile. This means that crowding in more wind turbines does not proportionally increase the amount of wind-electricity produced per square mile.[13] When using 2.5-MW turbines, five turbines can be placed per square mile. Thus, 1.4 million square miles of wind farms would be needed to meet the energy needs of 617.5 million Americans in 2100. The land area required is just under one half of the land area of the entire continental United States

$$7 \text{ million turbines} \div 5 \text{ turbines/square mile} = 1.4 \text{ million square miles}$$

The total installed nameplate wind power in 2100 would be 17,500 GW compared with the 6,180 GW of nuclear power needed.

$$7 \text{ million turbines} \times 2.5 \text{ MW/turbine} \div 1 \text{ GW/1000 MW} = 17{,}500 \text{ GW}$$

As of 2013, the United States had 60.7 GW of nameplate wind power installed. While this sounds like a great deal, it is only 0.35% of what will be needed in 2100—less than 1%. Assuming a start in 2020 to build the necessary wind farms to reach 17,500 GW by 2100, each year 219 GW of new wind farms must be built. This means that a capacity equal to 3X the current total installed capacity must be added each year. Also, with an expected component life of 25-30 years, most of the early wind farms—turbines, electrical transmission system, etc.—must be replaced at least once by 2100. Finally, as the population continues to expand due to continued immigration, the building of new wind farms does not stop in 2100.

[13] The wind's speed falls as it passes through the rotating blades of the wind turbine because the turbine is extracting power from the wind to turn the generator. As this happens, the wind picks up a rotational velocity that causes the lower-speed winds to mix with higher-speed winds at higher elevation. Due to this mixing, the wind's speed close to the ground increases back to its original speed. This occurs over a distance downwind of the turbine. Thus, if the next turbine is placed too close, the incoming wind speed is lower, producing less electrical power.

60.7 GW ÷ 17,500 GW = 0.35%

17,500 GW ÷ (2100 – 2020) = 219 GW/year of new wind farms

The large size of these turbines creates the impression that each will be able to meet the energy needs of a large number of people easily. This is not the case. In 2100, each wind turbine would provide the energy needed by around 88 people using the 50 BOE/year per-capita energy use assumed for 2100. In other words, a 500-foot-tall turbine would be needed for about every 40 homes. Each square mile of wind farms would provide for only 440 people. For comparison, a typical 1-GW nuclear power plant requires two square miles of land and provides the energy for 100,000 people.

30.9 billion BOE ÷ 7 million turbines = 4,414 BOE/turbine

4,414 BOE/turbine ÷ 50 BOE/person = 88 people/turbine

88 people/turbine × 5 turbines/square mile = 440 people served per square mile

To understand the impact of immigration, what happens if the population in 2100 stays at the zero net immigration value of 343 million people? Wind farms totaling 777,000 square miles would be needed in 2100.

343 million with zero immigration ÷ 617.5 million with likely immigration = 0.555

1.4 million square miles × 0.555 = 777,000 square miles (for 343 million)

Even with the lower population level, wind power is an impractical energy source. The primary reason is that the best areas of the continental United States for wind farms are the central states from north Texas to the Canadian border. This is America's breadbasket. Installing nearly 800,000 square miles of 500-foot-tall wind turbines would place wind farms on virtually all land between the Mississippi River and the Rocky Mountains. This would severely impact agriculture, the rural environment and standard of living, general aviation, and many forms of wildlife.

Ground Solar Energy

Ground solar energy is the other highly touted form of sustainable energy. Like wind energy, it also produces variable solar-electricity. In this case the variability is due to the day-night cycle as well as seasonal variations in the length of the available daylight and, of course, weather. Thus, the variable electricity from solar farms must be handled the same as wind-electricity—first converting the solar-electricity to hydrogen using electrolysis and then using the hydrogen for end consumer fuel and for generating dispatchable electricity at the utilities.

While the US Department of Energy identified a capacity factor of 40% as being a reasonable target for wind energy, the corresponding value for ground solar farms is only 20%, primarily due to the day-night cycle. The amount of solar-electricity needed to meet the 2100 energy needs of 617.5 million people is the same as that for wind-electricity—61.39 million GWh. However, due to the lower capacity factor, the installed nameplate power must be twice that of wind farms—35,000 GW of ground solar nameplate AC power.[14]

$$17{,}500 \text{ GW of wind power} \times (0.40 \div 0.20) = 35{,}000 \text{ GW of nameplate solar power}$$

To estimate how many square miles of ground solar farms will be needed, the starting point is to establish a baseline using large solar farms built in recent years in the American Southwest where the available ground insolation is the best in the country. These solar farms are averaging 81 MW per square mile of nameplate AC power. For comparison, wind farms have about 12.5 MW per square mile of nameplate AC power.

As the location of solar farms expands beyond these best insolation areas to meet the 2100 energy needs, the available average insolation will decrease primarily due to increased weather losses, e.g., cloud cover. Taking this into account, a value of 72.5 MW AC (0.0725 GW) per square mile is a reasonable value to use for calculating how many square miles of solar farms will be needed.

To meet the 2100 energy needs of 617.5 million people, 483,000 sq. mi. of land, primarily in the southwestern United States, must be leveled, scraped clean of vegetation, covered in gravel to control erosion and weeds/brush, and planted with solar photovoltaic arrays. The comparable area for a zero net immigration population of 343 million people in 2100 is 268,000 square miles. For comparison, the area of Texas is 269,000 square miles.

$$35{,}000 \text{ GW} \div 0.0725 \text{ GW/square miles} = 482{,}759 \text{ square miles (for 617.5 million)}$$

$$482{,}759 \text{ square miles} \times 0.555 = 267{,}931 \text{ square miles (for 343 million)}$$

Due to the terrain of many of the southwestern states, only about 20-25% of the land is suitable for solar farms. Hence, virtually all flat land in southern California, New Mexico, Arizona, Nevada, Utah, and western Texas would need to be covered with solar farms regardless of the land's current use. It is unlikely this would be politically or environmentally acceptable.

To install 483,000 square miles of solar farms by 2100, starting in 2020, an average of about 6,000 square miles of new solar farms must be built each and every year through 2020. With an expected lifetime of 30 years, much of this solar infrastructure will need to be rebuilt one or more times before 2100. It is also important to understand that, with immigration, the size of the US population does not level off by 2100, but continues to expand meaning more land must be converted to solar farms in the 22nd century.

$$482{,}759 \text{ square miles} \div (2100 - 2020) = 6{,}034 \text{ square miles per year}$$

[14] By their design, wind turbines produce alternating current or AC electrical power. Ground solar photovoltaic panels produce direct current or DC power. This must be converted to AC power before sending the electricity into the power grid. This DC-AC conversion is about 78% efficient. Thus, the nameplate power rating of solar farms must be stated in terms of the AC power produced.

M. Terrestrial Renewable Energy Sources Are Simply Not Practical to Replace Fossil Fuels

From these estimates of the size of ground solar and wind farms needed to power America in 2100, two more terrestrial sustainable energy options can be scratched from the list as being impractical. Conventional fission nuclear energy has already been shown as impractical. In the same vein, expanded hydroelectricity, geothermal-electricity, biomass, wave-electricity, and tidal-electricity will have little measurable impact. There are no plausible terrestrial solutions to replace fossil fuels especially if immigration continues. Yet, the clock is ticking on when the remaining US technically recoverable fossil fuels will be exhausted.

White's Law of Cultural Survival shows that to preserve American culture, economic prosperity, and national security, America's energy infrastructure must provide 50-58 BOE/year of affordable energy. Only about 15% or about 9 BOE/year now come from renewable and nuclear energy. America's standard of living will fall as the level of affordable energy per capita falls. Hence, if terrestrial renewable and nuclear options cannot be counted on to replace diminishing supplies of affordable fossil fuels, then America's cultural collapse is inevitable without a viable political and engineering solution. Plan A—the political naiveté of presuming that terrestrial renewable and nuclear energy can be counted on to replace fossil fuels—is a failure. Plan B must now kick in. While this is hard for some to comprehend, when all terrestrial potential solutions have been eliminated as being impractical, attention must focus on the one remaining doable engineering solution—space-based power.

N. Space-Based Power is the Remaining Solution to Make America Energy Secure

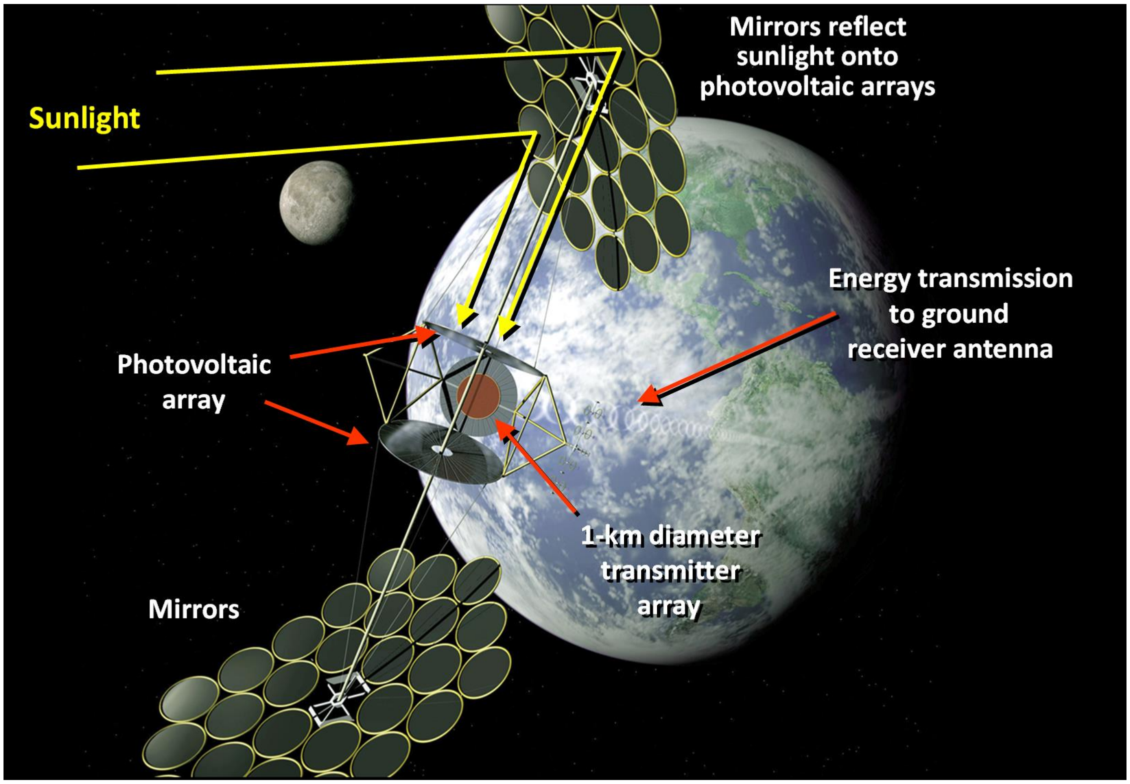


Figure 1. Notional illustration of a space-based solar power station. Source – NASA.

Space-based power is where solar energy is collected or nuclear energy is generated in space, most likely in geostationary Earth orbit (GEO), and transmitted to large ground receiving stations using microwave radio transmission. This space-based power would be generated almost continuously.[15] Ground receiving stations collect this transmitted power, convert it into AC power, and send it to the utilities' power grids. This would be baseload electrical power equivalent to what is generated by coal-fired and nuclear power plants today. This space-based electrical power can also be used to produce hydrogen fuel for transportation, heating, and industrial processing. Stored hydrogen fuel would provide a strategic reserve for backup gas turbine electricity generation should a receiving station go offline.

The design of the transmission system keeps the peak power level in the transmission beam at about one third of the equatorial noonday insolation. With this design, about 10 square miles of land of the ground receiving station is required for each 1 GW of output AC power. Thus, about 60,000 square miles of ground receiving stations would be

[15] The space-based solar arrays will be in continuous sunlight 365 days a year, 24 hours a day, except when these arrays pass into the Earth's shadow. This only happens near the spring and fall equinoxes and happens for only a couple of hours a day at local midnight, at a time when power demand is reduced. Gas turbine generators would provide electricity during this period.

required to deliver roughly 6,000 GW of AC power to the power grids. This is far less than the 483,000 square miles needed for ground solar energy or the 1.4 million square miles needed for wind farms. Also, these receiving stations can be located in parts of the country where the land use and environmental impact is suitable for this use.

Each space-based solar power station in GEO will likely generate 5 GW of electrical power. If this is done with large flat photovoltaic solar arrays, each GW of output power at the ground station requires about 1.7 square miles of space solar arrays in GEO. To obtain 5 GW of output on the ground, the space solar power platform will require about 8.5 square miles of solar arrays. To provide 6,180 GW, for a population of 617.5 million in 2100, would require 1,200 5-GW platforms totaling about 10,500 square miles of space solar arrays. This falls to about 5,800 square miles of space solar arrays needed for a 2100 population of 343 million.

$$5 \text{ GW} \times 1.7 \text{ square miles/GW} = 8.5 \text{ square miles of space solar arrays}$$

$$6{,}180 \text{ GW} \times 1.7 \text{ square miles/GW} = 10{,}506 \text{ square miles of solar arrays}$$

$$10{,}506 \text{ platforms} \times 0.555 = 5{,}831 \text{ square miles (for 343 million)}$$

O. Space-Based Power will be a Significant National Undertaking

Clearly, undertaking space-based power will require a revolution in space industrialization to build and operate, before the end of this century, up to 1,200 space power platforms, each the size of Manhattan. (The world's energy needs will require 5-6 times this number.) The current approach of launching satellites to GEO and hoping that they deploy and function properly and never require hands-on repair will obviously not work. The size, complexity, and, especially, the need for assured space-based power will make this very much a human undertaking. While this is contrary to the thinking of many now working to make space-based power practical—focusing on robotic, self-assembly, and human telepresence approaches—there are no terrestrial analogs of such a human-designed system functioning in this manner. Certainly, substantial robotic and telepresence will be used, but to achieve assured space-based power, humans will be living and working throughout the Earth-Moon system in large numbers. This is the proven way to get critical tasks properly done.

As the reality of space-based power being the only practicable solution to replacing fossil fuels and maintaining America's standard of living becomes understood, without doubt the American public will become excited about becoming a true human commercial spacefaring nation building and operating this new space-based power industry. Just as the 19th century was the age of steamships and railroads and the 20th century was the age of aeronautical flight—both ages bringing substantial technological and social changes—the 21st century will be the start of the age of true human spaceflight of the kind Americans have dreamed about since the 1950s. Not only will we build a substantial space-based power industry, but we will also then use a portion of this renewable power literally to power the expansion of human civilization throughout the central solar system and provide for the defense of the planet against asteroid impacts.

III. Building a New Spacefaring Logistics Infrastructure Will Be the First Step

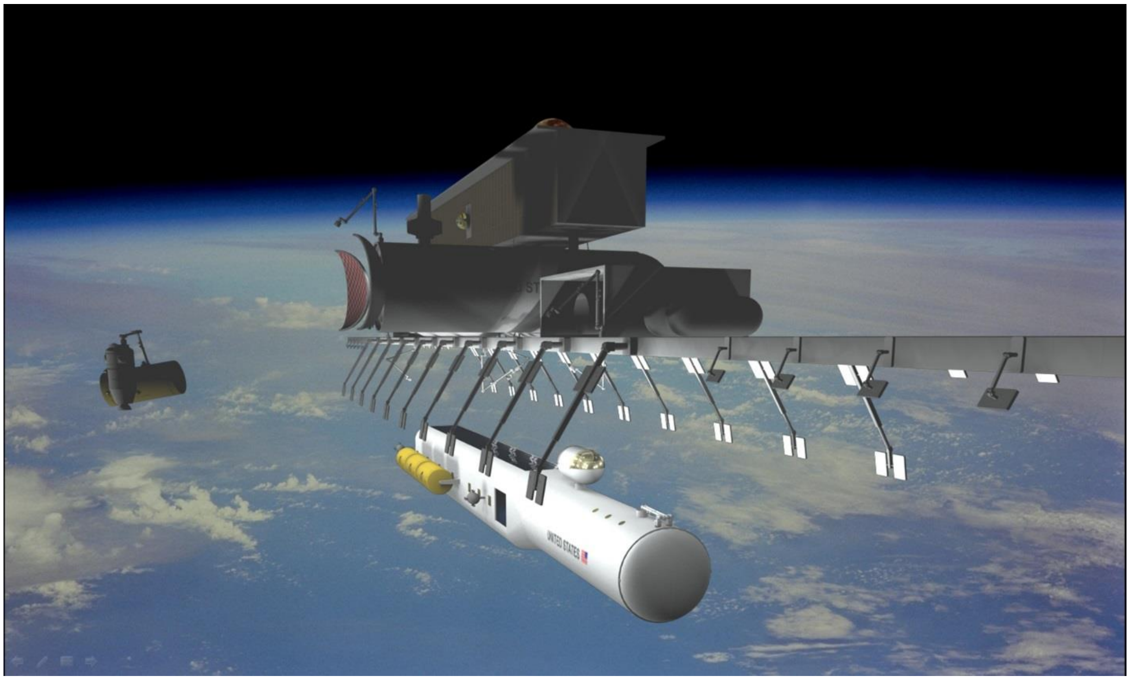


Figure 2. Low Earth orbit space base/space dock with spaceship departing. Source – US Government.

In this exciting future, tens of thousands of Americans will travel to, live, and work throughout the Earth-Moon system to build and operate this space-based power industry. When opening any frontier, the first enabling step is to build infrastructure providing safe, routine, and frequent access to and movement within the new frontier. The initial—repeat, initial—new spacefaring infrastructure will involve:

- Airline-like passenger transport to and from Earth orbit and throughout the Earth-Moon system using airworthiness-certified, fully reusable space transportation systems.

- Medium-class payload and freight transport to Earth orbit using fully reusable or expendable space transportation systems. The fully reusable systems will likely be space cargo versions of the airworthiness-certified, fully reusable passenger space transportation systems. (These will be similar to the air cargo versions of passenger airliners.)

- Heavy and oversize unmanned transport to Earth orbit using the new expendable Space Launch System being developed by NASA. Payloads can include large components for space power stations, entire small and medium-class spaceships (e.g., Space Guard cutters), and large components of large spaceships and space habitats assembled at the low Earth orbit (LEO) space dock.

- Space logistics bases/space docks, space habitats/hotels, and space fuel depots in LEO. These will be the primary destinations for passenger and payload traveling from the terrestrial spaceports to LEO.

- Space tugs to provide cargo and passenger transport between LEO facilities and to provide auxiliary transport at other locations in the Earth-Moon system (e.g., GEO, the Lagrangian points, lunar orbit).

- Space ferries to transport passengers and cargo from LEO to GEO, the Lagrangian points, and lunar orbit.

- Space Guard cutters to provide law enforcement and emergency support throughout the Earth-Moon system.

- Space logistics support bases in GEO and lunar orbit to support industrial operations on the lunar surface.

- Lunar landers for cargo and passengers.

- Lunar hoppers to move about the Moon.

- Large logistics support spaceships providing payload and passenger transport and on-site logistics services at GEO, the Lagrangian points, and lunar orbit.

- Lunar bases to support lunar resource extraction, processing, and transport.

A. The Feasibility of Building This New Infrastructure Is Right above Your Head

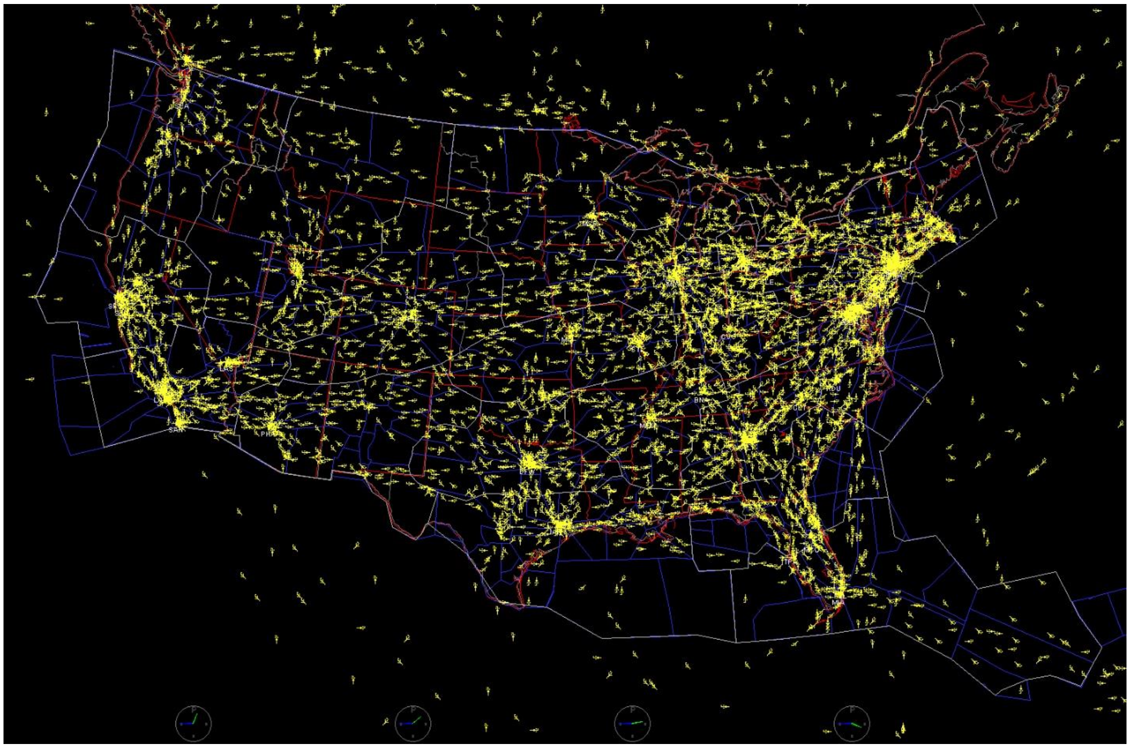


Figure 3. Snapshot of the airliners flying the sky above America. Source – NASA.

While many will express doubt about the feasibility of building this new spacefaring infrastructure, consider that on any typical morning or afternoon several thousand commercial airliners are flying above America carrying roughly a half million passengers and quite plainly demonstrating what America is capable of achieving. Think of what someone would have thought a century ago in 1916 of airliners capable of flying at near the speed of sound for thousands of miles carrying hundreds of passengers and of having thousands of these flying every day. If you time traveled back to that time, what would you have said to try to convince them that this is possible?

The reality is that the technical depth of the American aerospace industry is quite strong and everything listed above can be achieved using available technologies—yes, available technologies. Certainly, the initial spacefaring operational capabilities will later appear to be primitive, just as aircraft a century ago were primitive compared to those built today. But, it is important to understand that getting started with building a substantial initial capability <u>does not require</u> any major technical hurdles to be overcome. In other words, the American aerospace industry is primed and ready to proceed with the engineering development of the initial capabilities—most importantly, the fully reusable space access systems, the Space Launch System, and the LEO space base.

B. Putting some financial numbers to this undertaking

Establishing a new space-based power industry capable of delivering, with needed reliability and security, 6000+ GW of electrical power will not only be a significant technological undertaking, but also a major economic undertaking. From the previous discussion of a hypothetical all-nuclear terrestrial energy infrastructure to replace fossil fuels, 6,180 1-GW nuclear power plants would need to be operating in 2100 to meet the energy needs of 617.5 million. The ballpark cost of this is $7 billion per GW for a total cost of about $43 trillion through 2100.[16] Starting in 2020, the average annual cost of this is $541 billion each year.

$$6{,}180 \text{ 1-GW plants} \times \$7 \text{ billion/plant} = \$43.26 \text{ trillion}$$

$$\$43.26 \text{ trillion} \div (2100\text{-}2080) = \$541 \text{ billion/year}$$

A reasonable expectation is that this ballpark cost estimate is at the low end of the cost of building 1200 space-based power stations and 60,000 square miles of ground receiving stations. Hence, at least $500 billion to $1 trillion will likely be needed each year for the rest of the century, on average, to establish and build out this industry to meet the energy security needs of America in 2100.[17]

How does this compare to other federal expenditures? NASA's current entire annual budget is in the range of $18 billion, while the Department of Defense's budget is in the range of $600 billion. The NASA budget, at its peak during the Apollo program, was roughly $44 billion a year in current dollars. Thus, the effort to undertake space-based power will require annual expenditures, for the rest of the century, in the range of 10 to 20 times the Apollo program. It is apparent that a substantial percentage of the US GDP will become directly engaged in building and operating this new space-based power industry.

While these substantial expenditures at first appear alarming, in reality they offer a substantial new economic opportunity for America. Not only will America become energy secure with sustainable energy, thereby decreasing trade losses, but America's national security obligations related to imported oil imports will diminish. Properly undertaken, this program of space industrialization can have a broad beneficial national economic impact leading to a resurgence of domestic manufacturing. At the same time, the new spacefaring industrial technological revolution will bring broad ΔT advances across the board as improved technologies "invade" other industries, increasing America's industrial and commercial competitiveness.[18]

---

[16] This is the cost of building 6,180 new plants. With a projected nuclear plant lifetime of 60 years, about 1000 early plants would need to be replaced by 2100. This replacement cost is not included. Also, plant maintenance, fueling, nuclear waste disposal, and other such costs are not included.

[17] The rest of the world will likely need to expend $5-6 trillion each year to have their space-based power systems built—a substantial percentage of this could be undertaken by US companies.

[18] Building and operating this new spacefaring enterprise will require a significant step forward in design sophistication and standardization, product quality, manufacturing, robotic and tele-presence capabilities, software, etc. This new engineering expertise will filter into everything else as it sets the new standard.

From White's Law of Cultural Survival, it is clear that this investment in space-based power is a fundamental war-avoidance undertaking. There is no choice but to do this as space-based power is what will be required to transition to sufficient sustainable energy to replace fossil fuels and ensure America's energy security without either resorting to war or sliding backward in terms of the standard of living. Thus, the cost of building this new industry is America's anti-energy war cost. The cost of energy wars, likely with nuclear-armed adversaries, will certainly be far higher.

IV. Becoming spacefaring will be a new public-private enterprise

The depletion of America's technically recoverable fossil fuel endowment began in the mid-1800s and has been accelerating ever since due to population growth and an increasing energy need per capita. The previous calculations showed that with the most likely level of immigration, the remaining fossil fuel endowment will be depleted within 60 years. White's Law of Cultural Survival, buttressed by historical precedent, indicates that the consequences of this on America will be devastating unless sufficient replacement sustainable energy sources are built in time. With space-based power being the only practicable sustainable energy solution with the capacity to meet US 2100 energy needs, building an effective space-based power industry is a matter of national security of the highest importance.

National security needs transcend the commercial marketplace because the Federal Government—not private enterprise—bears the final responsibility for assuring national security. This does not, however, mean that the Federal Government would or should itself undertake this transition to space-based power. What it means is that private enterprise will undertake building this new space-based power industry and enabling spacefaring logistics infrastructure within a framework of public-private partnerships defined by national policy and federal legislation.

A. The Benefit of New Grand National Energy Engineering Projects

Americans have not been exposed to a grand national engineering project with a definitive goal since the Apollo program of the 1960s. Throughout American history, such projects have inspired the nation—the Erie Canal, the Transcontinental Railroad, the Panama Canal, the Hoover Dam, nuclear-powered submarine *Nautilus*, etc. America is a country with substantial, often world-leading, scientific, engineering, and technological industrial capabilities that have largely been underused since the 1960s—nearly three generations ago. Other countries now build the biggest dams. Other countries are erecting the largest buildings—ironically often designed by American companies. Other countries are digging the longest tunnels. Other countries build the biggest aircraft, the biggest ships, and the most modern cities. Far too many Americans now appear to be socially conditioned to ignore, if not outright deny, America's technological strengths and to be content with America's increasing national insignificance. This social trend is dangerous to America's future, as it creates a national sense of indifference leading to political hesitation in addressing key problems requiring technological solutions. When addressing America's current and growing energy insecurity, hesitation will bring disaster.

Building the vitally needed space-based power industry and the enabling spacefaring logistics infrastructure will require grand new national engineering projects surpassing all undertaken previously. Assume, for this discussion, that each 5-GW space power station in GEO is equivalent to a new aircraft carrier—the most complex military weapon system built in the world. The United States builds these aircraft carriers at a rate of about two per decade. Now imagine needing to build 1,200 of these by the end of century—delivering 15 each and every year—and having to assemble these at the top of a mountain 26,000 miles tall. This is but the tip of the iceberg of what will be undertaken as America becomes a true human commercial spacefaring nation to secure its sustainable energy future. This grand undertaking will define the 21st century for America.

B. America's Current Space Enterprise is Obsolete

Insignificance has overtaken America's government human space enterprise. With only a few exceptions, it has become technologically timid, focused on job self-preservation rather than bold but sound technological advancement. Inexplicably, for the first time in US history, a major national infrastructure—the Space Shuttle—ended operations in 2011 without a new and far better replacement coming into existence. As a consequence, NASA now has to depend on Russia to fly our astronauts into space on Russian expendable launch vehicles first designed in the 1960s. Now, embarrassed and trying for a quick fix, the federally funded solution is to go backwards to 1960s-era space capsules in an attempt to recapture the faded glory of the Apollo program.

On the aerospace commercial side, startup space companies are finding that there is no shortcut to safe human spaceflight. It really does take careful design, experienced engineering, a sound systems architecting and engineering approach from the beginning, lots of testing and evaluation, and lots of money to make complex aerospace systems function with acceptable operability, economics, and human safety. It has been more than ten years since SpaceShipOne won the suborbital Ansari X-Prize. Immediately after that success, the public was led, with great fanfare, to believe that only a few years would be needed to start commercial suborbital passenger spaceflight. Experienced engineers knew better, and were ignored, but have been proven right. Human flight systems are never easy, quick, or inexpensive. This is why effective public-private collaboration will be needed to achieve safe commercial human spaceflight.

C. Effective Public-Private Collaboration Will Be the Key to Success

For important national programs, collaboration and, quite often, formal partnerships of the government and private industry have been required to produce a successful outcome. Private industry brings competition, design creativity, industrial capability, customer engagement, and product-focused technical skills and experience to the partnership. Government brings broad scientific expertise, multi-program system engineering experience, substantial unique test capabilities, and anchor funding to the partnership. This partnership arrangement has been used to make operational, for example, jet-powered aircraft, nuclear energy, interstate highways, major ports and airports, large hydroelectric power plants, the first satellite-based telecommunications, and the entire manned orbital space program. In many of these areas, as the technical risk subsided and the experience and expertise of private industry grew, future efforts became completely private as the level of risk fell to be within the range suitable for private funding. Government, at that point, steps back to maintain only regulatory oversight if this is needed. This historically successful public-private model now needs to be used to start building the spacefaring logistics infrastructure and the new space power industry.

Many in the pro-commercial space movement deny the need for such public-private partnerships. They believe that dogged determination will get it done. To counter this view, the emergence of the commercial jet aviation industry in the 1950s is a very pertinent example. Jet engines, originating in the late 1930s, were integrated into aircraft in the latter years of World War II. The thermodynamic operation of jet engines optimizes their flight for high subsonic speeds at high altitudes. Quickly, aeronautical engineers determined that fundamental design changes were needed including swept wings, pylon-mounted engines, and pressurized fuselages.

Immediately after the war, new types of jet fighters quickly entered service at a rate that today would appear truly amazing. The key advancement, however, was the need for a new jet-powered bomber. Piston-powered, propeller-driven bombers were simply too slow to survive encounters with jet fighters. Bombers needed to fly higher and faster. To achieve this, aerodynamics called for swept wings while propulsion engineers found that they needed to put the jet engines on pylons hanging below the wing. The reasons were the need for easy access to the jet engine for maintenance and the need to prevent a seized jet engine or engine fire from damaging the wing's structure.

While these sound like fairly easy changes, they were quite complex, especially given the analytical capabilities of the time. The key engineering advancements were made during the development of the Boeing B-47 and Boeing B-52 jet bombers. These two military programs gave Boeing the engineering and manufacturing capabilities to develop its jet-powered transport prototype with swept wings, pylon-mounted engines, and a pressurized fuselage. Boeing offered this prototype to the military as the basis for a new jet tanker to keep up with the new jet bombers. This became the KC-135 tanker that is still flying today. As the KC-135 entered production, Boeing built on its design experience to produce the similar Boeing 707, one of the first successful commercial jet airliners. So successful was this design, compared to propeller-driven airliners, that the first operational Boeing 707, flying the 8-hour London-New York route, did not fly with an empty seat for the first six months. Everyone loved to fly jets and they still do. America took the lead in commercial jet aviation in the 1950s and 1960s because of the public-private partnership that enabled the needed technological advancements to be achieved. Done well, public-private partnerships accelerate the fielding of new capabilities—exactly what is now needed to begin to field the initial spacefaring logistics infrastructure.

D. The Space Industrial Boom is about to Begin

The United States is about to embark on industrializing outer space because of the need to develop space-based sustainable power to preserve its national security, economic prosperity, and standard of living. As the scale of the effort grows to be in the ballpark of \$1 trillion a year of economic activity, this new industry will be employing around 13 million people, at an average annual wage of \$75,000, just to meet US needs. Secondary employment will multiply this by a factor of 2-3. Thus, just as the steam power revolution enabled substantial new commercial enterprises to be formed in the 1800s, America's embarking on creating a new space-based sustainable power industry will bring comparable economic benefits throughout the 21st century. The proper descriptive word to use is “boom.”

The public’s “awakening” to the economic potential of space industrialization will reshape American politics. The public will come to understand the tremendous economic opportunity for technological creativity, entrepreneurship, business formation and expansion, job creation, and career development needed to build space-based power systems, a spacefaring infrastructure throughout the Earth-Moon system, and the many new enterprises making use of both of these. Further, the American public will quickly realize that much of this job creation will call for employees with critical science, math, engineering, technology, and vocational skills—the sort of jobs that create solid middle-class prosperity.

E. The Proven Path to Opening New Frontiers—Build New Infrastructure

The initial focus of this spacefaring industrial revolution will be establishing the permanent infrastructure to reach and work within space routinely and safely. Many, even in the pro-space movement, do not recognize the profound change that will occur as this spacefaring logistics infrastructure is established. Space is now difficult, costly, and unsafe to reach. This forms the current paradigm of how space operations are undertaken. To understand why this paradigm will soon be obsolete, we need to go back to the early 1800s on the Ohio frontier to help envision the changes that will unfold this century in space.

Following the Revolutionary War, Americans moved in large numbers into the Ohio frontier along the Ohio River and its tributaries. Many had earned land in exchange for service during that war. Others bought land from the Federal Government. The land was rich in terms of the needs of an agrarian society—fertile soil, plentiful rain, moderate climate, extensive forests of wood for construction and fuel, and navigable rivers for reaching deep into the frontier.

The one major disadvantage for early settlers was the lack of an established transportation infrastructure beyond Pittsburgh at the head of the Ohio River. There were no roads and the land was primarily dense forest, making cross-country travel difficult. River travel was the only practical means of movement within the frontier. Fortunately, the Ohio River and many of its tributaries were navigable much of the yea. However, trying to move cargo upriver to Pittsburgh and then back across land to the eastern cities was extremely difficult and generally unprofitable.

With the plentiful supply of timber, the primary means of travel was to construct a river raft called a flatboat. This was then floated downstream with St. Louis or New Orleans being the primary destination for selling farm produce. As a consequence of the impracticability of upriver travel, the flatboats were considered expendable, generally being used only once to reach a downriver destination and then sold for lumber or firewood. People, after completing their business and purchasing needed dry goods and farming supplies, simply walked home, perhaps over a thousand miles, carrying what they could on their backs or on pack mules.

There was some two-way passenger river travel, but with a high cost and long travel times. A round trip by keelboat in the early 1800s between Cincinnati and New Orleans took 78 days and cost $160, or about half a year's earnings for a worker. To go upriver, men used long poles to push or ropes to pull the boat upstream. More prosperous people would sail from New Orleans to an eastern port, go cross-country to Pittsburgh by coach, and then float back down the Ohio River to reach their home. The difficulty of expanding the territory economically beyond subsistence farming, due to this primitive and difficult one-way logistics infrastructure, was obvious to everyone. This prevented the vast wealth potential of the western territories from being realized.

In 1807, just four years after the Louisiana Purchase, Robert Fulton commercialized the first steamboat on New York's Hudson River, demonstrating the commercial profitability of fully reusable, two-way river transport of passengers and cargo. In 1811, a prosperous engineer, Nicholas Roosevelt, in partnership with Fulton, used this technology to build the first steamboat on western waters in the Pittsburgh area. This was a significant vessel of about 150 feet in length, displacing 371 tons, and having accommodations for 60 passengers in below-deck cabins. With Roosevelt at the helm, it departed Pittsburgh and traveled roughly 2,000 miles downriver to New Orleans over the 1811-1812 winter. Beginning in April, 1812, the steamboat—named the "New Orleans"—began two-way travel up and down the lower Mississippi, focusing on the growing cotton trade. It quickly became one of the most prosperous enterprises in America by making two-way river travel safe, comfortable, dependable, and affordable. The old paradigm of one-way, expendable river vehicle travel was destroyed with the new paradigm of fully reusable, two-way travel.

Competition adapted quickly to the new paradigm. Over 60 steamboats were operating within only two years—surprisingly, during the War of 1812. Some helped in the defense of New Orleans in 1814. By 1826, 143 steamboats were operating all along the major western rivers. Commerce and settlement exploded as new settlers and their equipment could be safely and affordably transported throughout the Midwest and farm products could be transported into markets serving the world. In the 1850s, 3 million passengers and 8 million tons of cargo were transported annually on just the Ohio River. In that same decade, railroads reached the Ohio valley. Passenger and freight began to switch to this newer form of transportation. By 1900, over 200,000 miles of track were laid, up from only 9,500 in 1850—about 4,000 miles were added each year on average. The paradigm shift from one-way, expendable transportation to two-way, fully reusable transportation made the Ohio-Mississippi River valleys the heartland of a rapidly growing, rapidly industrializing America in the 19th and early 20th centuries. This prepared the United States for the trials of the two 20th-century world wars as this heartland was at the center of building America's military capabilities.

History teaches that creating significant new infrastructure gives a shot of adrenalin to a nation's economy. For engineers and entrepreneurs, the decision to build significant new infrastructure opens the door to applying their imagination to building the initial infrastructure, figuring out how to make it better to build market share, and figuring out how to make use of it in new wealth-producing ways. For example, consider the digital information infrastructure called the Internet. It started with simple e-mail with no conception of what was to come. Two generations later, how much of the vast wealth created by this digital information sharing infrastructure has come from e-mail? Very little.

While the objective of the coming American industrialization of space will be to build a space-based power industry, the critical initial operational advancements will be in building an integrated human spacefaring logistics infrastructure extending throughout the Earth-Moon system. Building this infrastructure will, in itself, not only create substantial new jobs and companies, it will also foster an explosion of new products and services making use of this new infrastructure. Space-based power generation will be only one of these. Today, we can no better predict what the others will be than those who saw the first e-mail had any inkling of what was coming. All we know is that major new infrastructure leads to substantially increased prosperity, large job creation, company formation and IPOs, intellectual property, and lots of new fun. Building major new—repeat, new—national infrastructure is one thing government can do that creates true opportunity and progress. For anyone understanding America's current energy insecurity and the vital need for space-based power, the need to build a national integrated human spacefaring infrastructure should now be plainly obvious. The public will be asking why this has not already started.

V. Where the United States Stands Today in Terms of Commercial Spaceflight Passenger Transport

A. The Importance of Airworthiness-Certified Passenger Spaceflight Systems

Explorers explore and settlers settle. Consequently, exploration and settlement each have their own rules for safety. The early stages of space settlement will occur as the space industrial revolution unfolds. For space settlement to proceed, an acceptable level of operational safety must be achieved. This means that human operations in this new frontier will undergo a paradigm shift in safety from the higher level of risk inherent in exploration to the low level of risk associated with and expected for normal living activities.

Passenger transport safety highlights this distinction. Legally a passenger is a person who has hired a business to transport him or her to a destination by paying a fare. When hiring the business, the passenger surrenders the responsibility for his or her safety to the business owners and operators. In accepting the fare for the transportation, the business also accepts a "duty to care" obligation for the passenger's safety. If the business owner or operator is negligent and harm comes to the passenger, then the owner or operator may be sued to recover damages. If the negligence is severe, then criminal charges may also be brought. The duty to care obligation is part of common law, indicating that this is a normally expected legal obligation that the owner and operators accept when the business begins to operate.

Starting in the 1800s, as steamboats and railroads became a common form of passenger transportation, the increasing mechanical complexity of the systems exceeded the ability of the passengers to ascertain their safety by normal visual inspection. This was especially true for components such as the boilers, brakes, rails, and bridges, whose proper functioning were critical to safety. Regulation, independent inspection, and certification became the way the duty to care obligation was met. Regulations, usually involving design and manufacturing standards, were implemented by law, as were inspections by qualified independent experts. When the system being inspected was found to comply with the regulations, a certificate was issued. This protected the owners from unwarranted lawsuits claiming negligence and provided the basis for allowing the business to operate with the public's confidence.

For commercial aircraft, airworthiness certification is used to meet the duty to care obligation. This involves two parts. First, a new aircraft design or type must be shown by analysis, inspection, and ground and flight test to be safe—to be airworthy. This necessarily involves building and flying prototype and early production aircraft of the new type. When the new design is demonstrated to be airworthy, a "type certificate" is issued, freezing the design. Then the new design goes into serial production. Each production aircraft is (a) individually inspected to show that it was built per the approved design and (b) ground and flight tested to demonstrate that it was properly built—the controls work, all the cables are properly connected, the software is loaded correctly, the landing gear retracts and extends, etc. When this is demonstrated, each individual aircraft is issued an airworthiness certificate giving the owner who buys the aircraft the legal ability to transport passengers on that particular aircraft. Only then does that aircraft enter service and begin to carry passengers.

Undertaking the airworthiness certification process, while required by law, also demonstrates the builder's commitment to passenger safety as this is a carefully regulated process. Having the airworthiness certification process enables the builder to demonstrate the safety of the new design in a manner that the public accepts as being adequate to protect safety reasonably. Having an airworthiness certificate for each operational system—and maintaining it through proper inspections, maintenance, and repairs—enables the operator to demonstrate that its duty to care obligation is being met.

The key to making the airworthiness process work is that it is regulating fully reusable flight systems. Prototype and early production aircraft must be flown repeatedly to gather flight test data to support the type certificate. Each production aircraft must be test flown prior to receiving its airworthiness certificate and entering passenger service. This same safety-assurance rationale carries over into all other forms of passenger transport—certify, then operate. And, of course, this certification process cannot be applied to an expendable or partially expendable flight system, which is why public transportation systems are not expendable or partially expendable.

Obviously, for the commercial transportation of passengers to and from earth orbit and within the Earth-Moon system, only fully reusable flight systems will be able to be used in order to achieve the airworthiness certification necessary to meet the operator's duty to care obligation. Hence, to open space to commercial human operations, fully reusable spaceflight systems need to be developed, type certified, and, then, have each operational system be airworthiness certified before becoming operational. Current or planned human expendable or partially expendable spaceflight systems cannot be airworthiness certified and are, therefore, not useable for passenger transportation.

It is important to differentiate a certificated fully reusable space access system from the "reusable" concept of recovering and reusing a stage or major component, such as the engines, of an otherwise expendable launch vehicle. If any normal fight safety components of the flight system are expendable, then the system cannot be certified. Hence, reusing a recovered component is an economic choice only. While this may be important for decreasing the overall launch costs for these expendable systems, simply being reusable, but without formal airworthiness certification, says nothing about the safety of the system.

B. America's Interest in Fully Reusable Space Access Dates Back to the 1950s

The American dream to become a true human spacefaring nation has been widely evident with the American public since the mid-1950s, when Wernher von Braun, in cooperation with Walt Disney, introduced this spacefaring future to the public. Von Braun, an early pioneer in expendable rockets, understood the need to move to a more conventional logistics infrastructure. His view of the future involved reusable space access systems, orbiting space stations, and reusable spaceships to reach the Moon.

By the late 1950s, stimulated by Sputnik and the initial race to launch orbiting satellites, the American dream of human spaceflight evolved into operational intent within the US Government.[19] The US Air Force started a number of programs, including the original aerospaceplane studies for fully reusable, single- and two-stage space access systems, the hypersonic X-planes to explore the aerothermal environment of hypersonic flight (e.g., the X-15), and the orbital manned reusable spaceplane, DynaSoar (X-20).[20] When President Kennedy made his fateful decision to pursue expendable launch vehicles and space capsules to beat the Soviets to the Moon in the civilian space race, progress in the development of more aircraft-like reusable operational capabilities continued through military R&D.[21] Even after the military's DynaSoar program was cancelled in 1963, largely due to the rapid maturation of military surveillance satellite technologies and ballistic missiles, significant research continued into lifting body designs, advanced materials and structures, and advanced propulsion.

The second opportunity to pursue the spacefaring path began with the start of the Space Transportation System, better known by its popular name, the Space Shuttle. As the name implies, it was originally intended to provide frequent and routine civil access to LEO. It was conceived in the early 1970s as a fully reusable, two-stage system design to

---

[19] That the Soviet Union launched the first satellite was an intentional US foreign policy objective. By letting the Soviets launch first, they established, rather than opposed, the legal precedent of the freedom of orbiting satellites to pass over another country. They reinforced this with the first orbiting manned mission.

[20] The manned DynaSoar reusable spaceplane—about the size of small fighter jet—was to be launched on an expendable launch vehicle. This is being done today, although unmanned, with the Boeing X-40 spaceplane.

[21] President Kennedy was first and foremost a politician. He had no particular interest in space. The manned lunar landing goal was a 1961 political response to the Soviet Union's then lead in manned space operations coupled with the failure of the American CIA's Bay of Pigs invasion of Cuba just weeks earlier. After the Cuban Missile crisis that almost brought nuclear war, and shortly before he was killed in 1963, Kennedy appeared to be ready to roll back the lunar landing goal. In a speech at the United Nations he proposed a joint expedition to the Moon with the Soviet Union and was having policy analysts evaluate the projected costs of the Apollo Program. The key point is that the Apollo Program was pursuing political goals, not spacefaring operational goals. After Kennedy's death, it became his legacy. This is why this program left little useful post-Apollo spacefaring infrastructure. The need for America to become energy secure with sustainable space-based power is a clear operational goal rather than merely a "feel good" political goal.

be used in conjunction with an orbiting space station—reflecting the common sense fact that a reusable space access system needs someplace to go to in orbit in order to deliver passengers and cargo. Unfortunately, by 1972, politics and funding constraints changed this into the partially expendable system that we know as the Space Shuttle. Also, the space station was dropped. Safety concerns were addressed by presuming that production and pre-flight quality control of the expendable components would suffice. These changes subverted its original mission goal to operate frequently and routinely, with airline-like safety, because each new flight required the untested use of new and rebuilt components—the external tank and the solid rocket boosters.

Over the course of its 30 years of operation, the Space Shuttle only flew 135 times while unfortunately having two catastrophic failures with loss of crew—failures originating in the new/rebuilt expendable components. Thus, the proven risk of mission failure was about 1:60—far, far less than what is acceptable for public transportation.[22] Expendability prevents knowing for certain that a system is safe to operate prior to being used in regular service. This elevates the risk substantially, making this form of space travel unacceptable for spaceflight passengers.[23]

C. The US Aerospace Industry Has Been Able to Build Fully Reusable Space Access Systems since the 1980s

This engineering common sense need for full reusability in space access was recognized in the 1950s. The first aerospaceplane design studies, started in the late 1950s, were focused on trying to find a fully reusable technological solution to space access. After the Apollo program—and its use of expendables as a politically expedient way of beating the Soviet Union—the focus returned to fully reusable space access when the Space Shuttle requirements were initially defined. It was intended to be a fully reusable, two-stage-to-orbit (TSTO) spaceflight system with airline-like operations. This was a very ambitious objective given the fact that the entire preceding operational and industrial experience was with high-risk expendable launch systems. The requisite political support for the funding necessary to substantially advance the state of the art in a system development program did not exist. The political compromise of the partially expendable Shuttle, with a much larger capacity to accommodate military payloads, was implemented.[24]

With the decision to not pursue full reusability with NASA's Space Shuttle, the pursuit of this approach returned to the military. At the same time the Space Shuttle was about to begin flight operations in the early 1980s, the US Air Force was evaluating military applications of fully reusable military aerospaceplanes. There was common agreement

---

[22] A safety risk assessment performed by NASA after Space Shuttle operations ended, using safety assessment tools not available 30 years ago, found that the early Shuttle flights had a likely probability of failure of about 1:12. By the end of the program, this had only improved to about 1:100.

[23] An employee of a company traveling to a destination on a company-owned system is not a passenger in the legal sense of the word. Employees accept the safety risk of the transportation used by willingly being employees. Employee safety is governed by other laws and regulations. NASA astronauts, as employees, are not passengers when they travel on NASA-provided spaceflight systems like the Space Shuttle. However, when the company sends the employee on a trip using a commercial carrier with a purchased fare, the employee becomes a passenger.

[24] These decisions were made prior to the first oil supply crisis—an important event in triggering the initial interest in space-based power undertaken in the late 1970s and early 1980s.

that, to be operationally effective, the system had to be aircraft-like and not some version of an expendable launch vehicle. This moved the intended user of the system from the launch community to the aircraft operations community, meaning that the system would be based at airfields and not at launch facilities. For this reason, the concept studies focused on horizontal takeoff and landing approaches on runways using quasi-single-stage-to-orbit (SSTO) and TSTO systems.[25] A new name was invented—TransAtmospheric Vehicle (TAV)—to separate this concept politically from NASA's Space Shuttle and the military's expendable launch vehicles (ELV). Multiple concepts were studied under contract.[26] A baseline study objective was to define concepts employing 1980s technologies so that a formal program start decision could be pursued.

In 1985, at the conclusion of the TAV conceptual design evaluation, the Air Force decided not to pursue gaining Department of Defense approval to start the formal engineering and manufacturing development of a TAV military system. This decision was based on changing mission needs and funding priorities. Instead, attention turned to developing a revolutionary airbreathing propulsion solution for an SSTO approach. The TAV decision was <u>not</u> a decision based on a determination of inadequate technology or inadequate industrial readiness needed to proceed into formal system development.[27] What the TAV studies showed was that since the start of the Space Shuttle development in the early 1970s, the US aerospace industry had acquired the necessary industrial capability to begin the development of fully reusable, two-stage, rocket-powered space access systems with acceptable program risk.

For the future of the American human spaceflight program, the failure to proceed with the TAV development was another fateful decision, just as was the decision not to pursue full reusability for the Space Shuttle. The military's development of new flight technologies and systems generally precedes commercial adoption, because this provides a proven path to overcome the inevitable technical obstacles and achieve the necessary technical and operational maturity necessary to enable commercial operations. The Air Force's KC-135 jet tanker, developed in the early 1950s by Boeing, gave rise to Boeing's B-707 commercial jet airliner that helped to jumpstart the commercial aviation industry in the late 1950s. The same has been true for advanced materials and structures, engines, digital flight controls, etc.

Had the TAV program been pursued, a military TAV TSTO system would have likely become operational by the late 1990s.[28] This would have opened the door to commercial

---

[25] A quasi-SSTO approach used some form of launch assistance such as droppable rocket packs.

[26] A decision to start the conceptual assessment of a new military weapon system follows the preparation and approval of a formal statement of need, citing a military mission deficiency and the lack of an existing solution. This is how the military TAV studies began.

[27] One quasi-SSTO approach was the Boeing Reusable Aerospace Vehicle (RASV). This concept emerged in the late 1970s from Air Force studies. It used then-available rocket, structures, and materials concepts. In 1982, the chairman of Boeing gave the internal company go-ahead to propose to the Air Force building a prototype RASV. This indicates the level of maturity of these primarily rocket-powered systems in the 1980s was sufficient for a major aerospace contractor to support program initiation. The RASV was one of several TAV concepts studied as part of the TAV studies.

[28] See Boeing's patent, US4802639, Horizontal-takeoff transatmospheric launch system, originally filed on September 28, 1984, during the time the Air Force TAV studies were underway. This patent was granted

TSTO derivatives, especially given the 1986 Space Shuttle Challenger failure that exposed the substantial safety and operational inadequacies of the entire US space access infrastructure. A civilian passenger version of such a TSTO TAV system could easily have transported 20 or more passengers to LEO. A civilian cargo version could have transported medium-sized payloads. Think of the impact this would have had on the course of US manned space operations, both civil and commercial, versus where the American human space program stand's today.

It is very important to recognize that from the mid-1980s, America's commercial aerospace industry had signaled that it had the capability to develop fully reusable space access systems—most likely TSTO systems. Yet, for more than a generation, normal commercial market forces/constraints have prevented industry from pursuing this approach, even when the termination of the Space Shuttle and the consequences of this became apparent. Hence, there is a clear need for an effective public-private partnership to initiate this capability as industry will not do this itself.

Within months of the decision not to pursue the military's TSTO TAV, the Federal Government instead chose to pursue the goal of demonstrating a fully reusable SSTO system capable of taking off and landing on a runway. This became the National Aerospace Plane (NASP/X-30) program as part of a national effort to reinvigorate aerospace science and engineering. The technical path chosen was to maximize the use of airbreathing propulsion, employing scramjets capable of operating to Mach 12 and above.[29]

To put this into perspective, the NASP program was initiated in 1985 when the first personal computers were just becoming available. A typical laptop PC today has more computing power than the supercomputers of that time. While exciting, NASP was the point where the nation's intended reach exceeded its technical grasp. While the US aerospace industry had the technical ability to execute a rocket-powered TSTO system development with acceptable risk, the X-30 SSTO program was very high risk. This became quite evident by the end of the 1980s as the projected gross takeoff weight of the flight system grew substantially as design closure—the predicted ability to achieve orbit—became increasingly uncertain.[30]

Consequently, with the NASP program floundering, with the military's TAV not being pursued, with the military doubling-down on ELVs in the wake of the Challenger failure in 1986 and not seeing any need for human military operations in space, and with NASA doubling-down on the Space Shuttle after the Challenger failure, the US aerospace

---

in 1989. This patent is for a fully reusable, two-stage, horizontal takeoff and landing manned space access system.

[29] The concept of a scramjet-powered SSTO came out of the first aerospaceplane studies of the early 1960s.

[30] To achieve a stable LEO, the space flight system must reach the required orbital velocity—a function of orbital altitude—which is not dependent on the design of the flight system. Whether the system is one-stage or two-stage, is rocket-powered or uses airbreathing propulsion, the necessary orbital velocity is the same. Design closure is when a design is predicted to be able to reach this orbital velocity. Only designs that close, with reasonable margins for shortfalls in design and performance, are considered viable.

industry began to dismantle its then-impressive manned fully reusable spaceflight development capabilities. The practical reason was that there was no likely near-term return on their investments to be prepared for a government development contract for a fully reusable system.

The final fling at SSTO was the ill-conceived X-33 program in the 1990s. This started as a follow-on to the earlier rocket-powered studies that produced the Boeing RASV concept in the 1970s. In the 1980s, the military began to address the need for ballistic missile defense seriously. Placing platforms into Earth orbit to detect, track, and destroy launched ballistic missiles was one approach being considered. For this to be practical, the means to place military payloads into orbit at costs substantially lower than ELVs was needed. Drawing on efforts originating in the 1970s, an all-rocket, vertical-takeoff and vertical-landing (VTVL), subscale demonstrator program was proposed. Focusing on demonstrating VTVL capability and aircraft-like reusability, the Delta Clipper Experimental (DC-X) effort was started in 1991 under contract to the military. The 39-foot tall, 42,000 pound, unmanned, fully reusable DC-X experimental vehicle made eight test flights, demonstrating that such rocket-powered systems could be built and operated. As the first phase of the DC-X program ended with several successful fully reusable flights, a 1995 revision to the National Space Transportation Policy placed responsibility for developing fully reusable space access capabilities under NASA. Once again, the military, even though making significant progress, was taken out of the picture by national political priorities.

This policy change placed developing fully reusable space access into political conflict with NASA's jobs- and budget-heavy "800-pound gorilla" called the Space Shuttle. If the fully reusable space access approach had become successful, then the Shuttle program would have ended. The only political path forward for the fully reusable approach was to try again for an SSTO solution. Such a technically demanding approach would protect its development funding in the budget process, because politicians would view the potential of it really threatening the Shuttle program as very unlikely.

Like the NASP program before, the guiding national policy was flawed in that preference was given to the Space Shuttle and ELVs. The common sense next step of developing a fully reusable TSTO system, even as a demonstrator to prepare for the future, was pushed aside in favor of another high-risk, but politically safe, SSTO approach. What was most unfortunate with the X-33 program was that it did not reach flight testing because an inadequate technical design was selected from the competing designs. (The design selected was not from the company that had done the DC-X effort.) Even if the X-33 had not reached orbit, the technical information gained would have been very useful for future programs. Unfortunately, the X-33 program was cancelled after the propellant tank's ground structural test article failed prematurely, casting doubt on the overall airframe design approach, since the SSTO airframe is essentially a large propellant tank.

The one good aspect of these past 30 years has been the growing competence of the US aerospace industry in on-orbit operations. The International Space Station (ISS) program has kept this segment of the industry engaged developing capabilities that will now be needed to undertake building the LEO component of the integrated spacefaring logistics infrastructure. However, manned space access of the type needed by a true human spacefaring nation has been withering for over a generation and this must be rebuilt.

VI. Where to Start to Become Spacefaring and Energy Secure

Politics is how a society establishes priorities and allocates resources to achieve these priorities. While it would be nice if this happened in a logical and amiable manner, this is not how real life works. Emotion and passion establish priorities among many competing issues. Political leaders exercise the public's passion to elevate some issues onto the warning radar screen of the body politic to become an issue of serious concern warranting attention to resolve. Elected officials then, using their legal and political powers, reallocate resources to address the issue. For the critical issue of America's now inadequate future energy security, who first should be waving the red flag of warning of a serious national policy issue needing to be addressed? Engineers, as this is why the profession exists—to protect the public.

A. Engineering Societies Must Take the Lead

As previously discussed, White's Law is expressed generally as:

$$\textit{Energy} \bullet \textit{Technology} \rightarrow \textit{Standard of Living}$$

At the very heart of White's Law is technology. Technology is the instrument of true progress elevating the standard of living and the instrument of problem resolution when the standard of living is threatened, as it is now by the end of affordable fossil fuels.

The earlier calculations clearly show that the domestic endowment of technically recoverable fossil fuels will be depleted this century. The science and technology needed to build replacement sustainable energy sources exists, so the resolution of this critical issue is <u>not</u> a fundamental scientific research problem but is an engineering challenge. Hence, what is now needed is the detailed engineering work necessary to deploy known science and technology into the specific hardware and software designs and industry that will build the new space-based power industry and the enabling spacefaring logistics infrastructure.

Unlike the 1800s and early 1900s, when engineers like Robert Fulton and Nicholas Roosevelt, John and Washington Roebling, and the Wright Brothers were well known to the public, no prominent engineers have an effective political voice in America at this time. Today, engineering societies speak to the public on matters of national technological importance—or, at least, they should. On the strength of the quantitative data available, America's engineering societies should be taking on the task of elevating American energy insecurity onto the radar warning screen of the body politic and, through letters, testimony, and presentations, educate the American public and its elected representatives on the seriousness of this issue and its needed solution.

B. Presidential Leadership Is Critical

The need for America to become energy secure has existed since the 1970s without any effective presidential political leadership to make this happen. It will not happen without committed presidential leadership. Hence, the commitment for America to become a true human commercial spacefaring nation must start at the very top with a clear presidential policy to have America become energy secure using sustainable space-based power. Obtaining this commitment will be a significant challenge, because of the ignorance of political leaders in recognizing national energy insecurity as an issue needing immediate national political attention. Only the election of a president in 2016 who acknowledges this will make this politically possible for the next eight years. Otherwise this issue will be in conflict with everything promised during the campaign—priorities, funding, and legislation.

C. With Such a New President, the Starting Point Is Policy

As the nation's chief executive, each president promulgates the execution of the president's constitutional duties by issuing executive orders. One form of an executive order is a formal statement of national security or foreign policy. These are generally referred to as Presidential Decision Directives, with the subject of each directive being a statement of policy on a particular topic or a tasking to undertake a particular action. If a national security topic believed to be of national significance is not addressed by a Presidential Decision Directive, it is unlikely to warrant much attention by that administration.

With the new presidential administration in 2017, the starting point to address America's energy insecurity is to establish or revise these four national policies:

- National Energy Security Policy
  - National Space-Based Power Policy
- National Space Policy rewritten as the National Spacefaring Policy
  - National Space Transportation Policy rewritten as the National Spacefaring Infrastructure Policy

D. New National Energy Security Policy

The United States has fought wars and continues to deploy significant military forces overseas, at great human and monetary cost, to protect its oil supplies. Also, it has invested billions, often foolishly, in sustainable energy technologies that lack practical scalability. All of this has been done in the absence of a formal national energy security policy. No president has yet said that the United States should be energy secure or has clearly defined how this is to be accomplished.

A formal policy commitment by the next president to US energy security is necessary to focus the nation's resources on making the United States energy secure. *The primary policy objective should be for America to become energy secure with affordable sustainable energy sources, under its legal control and military protection, to replace fossil fuels by a year established by the president.* The president would make clear that the policy is needed to maintain America's national security, economic prosperity, and standard of living as the era of affordable fossil fuels unavoidably ends.

E. New National Space-Based Power Policy

Subordinate to the National Energy Security Policy would be a new National Space-Based Power Policy. This policy would establish the goal for the United States to replace fossil fuels with reliable and secure space-based power production delivered to America and delivered to US spacefaring enterprises in space by electromagnetic power transmission. The policy would guide the establishment of a new National Space Power Agency to oversee the private sector's development, construction, and demonstration of US-owned space-based power production systems and to develop an integrated private space-based power industry. The policy would also establish appropriate national defense responsibilities for the protection and defense of the new space-based power industry.

F. National Space Policy → National Spacefaring Policy

Each new administration releases an updated National Space Policy. The current policy, released in 2010, has these goals: energize competitive domestic industries, expand international cooperation, strengthen stability in space, increase assurance and resilience of mission-essential functions, pursue human and robotic initiatives, and improve space-based Earth and solar observation. These bland goals are obviously intended to maintain the current American paradigm of limited space operations primarily focused on robotic science programs and only infrequent government human operations.

To be fair, there are important elements of the current policy, such as the use of nuclear power in space and radiofrequency spectrum protection. However, the entire policy needs to be refocused, starting with the title. "Space" is merely a place. Policies guide activity and should be appropriately named.

Undertaking space-based power will clearly be a spacefaring undertaking. *The revised and renamed National Spacefaring Policy should make clear that a fundamental transformation in US operations throughout the Earth-Moon system will begin.* To the current categories of military/intelligence, government human operations at the ISS, commercial satellite operations, and government robotic science and exploration projects, *will be added the establishment of routine and continuous government and commercial human operations throughout the Earth-Moon system*. This will include, but not be limited to, transportation and logistics; research and development; fabrication, assembly, maintenance, and operation; commercial resource exploration; natural resource recovery and extraction; settlement; protection and defense; and emergency services. This revised policy will guide the paradigm shift from the past focus on limited human operations in space to the new normal of extensive human operations in space.

G. National Space Transportation Policy → National Spacefaring Logistics Policy

The National Space Transportation Policy is subordinate to the National Space Policy. The National Space Transportation Policy has been where specific directions regarding space transportation systems and organizational ownership have been defined. Consistent with the expansion of the National Space Policy into the National Spacefaring Policy, the National Space Transportation Policy must expand in name and scope to address the national needs for creating an integrated spacefaring logistics infrastructure extending throughout the Earth-Moon system. The National Space Transportation Policy should become the National Spacefaring Logistics Policy.

The name change emphasizes to the public the paradigm shift in human spacefaring operations that must now be undertaken to enable America's energy security to be achieved through space-based power. Earth-to-orbit space transportation is, after all, just one part of what it will take logistically to open the Earth-Moon system to routine, frequent, and safe government and commercial human operations. Hence, the name change will help to emphasize that the age of human space exploration, within the Earth-Moon system, is transitioning into the age of human spacefaring commercialization. Of course, human space exploration will not end, but will, in fact, expand as the new spacefaring logistics and space-based power transmission capabilities make human exploration far more affordable and safe.

A key part of the updated policy will be to integrate the first initial government and commercial spacefaring logistics operations. Routine, frequent, and safe operations of Americans throughout the Earth-Moon system will be necessary for companies to undertake developing, building, and operating space-based power systems. This requires that a substantial and almost entirely new spacefaring logistics infrastructure, operating throughout the Earth-Moon system, be established. The policy should make clear that the Federal Government will lead this effort in a manner that will foster substantial new entrepreneurship within America and will engage all sectors of America, economically and geographically, in this spacefaring transformational effort.

In this rewritten policy, specific direction should be established to:

- Implement a National Spacefaring Logistics Agency to oversee the implementation of this policy in an effective and integrated manner and undertake the government responsibilities defined in this policy.

- Extend aviation airworthiness certification to human spaceflight. To maintain independence, this should be undertaken by the Federal Aviation Administration.

- Develop, and bring into operation, airworthiness-certified, commercial, fully reusable, TSTO space access systems capable of transporting passengers and cargo to and from LEO. Establish a Civil Reserve Space Fleet, under the control of the Department of Defense, and incorporate these new systems into this fleet.

- Develop and bring into operational status the Space Launch System to be used for transporting large and oversize cargo and payloads to LEO and for use in launching payloads into higher Earth orbits or on Earth-escape trajectories.

- Build and bring into operational status an initial Space Logistics Base—with a space dock and co-orbiting space propellant depot—in an LEO "logistics" orbit at an orbital inclination close to 30 degrees.

- Upgrade and extend the Kennedy Space Center to accommodate the terrestrial spaceport needs for implementing the new National Spacefaring Policy and National Spacefaring Logistics Policy.

- Upgrade and extend the Johnson Space Center to train the government and commercial space operators necessary to undertake these new logistics capabilities.

- Utilize the manned spaceflight capabilities developed under the NASA Commercial Crew Program to transport government and contractor personnel to LEO to undertake the assembly and initial operation of the Space Logistics Base.

- Utilize competitive commercial launch capabilities to transport freight and small-medium payloads to LEO to support the assembly and initial operation of the Space Logistics Base.

- Direct NASA and the USGS to survey lunar and asteroidal natural resources to support future commercial spacefaring operations.

- Deploy the initial US Space Guard capabilities.

VII. Conclusion – What This All Means

The future national security of the United States depends on having sufficient and affordable sustainable energy supplies. Current efforts to achieve this through haphazard, non-integrated attempts at ground-based renewable energy are inadequate. Quantitative analyses, shown herein, establish that the current approaches will simply not work. Energy security is certainly one area where ignorance of the facts will only bring disaster and waste.

Space-based power transmitted to ground receiving stations is the only approach to sustainable energy that is capable of being scaled up to meet US energy needs. This, however, requires that a spacefaring industrial revolution be undertaken to transform America into a true human commercial spacefaring nation. The scope and favorable impact of this transformation on American society will be immense.

The starting point of this transformation is to do what government typically does best—build new infrastructure. At the same time the research and development of the approaches to be used to actually design and build the space-based power industry are being developed, the Federal Government, in partnership with private industry, must first build the enabling spacefaring logistics infrastructure. In doing this, America must pursue the common sense path of creating a new spacefaring logistics infrastructure comparable in safety and operational effectiveness to the commercial airline industry.

The bottom line that every American needs to understand is that time is not on our side. The rapidly growing American population, driven by immigration, is depleting America's remaining technically recoverable fossil fuel endowment at an increasing rate. Drawing on White's Law of Cultural Survival, our increasing fossil fuel energy demand is bringing the end of the era of affordable fossil fuels dangerously close—perhaps only 60 years—without any sound sustainable energy security plan to replace these fossil fuels. The only way to characterize this is cultural suicide.

The need to bring the critical issue of national energy security to the public's attention is obvious. The only groups positioned within American society to do this effectively are the national engineering societies. It is time for these societies to promote national energy security with sustainable energy and identify space-based power as the only practicable way to achieve this.

America has faced an energy security crisis before when coal rescued an economy faced with diminishing wood fuel supplies. In the process, the American economy and prosperity soared as per-capita supplies of affordable energy increased through the use of domestic fossil fuels. Becoming energy secure with sustainable space-based power will bring the American dream of becoming a true spacefaring nation into reality. It will be technologically challenging and costly, no doubt, but it will also be a lot of fun!

****

About the Author: James M. (Mike) Snead has wide-ranging systems and structural engineering experience from a variety of significant projects including the X-30 National Aerospace Plane, Delta Clipper Experimental (DC-X), and USAF Transatmospheric Vehicle (TAV). He holds an MS in Aerospace Engineering from the US Air Force Institute of Technology and a BS in Aerospace Engineering from the University of Cincinnati. He is a registered professional engineer in the State of Ohio and a graduate of the Department of Defense's Advanced Program Management program (in residence). He has chaired the AIAA Space Logistics Technical Committee and is an Associate Fellow of the AIAA.

Mike was the Project Engineer for the Air Force TAV Project Office where he led the technology readiness assessment for a fully-reusable, manned, space access system. Following establishment of the National Aerospace Plane Program (X-30), he was the Chief Flight Systems Engineer (Phase I) and Lead Structures Engineer (Phase II) in the X-30 Joint Program Office Systems Engineering Division. Later, he was a name-requested Government Technical Consultant for the DC-X Program – supporting this program through the fourth flight test – and served on the X-33 source selection. He developed systems engineering concepts for an integrated spacefaring logistics infrastructure focusing on fully-reusable to-space and in-space transportation capable of achieving the equivalent of airworthiness certification for safety. His primary efforts were developing fully-reusable, rocket-powered, TSTO system concepts using current technologies as well as concepts using advanced airbreathing propulsion.

Prior to his focus on space systems, Mike worked in the Air Force Aeronautical Systems Center's Engineering Directorate doing both original engineering and contractor structural engineering oversight on a diverse range of aircraft including the F-4, F-111, C-141, and Saudi AWACS. He served on the Executive Independent Review Team assessing first flight readiness for the YF-22 and YF-23 Advanced Tactical Fighters and on the F-22 independent cost team. While working in the Air Force Research Laboratory, He served as Lead for Agile Combat Support where, in addition to focusing on future space logistics, he co-developed the Configurable Air Transport (CAT) tanker and air mobility concept. He also initiated and led a wide-ranging futures wargaming effort, reporting to the Air Force Chief Scientist, focusing on advanced military weapons system conceptualization.

In addition, he established and leads the Spacefaring Institute LLC with a special focus on space solar power and the integrated spacefaring logistics capabilities needed to make space solar power a primary sustainable energy supply capability. In this effort, Mike has published several papers and a YouTube video on space solar power and the enabling spacefaring logistics capabilities.

Editors' Notes: Mike Snead is one of the world's leading energy researchers and a frequent publisher in the Journal of Space Philosophy. In this article he broadens his scope to the macro issue of the United States becoming a Spacefaring nation and resolving Space Faring logistics, Space leadership and policy, social problems like immigration and culture along with energy security which will translate to overall national security, He states that the Space industrial boom is about to begin and tells readers how the financing for these revolutionary changes can be managed. ***Bob Krone and Gordon Arthur.***

Journal of Space Philosophy 4, no. 2 (Fall 2015)

Passing the Philosophic Torch of Basic Rights and Freedoms for Space Migrants to Evolve and Survive … Or Become Extinct: A Proposed Modified US Declaration of Independence and Future Constitution Applicable to Long Duration and Permanent Spacekind Inhabitants

By George S. Robinson

Abstract

The Unites States and the Soviet Union, along with others, developed a framework for a basic Space law in the Outer Space Treaty of 1967. This is still the basis for Space law, but it has specific provisions on universal rights. This article suggests that the US Constitution, Declaration of Independence, and Bill of Rights offer a model of such rights that Spacefaring nations can and should adopt. It offers a Declaration of Negotiable First Principles for the Governance of Earth Originated Outer Space Civilizations and Their Inhabitants as an example of how this might work.

Keywords: Space law, US constitution, Bill of Rights, Outer Space Treaty, Principles for Space governance.

Introduction

The US Declaration of Independence and the US Constitution … as well as very similar documents of other Free World nations … can serve as a *prototype example* for a long-duration and/or permanent space society and civilization. Or would totally different mandates be required for totally different life-support venues? Let us start with the one document we should know best in the United States.[1]

---

[1] It should be noted at the outset that the ensuing discussion is a *personal "declaration of conscience"* of the present author, i.e., a declaration of humankind rights and freedoms, and the guardianship roles of space law and space lawyers with respect to the ongoing evolution and adaptation of the human genome and the essences of *Homo sapiens sapiens*, of modern humankind, and its evolving descendants. It is a reflection on the imperfect past of the Constitution, its interpretation and application, and its very questionable interpretation and application in the present. It also reflects the hopeful future history of space law, embracing and representing the principles of social order between and among varying species with sentience, with abstract perception capabilities *in extremis,* and all in a truly unique medium where human biochemistry and evolving technology are integrated for survival in a fashion and for purposes having no equal. This declaration of conscience is offered by a deeply concerned, but ever hopeful, servant of space philosophy, and concern to implement positive laws that have yet to embrace a definitive bill of humankind rights to "extinguish from the bosom of every member of the community," as James Madison asserted almost two hundred years ago, "any apprehension that there are those among his countrymen who wish to deprive them of the liberty for which they valiantly fought and honorably bled." The time to fight for those liberties and acceptable variations in space is now.

The US Constitution was drafted in 1787 and then ratified two years later in 1780.[2] But it was the Declaration of Independence[3] and a specific Bill of Rights[4] that convinced leaders of the English colonies in America, such as Thomas Jefferson, James Madison, and George Mason, that the subsequent Constitution would not be … could not be … a shallow and impotent document largely reflecting wishful thinking. In a letter to James Madison, Thomas Jefferson wrote that "The Bill of Rights is what the people are entitled to against every government on earth, general or particular and what no just government should refuse or rest on interferences."[5] The efficacy, of course, rests solely on the actual manner of its implementation by governing authorities.

But it is not just the Constitution, generally, that may well provide the platform for understanding what were and are considered the inherent rights of all humankind. It is particularly the Bill of Rights that was drafted in 1789 and ratified in 1791 that made it clear that these rights penetrated every facet of governmental authority and everyday decisions and conduct in order to protect and promote the inherent, indeed Natural Law premised, rights of every human individual against potential compromises and impositions, unjustifiable excesses, committed by those elected and appointed to govern. As the international community prepares humans, *trans*humans, and post humans[6] for ever-longer terms and permanent occupation and settlement off-Earth, we seem to be

---

[2] For an excellent concise history of the evolution and establishment of the United States Constitution, see "Constitution of the United States: A History" online at www.archives.gov/exhibits/charters/constitution_history.html.

[3] For a brief, but helpful, discussion of the history of the US Declaration of Independence, see "Declaration of Independence: United States History" online at www.britannica.com/topic/Declaration-of-Independence and at www.archives.gov/exhibits/charters/declaration_history.html.

[4] The Bill of Rights is embraced in the first ten amendments to the US Constitution. For a listing of the Bill of Rights and a brief discussion of its history, see "The Bill of Rights: Its History and Significance" online at law2.umkc.edu/faculty/projects/ftrials/conlaw/billofrightsintro.html.

[5] What Jefferson was not in a position in those times to understand was the empirical basis underlying the philosophic construct giving rise to the Declaration of Independence and the Constitution. That construct is premised on Natural Law Theory (see Black's Law Dictionary, 4th ed. [St. Paul, MN: West, 1951], 1177 for a helpful discussion of Natural Law Theory, or *jus naturale*, in the ages of the Antonine and Stoic doctrines, i.e., the incipient stages of recognizing that all life and biotic behavior is controlled by the dictates of a quantifiable nature). Unknown during the formulation of the Declaration and the Constitution was the issue, regardless of the answer, of whether survival of an individual or society is a product of chance or the result of infinitely complex relationships that are created and directed in a predetermined fashion, as dictated by a "single, basic, underlying law of energy." Further, is the whole truly greater than the sum of its parts? Natural Law is greater than the sum of all jurisprudential characteristics, which are greater than the sum of the parts of all implementing positive laws. Regardless of the methodology followed to determine the question of neurophysiologically predicated decisions versus subsequent free will selection of questions and answers embraced in the context of abstract perception *in extremis* and individual and collective essences, the answers will be found only in the relative short term by the discipline of quantum physics.

[6] As we meld human biology with technology, we create an entity that transitions into a totally self-sufficient, independently thinking entity referred to as post human. And as we continue to design and create these entities that will be required to survive in an otherwise hostile environment, also *in extremis*, it is essential to be ever so sensitive to the need for unparalleled principles of law that will allow this type of spacekind progeny of humankind the necessary safeguards to survive in space as truly free "envoys of humankind." In this context, see G. Robinson, "METALAW: From Speculation to Human*kind* Legal Posturing with Extraterrestrial Life," *Journal of Space Philosophy* 2, no. 2 (2013): 49-56; and also G. Robinson, "The Biochemical Foundations of Evolving Metalaw: Moving at a Glance to the Biological Basis of Sentient 'Essence'," *Journal of Space Law* 39, no. 1 (2012): 181-216.

overlooking … perhaps have even forgotten … this core of humankind motivation and evolution. It is the only heritage that struggles to separate and ensure that our descendants who inhabit outer space, temporarily and permanently, will do so absent the dictates of totalitarians, imperialists, and military ideologues.

Space is not just another object of idle, but extraordinarily expensive, curiosity, as space research has been called by various presidents and other world leaders. Quite unfortunately, migration to and settlement of off-Earth locations in space and on other celestial bodies for the purposes of humankind genome survival is faced with a rapidly dwindling interest globally; certainly in terms of having space settlers and "envoys of humankind" carry with them and abide by such US Constitutional rights as freedom to exercise religious beliefs, free speech, peaceable assembly, and the right to petition the governing body for redress of a grievance; to be secure from unreasonable search and seizure; not to be subject to double jeopardy and self-incrimination; not to be deprived of life, liberty, or property without due process of the law; to be tried speedily by an impartial jury; not to be subjected to cruel and unusual punishment; not to be enslaved; and to retain all those basic human rights and freedoms *not specifically given up.* Clearly, given the somewhat unique circumstances of survival by off-Earth space inhabitants and the type of interim Earthkind support required, these rights must remain very flexible in terms of how they are formulated … perhaps unique and innovative … and interpreted and under what circumstances; and then how they accommodate progressively discovered empirical dictates and apply them appropriately in each situation. The same is true, of course, in terms of the application of these rights and freedoms on Earth, but the unique challenges in off-Earth survival will require extraordinarily careful and detailed study, modification where necessary, and application … without losing the spirit and relative intents of the underlying principles set forth in the Bill of Rights.

Without a rather creative and intense refocusing of these basic humankind freedoms in their applications to long-term and permanent space inhabitants, the underlying principles will never be restored to the ongoing evolutionary odysseys of humankind and its evolving essences in space. Again, space must not be considered just another place for migratory curiosity to express itself … certainly not as our military servants would have us believe. To the contrary, space must be considered an arena for the continuous exercise of evolving and finely tuned basic humankind rights and those of its *trans*human and post human descendants … and a reasonable document from which to pull and assess the relevant principles may well be the US Constitution. Without an intense and very careful refocusing of those rights in a space society ambience, the underlying principles and appropriate variations in interpretation and application will never be restored to the continuing humankind evolutionary odyssey off-Earth.

For the moment, near and deep space are the only loci where the hard-won lessons of ecumenical politics, economics, and theology can be put in place and tested for our permanent extraterrestrial descendants, i.e., our own sons and daughters, grandsons and granddaughters, and evolving human essences embraced in *trans*human and post human individuals and populations … *ad infinitum*. But what makes the American movement into space, both nationally and collectively premised on significantly interdependent collaboration with other nations, more than another cycle of economic and military imperialism? What may be even unique about what the United States has to offer humankind's ongoing survival migration off-Earth? Perhaps, in the final analysis, it is an ideology and governing structure committed to its traditional basic and collective human*kind* rights and sentient capabilities allowing the survival and evolution of our species essence, regardless of what part of the known Universe those individuals occupy … inhabit.

It is too terribly facile to sacrifice unwittingly these rights, these hard-won principles, in the name of raw survival expediency (on Earth as well as in space) once long-term and permanent habitation of humankind in space is established. These rights must not be treated casually and distorted by current and future parochial domestic politics and geopolitical alliances. These basic rights must not be allowed to be distorted for the sake of domestic political conveniences, twisted by international arms control posturing, or cramped as well as liberated by international pragmatism about technological capabilities, monumental costs, and staggering domestic and global fiscal deficits. It would not be surprising to see basic human rights addressed in the US Constitution sacrificed principally, if not solely, in order to obtain military objectives in the use of near and deep space.[7]

The rather ephemeral start-up principles agreed to by the leading nations in early space activities, principally the United States and the former Soviet Union, long before anyone knew whether outer space really could or even would be explored and exploited successfully, were articulated in the 1967 Outer Space Treaty[8] in the following manner:

- Space exploration shall be conducted for the benefit of all countries, and shall be the province of all mankind.

- Outer space and celestial bodies cannot be claimed by any country for itself.

- Space research is to be carried out in the interest of furthering international cooperation, understanding, and peace everywhere.

- Outer space may not be used for the placing of nuclear weapons or other weapons of mass destruction, nor shall there be any military bases,

[7] It is interesting to note the serious concerns being expressed about the diminishing relevance of space treaties and applicable implementation of domestic laws being addressed by leading space law experts, space engineers and scientists, space program and project economists, and the like, at an August 2015 conference held in Greece. The subjects addressed at the International Conference on New Challenges in Space Law – The Space Treaties at a Crossroads, include (1) the rationale and scope of space treaties, (2) challenges to the rescue agreement and the liability convention, (3) challenges to the registration convention, (4) challenges to the space treaties resulting from new space-related activities, (5) space treaties and the rising concern about environmental issues, (6) the commercial exploitation of space-related resources, interaction with other seemingly related legal regimes, and (7) where and how should international space law be created.

[8] The *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodie*s entered into force for the signatories in January 1967. For a full statement of the Treaty and its provisions, see history.nasa.gov/1967treaty.html.

installations, or fortifications, maneuvers, or weapons testing in outer space.

- Astronauts shall be considered as envoys of mankind and shall be given assistance and protection in their endeavors.

- States, governments, and international organizations shall have certain liabilities for activities and accidents arising from space exploration.

- Efforts will be made to avoid contaminating celestial bodies or harming the Earth environment as a result of the introduction of extraterrestrial matter.

Nowhere, however, in all of the related domestic laws and international agreements is there a definitive embracing of human and humankind rights and freedoms in space. There is no space law … currently … that incorporates or specifically embraces and articulates a definitive bill of rights and freedoms for humankind, transhumans, and post humans while living in the synthetic and alien life-support environments of off-Earth space … no bill of rights to "extinguish from the bosom of every member of the [space] community," as James Madison so eloquently observed a couple of hundred years ago, "any apprehension that there are those among his countrymen [i.e., fellow space inhabitants] who wish to deprive them of the liberty for which they valiantly fought and honorably bled." Inflexible lessons from Free World history!

Those involved in the growing use of space for military purposes, starting initially under the umbrella of the US Strategic Space Initiative,[9] must not disregard the fact that these activities by the United States independently and collectively with its allies are designed to protect not only the United States and the so-called Free World, but also the concept and principles upon which the United States and most of the prevailing and future Free World were, and will be, founded. It is the regime of space law, a strange and often bewildering mosaic of public and private, domestic and international principles of law, that must be constantly reviewed as the shelter and guardian of human and humankind rights (and duties to one another). At times and under certain circumstances, components of this body of law still make infinite sense to all signatories. More often than not, it is becoming non-responsive and insensitive to developing space capabilities and activities traditionally considered to be peaceful, civilian, and non-military. Interpretations and proposed amendments to various bodies of space law are bound up in precatory assertions of the obvious frequently assumed by lawyers and statesmen to be tightly and carefully drawn legal positivisms. Good or parochial and self-serving, sensible or confounding, forthright or intentionally deceptive, space law and its underlying philosophic construct derived from the essence of Natural Law Theory exists in many respects in the helter-skelter image of the evolved law of the high seas.

[9] The Strategic Defense Initiative was first proposed by President Ronald Reagan during a nationwide television address on March 23, 1983. Because parts of the defensive system that the President advocated would be based in space, the proposed system was dubbed "Star Wars" after the space weaponry used in the popular movie of the same name.

Conclusion

Space law positivisms deriving from the principles of space jurisprudence are not always concise and clear to those who adopt and implement them. Space law is not effectively codified, except perhaps in domestic law positivisms. But whatever international space law is intended to achieve, peacefully and/or militarily, it does not embrace a clear and definitive statement of humankind rights. Nevertheless, as this body of law evolves through applications and changing space capabilities, it has the potential for doing what is desired, as long as Free World nations are committed to the long-term values with which humankind started its journey and evolution in space. What is important for species migration, adjustment, mutation, accommodation, and survival … or extinction … is the philosophic and empirical methods relied on, and not just that evolving technology has made it possible. Also, as we meld human biology and technology into a unique entity of Spacekind, we must be ever so sensitive to the need for unparalleled principles of law that will give them the necessary safeguards to live in near and deep space as truly free envoys of Earthkind … or as a totally separate and distinct species.

Unfortunately, throughout the comparatively embryonic history of space law, interpretive continuity has reflected primarily the efforts of lawyers, statesmen, and political/military strategists to make highly questionable, if not invidious, rationalizations of the true spirit and intent underlying much of domestic and international space law. Collectively, these rationalizations and accommodations have outraged the intellectual chastity of many of the initial students and practitioners of the discipline. Space law was considered a transcending and unique legal regime that for many reflects humankind's deeply felt hopes and aspirations that moving into near and deep space would constitute exploration, migration, and exploitation, for peaceful purposes only … "for the benefit of *all* humankind."

Human movement into and occupation of off-Earth space has been one of those rare and unique opportunities in the history of human cultures furthering biological and biotechnological survival … a unique opportunity in the history of disparate human civilizations to break the seemingly endless cycles of economic imperialism, colonialism, denial of basic human rights, and the subsequent violent confrontations that inevitably follow. This personal declaration of the present author's conscience hopefully will help serve, amidst the extraordinarily brutal contests between and among varying cultures and religions, as a sharp if not shrill clarion call among jurists and laymen alike to focus attention on the US Constitution (and clearly similar documents) and its Bill of Rights, which embrace universal humankind values. These values allow the very essence of the species and its evolving descendants to focus on the absence in human affairs of outer space of any carefully considered and crafted assertions of inalienable and basic humankind rights and freedoms; and the critically imperative need to define them and clearly articulate them.

Toward this end, the present author encourages assessment of the following suggested Declaration of Negotiable First Principles for the Governance of Earth Originated Outer Space Civilizations and Their Inhabitants:

PREAMBLE[10]

We, the undersigned Petitioners,

- Bearing witness to the exploration and inevitable permanent settlement of outer space by humankind and its evolving descendants;

- Recognizing the universal longing for life, liberty, equality, peace, and security for all long-term and permanent inhabitants of near and deep space;

- Expressing an unshakeable belief in the dignity of the individual and the societies and civilizations of which they are component members;

- Placing trust in societies that guarantee their members full protection of law, due process, and equal protection under the law;

- Reaffirming a faith in existing and yet to be determined fundamental freedoms inherent in space societies and civilizations;

- Mindful of the self-evident truth that all humankind and its descendants were endowed by the Creator with certain inalienable rights and responsibilities;

- Recognizing the responsibility of Earth-indigent governments and space governments and, indeed, all governing entities present and future, to protect the rights of the governed spacekind to exist, evolve, and practice their established and evolving personal and collective freedoms under a Space Bill of Rights,

Do assert and declare in this petition the intrinsic value of a set of First Principles for the Self-governance of Outer Space Societies and Civilizations, and urge all of Earthkind and Spacekind to acknowledge, accept, and apply such First Principles as hereinafter set forth.…

****

About the Author: Dr. George S. Robinson, III is a space law pioneer and international space expert. His book, book chapter and professional article publications – over 100 – are found throughout the aerospace and Space literature and continue to date. He served as International Relations Specialist for NASA, legal counsel to the FAA, and legal counsel at the Smithsonian Institution in Washington, DC. He serves on numerous Boards of Directors for science research. Dr. Robinson was a strong supporter of the Aerospace

[10] For an expanded discussion of certain aspects of the suggested preamble appearing in the context of a celebration of the Bicentennial of the US Constitution, see G. Robinson "Essay – Re-Examining our Constitutional Heritage: A Declaration of First Principles for the Governance of Outer Space Societies," *Berkeley Technology Law Journal* 3 (1): 81-89.

Technology Working Group, which was the forum from which Kepler Space Institute and University emerged.

Dr. Robinson has taught and lectured in law and business relating to space commerce at numerous universities in the United States and abroad, including George Mason University, Oxford University, McGill University, George Washington University, and Georgetown University. He serves on the board of directors for various science research facilities, foundations, and hospitals. He has also consulted for the National Research Council, the Smithsonian Institution, the Department of the Interior's Remote Sensing Data Archives, the Maritime-Aerospace Liaison Project of the Maine Maritime Academy, and NASA, where he serves on the Planetary Protection Advisory Committee.

Editors' Notes: Our esteemed colleague, Dr. George S. Robinson, a global Space Law pioneer throughout his long professional career, here emulates our US forefathers and provides leadership of the world in his set of principles and foundations for *human*kind rights and freedoms in Space, This is a milestone article in the fifty-year evolution of thinking, writing, and talking about governance human settlements in Space, This article forms part of a trilogy of new publications focused on the essential need to create guidance and policy for human behavior and leadership if the failures on Earth are to be prevented in humanity's movement to Space. The other two articles in that trilogy are Yehezkel Dror's "Preventing Hell on Earth" and Stephanie Lynn Thorburn's "Progressive Etudes on Consciousness and Noetic Sciences," both in this edition of the *Journal of Space Philosophy*. ***Bob Krone and Gordon Arthur*.**

Journal of Space Philosophy 4, no. 2 (Fall 2015)

Progressive Etudes on Consciousness and Noetic Sciences

By Stephanie Lynne Thorburn.

Cover image for *The Astrosociological Imagination'*, with art and prose by *Stephanie Thorburn*, illustrating space advocacy themes.

Excerpts from *World Ontology*, representing the *Thought Matrix* educational series by author Stephanie Lynne Thorburn.[1]

Introduction

The aim of *Progressive Etudes on Consciousness Studies* is to define concepts of *new humanism* and the fruition of higher consciousness through enhancing human conscience and creativity.

This work is dedicated to Gaia Earth, in the context of the growing insular fragility of both Earth and humanity. The text embraces definitions of *homo noeticus* or new humans, evolving in an age of both practical and philosophical crises. Humanity's nascent environmental conscience is contextualised through the complementary ethos of *The Overview Institute.* The mission of the institute is to accomplish global unity and a shift in the cadence of human consciousness through the establishment of a *holistic* world view.

A consistent ethical theme evoked throughout the author's work is the challenge of human progress in light of our increasingly enhanced technological capacities to ensure human survival. Technology is juxtaposed thematically with human empathy

[1] The work has also been developed in the spirit of supportive resonance for the 39th Annual Conference of the *International Institute of Integral Human Sciences* (IIIHS) and the *Spiritual Science Fellowship* (SSF). Themes addressed encompass new-humanism, higher consciousness, and a desire for the establishment of global peace. (Succinct summary information on *IIIHS* and *SSF* is included at the base of this précis paper. The reference index includes information on a range of resourceful independent organisations related to consciousness studies, ecology and noetics sciences. The organisations highlighted reflect admirable humanitarian goals that have been researched and recommended by the author.)

for the natural environment. The discussion is enriched through an integration of academic research, astrological concepts, and cultural insights.

Stephanie Lynne Thorburn is an author, social researcher, and Reiki Master, who has written texts on academic and holistic spheres; she also has a notable penchant for nanotechnology issues and engages with environmental politics. All these facets are represented in this vignette work, encapsulating themes represented in *World Ontology.*

Key Concepts & Themes: Human progress, transformative studies, the Overview Effect, new humanism, global peace, paradigmatic science.

Theorists: Dr. Edgar Mitchell, Frank White (Overview Institute), author Stephanie Lynne Thorburn, *Thought Matrix* series.

Overview: The Concept of *Homo Noeticus*

Prose by Stephanie Lynne Thorburn.
Progressive and avant-garde reading in the parapsychological domain frequently refers to the notion of *homo noeticus.*[2] The concept being evoked is related to humanity's potential to evolve towards a heightened state of consciousness and intellect. *Homo noeticus* is essentially a *new human*, originating from a nascent generation, with new, refreshing beginnings. I am not convinced the notion of *homo noeticus* is avant-garde for those with a spiritual or ecological conscience. Earth and humanity are facing challenging times; undoubtedly admirable human qualities extend beyond the remit of individuals and concern the need for a conceptual reassessment of our environmental crisis. I hold a conviction that humans would benefit through a greater intellectual curiosity, pertaining to the restoration of cultural confidence in constructive advances achievable through technology. Popular fictional classics such as Orwell's *Nineteen Eighty-Four* and Huxley's *Brave New World* express inherently dystopian anxiety connected to philosophies such as *transhumanism*.[3] I resonate with the integrated perceptual insights of new humanism. To ensure the survival of Gaia Earth, perhaps humans must first overcome our dependence on fossil fuels, embracing a genesis in understanding and application of the technological sphere. This may be one of our fundamental challenges in cultivating the realisation of the evolving construct of *homo noeticus*.

Gaia Earth – Igniting Global Consciousness: The Overview Institute.

World Ontology includes a resume and vignette from some of the author's postgraduate published work on the emerging sphere of *Socioastronomy*. This work is connected to the ethos of the Overview Institute, welcoming a shift in global

---

[2] The conceptualisation of new humans or *homo noeticus* is illustrating a new age paradigm. The fruition of advancing human intellect is expressed through specific conceptual schemata related to honing human rational and emotive cognitive skills. See Mary Rodwell, "The Star Children," Australian Close Encounters Resource Network (*ACERN*), www.thelosthaven.co.uk/StarKids.html.

[3] Kyle Munkittrick, "Science not Fiction," Editorial, *Discover Magazine*. September 2010, blogs.discovermagazine.com/sciencenotfiction/2010/09/15/the-most.... This is an evaluative discussion on scientific advances and transhumanist fiction encompassing critical insights on Darwinism, Orwell, and transhumanist ethics. For further contextual discussion and the key precepts of transhumanism, see Sebastian Anthony, "What Is Transhumanism, or, What Does It Mean to Be Human?" *ExtremeTech Newsletter*, April 2013. www.extremetech.com/extreme/152240-what-is-transhumanism-or-what-does-it-mean-to-be-human

consciousness, grasped though realisation of the vulnerability of planet Earth perceived as a fragile ball of life, shielded and nourished by a fractured atmosphere. The challenge of achieving global planetary unity and furthering the evolution of global consciousness toward a holistic world-view is ignited as a viable unifying vision when perceived through the insights of Socioastronomy.

Socioastronomy can be defined as a newly developed domain established in line with the key objectives & mission of the Overview Institute. In principle, Socioastronomy co-exists with the Overview Institute in focussing on potentially unifying social effects of astrological paradigms, in light of the cognitive, practical shifts mobilised through enhanced technologies of communication. Socioastronomy further supports the precepts of the Space Renaissance Initiative (SRI), a diverse working group of astro-humanists with an agenda aimed at improvements in *scientific education, environmental protection, cultural development*, and *the establishment of humanitarian goals* such as *global peace.*

Natural Resonance

An ethical theme inferred by the challenge of enhanced technologies is the question of how humans might maintain an organic sense of connection to nature. For environmentalists of an eco-feminist persuasion, resonance with nature is potentially compromised by the prospect of a future in which humanity may be confronted by the alienating domination of cyber culture (even if such technology has the potential to be cultivated to provide genuine benefits for our environment). This paradox I believe is challenging, although not impossible. The achievement of an amicable resolution is dependent on both humanity's *adaptive and creative* capacity; hence the fruition of *homo noeticus*.

Organisational Links

The Overview Institute homepage. Organisation inspired by space philosopher and author *Frank White*. See www.overviewinstitute.org.

The Institute of Noetic Sciences™ was founded in 1973 by Apollo 14 astronaut *Dr. Edgar Mitchell*. It is a 501(c)(3) non-profit research, education, and membership organization whose mission is supporting individual and collective transformation through consciousness research, educational outreach, and engaging a global learning community in the realization of our human potential. Noetic comes from the Greek word nous, which means 'intuitive mind' or 'inner knowing.' The Institute's primary program areas are consciousness and healing, extended human capacities, and emerging worldviews. See noetic.org.

International Institute of Integral Human Sciences. The IIIHS is a non-governmental organization affiliated with the United Nations Department of Public Information. The IIIHS is also integrated with the SSF, an interfaith member unit of the International Council of Community Churches, Geneva, offering spiritual services and educational programmes representing all traditions. The IIIHS was established in 1975 by Prof. John Rossner and co-founded with Dr. Marilyn Rossner (founder & president of SSF). Annual Conferences of the IIIHS are held in Montreal, Quebec, Canada. See www.iiihs.org.

Feature and Resource Index by Stephanie Lynne Thorburn
NB. A précis of this paper is available on *International Space Fellowship* news pages: spacefellowship.com/news/art36784/progressive-etudes-on-consciousness-noetic-sciences.html.

"Progressive Etudes on Consciousness and Noetic Sciences" is an integral chapter from Stephanie Lynne Thorburn's ***Thought Matrix*** Trilogy, cited within book two, *World Ontology*. This Kindle work supports Stephanie Thorburn's initiative in developing *World Ontological Webs.*

Exploring the Integral Human Sciences
World Ontology extenuates the mission of the Overview Institute and the domain of noetic sciences, presenting a vignette compendium of unpublished preview works, focusing on *mind*, *science*, and *spirituality*. The work addresses thematically cogent aspects of paradigmatic science, deconstructions of public discourse, and contemplations on humanity's collective future. *World Ontology* is assimilated as a sincere collection with open-ended intent, designed to stimulate the community of readers and participants within the emerging sphere of *integral human science* towards new contemplations and conceptual understandings of both the human condition and the human psyche, situated within the broader nexus of our cosmos.

The anthology presents a stark holistic integration of traditional and Quantum theoretical science, framed by potent Taoist philosophies. *Thought Matrix* explores social and human challenges characterized by post-modern humanistic academic domains. The series evaluates issues of *academic credibility*, *methodology*, *education*, and the overarching ethical dilemmas posed through stretching human experience towards new paradigms inherent within the emerging domain of Exoscience.

This is a progressive etude in the *Thought Matrix* Study Series.

Kindle edition: www.amazon.com/World-Ontology-Thought-Matrix-Book-ebook/dp/B00VGUHCTK/ref=sr_1_3?ie=UTF8&qid=1445457338&sr=8-3&keywords=stephanie+lynne+thorburn.

Stephanie Lynne Thorburn – CV and Author-Educator profile page via *World Metaphysical Association*: www.worldmeta.org/stephanie.htm.

World Ontological Web (in development): http://www.worldontologix.webs.com.

****

About the Author: Stephanie Lynne Thorburn is a freelance writer, researcher, and alternative therapist with an interest in holistic health. She writes features primarily focused on music and nascent areas of social science, including Sociology, especially Environmental Sociology and Parapsychology. She holds an MA in Sociology: Qualitative Research from Goldsmiths College, London, UK and a combined honours degree in Sociology Psychology from City University, London. Stephanie has undertaken a range of vocational diplomas including Graphic Arts (UKCHT), Parapsychology, and Computing with distinctions. She is a fellow of the Institute for Meridian Psychotherapy and Associated Complementary Therapies and is on the Board of Editors of the *Journal of Space Philosophy.*

Stephanie has freelanced extensively for press, especially the online news journal Los Angeles Chronicle and PR-Inside.com. She assisted on the Space Renaissance Initiative Board of Directors in 2010. Over time, Stephanie Lynne has authored a series of music-related e-books, notably *Incendiary Soul*, a succinct biography of the Sales Brothers and *Blues Scholars*, a compendium e-book of her features on blues greats including Robert Johnson and John Lee Hooker. Ongoing academic works include her continuing postgraduate published papers, *The Astrosociological Imagination* and *Primordial Essences*, a book on creative arts and energy healing (recently a top-ranked text on Amazon KDP select). She edits her own avant-garde webzine “Nuance.” Currently Stephanie Lynne is working on an independent research project via prior publication, utilising sociological discourse analytical methods. For up-to date news and publications, see www.stephaniethorburn.webs.com.

Editors’ Notes: Stephanie Lynne Thorburn is the only contributor to the *Journal of Space Philosophy* from the Noetic Sciences. Her Human Factors focus on combining with Frank White’s *Overview Institute* for a holistic world view needed by Earth's leadership if humanity is to thrive and survive. Her article has links to Yehezkel Dror’s article “Preventing Hell on Earth,” also in this issue of the *Journal of Space Philosophy*. In this context, she will lead a panel that the Kepler Space Institute will conduct at the 2016 International Space Development Conference in Puerto Rico, which will address human pathologies and the Forthcoming Space Epoch. ***Bob Krone and Gordon Arthur***.

Journal of Space Philosophy 4, no. 2 (Fall 2015)

Key Determinants in Space Science Experimentation

By Terry Tang

Space Science is defined as:

1. Any of several scientific disciplines, such as exobiology, that study phenomena occurring in the upper atmosphere, in space, or on celestial bodies other than Earth.

2. A discipline related to or dealing with the problems of space flight.[1]

Knowing how electromagnetic, gravity, and life energy forces function and interact is crucial for enabling humans to survive in Space's micro-gravity.

With James Maxwell's magnetic equations and theories, one can calculate electro nuclear forces in or around human living cell atoms to create instruments controlling gravity so that human life is not affected when gravity changes from Earth to Space.

****

At the National Geographic Channel Ceremony for 2016 on November 8, 2015, the Breakthrough Prize in Mathematics was awarded to Ian Agol; in Life Sciences it was awarded to Edward S. Boyden, Karl Deisseroth, John Hardy, Helen Hobbs, and Svante Pääboin; and in Fundamental Physics it was awarded to leaders and members of experiments on Neutrino Oscillation in China, Japan, and Canada.[2] "By challenging conventional thinking and expanding knowledge over the long term, scientists can solve the biggest problems of our time.… The Breakthrough Prize honors achievements in science and math so we can encourage more pioneering research and celebrate scientists as the heroes they truly are," Mark Zuckerberg said.

"Space needs another *Moon Shot*, Google's Government Innovation Labs initiative to bring about audacious moonshot thinking involving partnering and collaborating in humanity's never ending search for innovations for improving how we live," many think.

This manuscript is a continuation and expansion of "Milestones to Space Settlement – An NSS Roadmap Part IV: To the Moon, Particular Barriers,"[3] Sections 1: Biological—radiation and gravity 1/6th Earth's and 2: Psychological and political, addressed in this paper, *specifically MILESTONE 11: A Lunar Research Facility* to study human habilitation, test equipment and techniques, and conduct lunar investigations.

The Moon's gravity is 1/6th of the Earth's, the Moon's mass is 1.23% of the Earth's, the moon's density is approximately 60.6% of the Earth's, and the Moon is approximately

---

[1] American Heritage® Dictionary of the English Language, 5th ed. (Boston: Houghton Mifflin Harcourt, 2011).
[2] breakthroughprize.org/News/29.
[3] *adAstra* (Spring 2014): M12-M15.

27% the size of the Earth, *which is much larger than of ISS. Larger mass means more resources for constructing shields against radiation and more gravity for enabling longer-duration living with optimal vitality when gravity is less than that of Earth's*. *Larger mass also means more resources and more area for constructing instruments for controlling electromagnetic and life energy forces.*

An Experiment in Progress

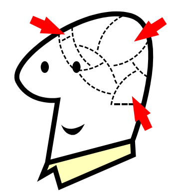
US astronaut Scott Kelly and Russian cosmonaut Mikhail Kornienko are on the ISS, scheduled to return to earth March 2016 after completing a one-year mission on how a long space stay affects them. Kelly's identical twin former astronaut brother – with the same genetics – concurrently studied on Earth under similar experimental conditions to control for genetics while studying gravity's effect on humans: the in-space data will be compared with the on-Earth data to identify changes caused by living in Space. Scott and Mikhail, in turn, will be joined by rotating other ISS astronauts in Space from periods ranging from 10 days to six months as part of the one-year mission experiment.[4]

Envisioning More Experiments

This one-year mission can be expanded to include a third, experimentally yoked condition with astronauts on the Moon, where they are likely to be healthier than on the ISS, because the Moon has more gravity than ISS.

Envisioning Your Experiment

Gilbert Ryle (1900-1976), the British philosopher of anti-dualism, distinguished between knowing that and knowing how. Most knowledge is declarative and states that something is the case. *Far rarer, and usually of greater practical utility, is the procedural knowledge explaining how to do something or how it comes about*. Most theory and research takes it as a given that a person with a plan, a leader, creates, shapes, and maintains organizational structures for accomplishing a goal. The important question is just how might they, or might we and or others, do it? Thoughts, Concepts, Cognitions?



Increasingly, Space Science encompasses exobiology, and the disciplines related to or dealing with problems of space flight include cognitive science, computer science, neuroscience, psychology, genetics, and epigenetics. Global research is providing a clearer understanding of how brains and nervous systems develop and change both naturally and under stress and other demanding conditions. We need someone to learn something – say with scientific experimentation on how the human body learns, develops, and adapts to internal and external stressors, both on Earth and in Space.

Fundamentally this is about protecting the body from external stressors and about enabling the creation and strengthening of neural networks in the body's central and peripheral nervous systems. Studies being published daily are stunning in their details and results, as the 2016 Breakthrough Prizes indicated, e.g., in *optogenetics*, a biological

[4] Jeffrey Kluger, "Mission Twinpossible," *Time* 184, no. 26-27 (2014): 34-38.

technique that involves the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels.

Funding Your Experiment

The ISS US National Laboratory's research platform, CASIS, regularly provides solicitation opportunities in the life, physical, materials, and observational sciences. *It welcomes unsolicited proposals for research and product development* that might be suitable for the National Lab. The CASIS mission is to utilize the National Lab fully, enabling cutting-edge research on the station from every corner of the country.[5]

For example, NASA's Physical Science Research Program will fund seven proposals to conduct physics research using the agency's new microgravity laboratory scheduled to launch to the ISS in 2016. This cold atom laboratory will provide an opportunity to study ultra-cold quantum gases in the microgravity environment of the ISS – a frontier in scientific research that is expected to reveal interesting and novel quantum phenomena, because atoms can be observed over a longer period, and mixtures of different atoms can be studied free of the effects of gravity, where cold atoms can be trapped more easily by magnetic fields. The chosen proposals came from seven research teams in response to NASA's research announcement "Research Opportunities in Fundamental Physics." The proposals will receive a total of about $12.7 million over a four- to five-year period, which will begin immediately.[6]

If you have an idea for a government project, you may not have to wait for a request for proposal that matches your dream contract before you start writing your proposal. The federal government and its associated agencies will not rule out an unsolicited proposal, because they have a stated interest in receiving proposals that contain new ideas and innovative concepts pertaining to their program areas.[7]

An unsolicited proposal is a written but informal bid, proposal, or quotation submitted on the initiative of the submitter and not in response to any formal or informal request. It may be submitted to any potential funding and research support group, governmental organization, or nongovernmental organization.

Networking and interpersonal contacts may assist in identifying potential funding and experimental support, e.g., by being an active member of National Space Society[8] or other organizations or by consulting with others such as your US Member of Congress, who may be on or know members of the Committee on Science, Space, and Technology[9] to listen to concerns and provide assistance.

---

[5] www.iss-casis.org/opportunities/unsolicitedproposals.aspx.
[6] www.jpl.nasa.gov/news/news.php?feature=4030.
[7] www.onvia.com/business-resources/unsolicited-proposals-what-you-need-know#sthash.SdmNJV1o.dpuf.
[8] www.nss.org.
[9] science.house.gov/about/membership.

Motivation

Psychological and political barriers are resolvable with guidance from synergy theories,[10] and organizations such as the United Nations. The United Nations uses six official languages augmented with organizational operations and procedures, committees, groups, rules, regulations, and electronic devices guided by history, practice, politics, theories, and intelligence algorithms. Motivation increases when barriers are overcome.

Language is a primary force connecting human individuals by facilitating communication of cognitions, concepts, and denotations, which enable science to progress. How language affects science is theorized by philosophers. One theory is the constructivist theory that says that scientists construct mental models to understand the world around them and that this happens most effectively when they conduct experiments. Science is the experience of scientists reconstructing the phenomenon being investigated and the transmission of this knowledge.

Human research is most effective when the experience constructs a meaningful product that is denotatively communicated accurately to others globally.

Linguistic relativity holds that the structure of a language affects the ways in which its respective speakers conceptualize their world, i.e., their world view, or otherwise influences their cognitive processes. Popularly known as the Sapir–Whorf hypothesis, or Whorfianism, the principle is often defined to include two versions: the strong version states that language determines thought and that linguistic categories limit and determine cognitive categories; the weak version states that linguistic categories and usage influence thought and certain kinds of non-linguistic behavior.

Linguistic or communicative relativity can be controlled with mathematics and other forms of symbolic logic, imagery, cognition, or neuronal activity, signal detection (e.g., Bayes criterion), etc., by intelligence algorithms, by various instruments denoting measurements,[11] and by mathematical formulations and processes.[12] New electronic instruments and tools can be created for assisting scientists.[13]

What policy will support international Moon infrastructure? How can the work involved be framed so that the global public understands and appreciates the value added? How might global entities respond to cultural differences and contexts?

Noam Chomsky indicated that global agreement is not possible: artificial intelligence will never be able to obtain an algorithm for cognition, i.e., artificial intelligence translations of languages will always be inadequate.[14] Noam Chomsky discredited behaviorism and became a founder of modern linguistics (and/or cognitive science).

---

[10] See, for example, wikipedia.org/wiki/Synergy.
[11] See, for example, C. Joseph (Ed.), *A Measure of Everything* (New York: Firefly Books, 2005).
[12] See, for example, D. Darling, *The Universal Book of Mathematics* (Hoboken, NJ: Wiley, 2004).
[13] See, for example, S. Gibilisco, *Electricity and Electronics* (New York: McGraw-Hill, 1997).
[14] Socrates, "Noam Chomsky: The Singularity is Science Fiction!" www.singularityweblog.com/noam-chomsky-the-singularity-is-science-fiction.

The United Nations, however, continues to attempt to fulfill its mission statement:

> WE THE PEOPLES OF THE UNITED NATIONS DETERMINED
> - to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and
> - to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small, and
> - to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and
> - to promote social progress and better standards of life in larger freedom.[15]

This last item can be continued on the Moon and in Space to resolve the NSS Roadmap's, psychological and political barriers as discussed in "Milestones to Space Settlement."

In studying the effects of space on human physiology, evaluating risks vs. benefits is crucial. Living in space and spending time in microgravity is known to have serious effects on the human body, witnessed by astronauts within months with all available precautions taken, e.g., two hours of vigorous exercise daily, etc.[16]

As researchers, theoreticians, physicists, and Space Scientists in the Americas, Europe, Asia, and everywhere globally study and discover new laws or concepts of physics, exobiology, and cognition, scientific experimentation is required for understanding and sharing the innovations.

Pursuant to *Constructivist* Theory, scientists understand the world most effectively when they conduct experiments. Many experiments have been conducted to affirm the nature of *binding energy*, described as follows:

> In general, binding energy represents the mechanical work that must be done against the forces which hold an object together, disassembling the object into component parts separated by sufficient distance that further separation requires negligible additional work.
>
> At the atomic level the atomic binding energy of the atom derives from electromagnetic interaction and is the energy required to disassemble an atom into free electrons and a nucleus. Electron binding energy is a measure of the energy required to free electrons from their atomic orbits known as ionization energy.…
>
> In astrophysics, gravitational binding energy of a celestial body is the energy required to expand the material to infinity.[17]

[15] www.un.org/en/documents/charter/preamble.shtml.
[16] See Kenneth Chang, "Beings Not Made for Space," www.nytimes.com/2014/01/28/science/bodies-not-made-for-space.html.
[17] en.wikipedia.org/wiki/Binding_energy.

This quantity should not be confused with the *gravitational potential energy*, which is the energy required to separate two bodies, such as a celestial body and a satellite, to infinite distance, keeping each intact (the latter energy is lower).

> The gravitational binding energy of an object consisting of loose material, held together by gravity alone, is the amount of energy required to pull all of the material apart, to infinity. It is also the amount of energy that is liberated (usually in the form of heat) during the accretion of such an object from material falling from infinity.
>
> The gravitational binding energy of a system is equal to the negative of the total gravitational potential energy, considering the system as a set of small particles. For a system consisting of a celestial body and a satellite, the gravitational binding energy will have a larger absolute value than the potential energy of the satellite with respect to the celestial body, because for the latter quantity, only the separation of the two components is taken into account, keeping each intact.[18]

For a spherical mass of uniform density, the gravitational binding energy *U* is given by the formula

$$U = \frac{3GM^2}{5r}$$

where *G* is the gravitational constant, *M* is the mass of the sphere, and *r* is its radius. This is 80% greater than the energy required to separate to infinity the two hemispheres of the spherical mass.

> Atomic ionization energy can be predicted by an analysis using electrostatic potential and the Bohr model of the atom, as follows (note that the derivation uses Gaussian units).
>
> Consider an electron of charge *-e* and an atomic nucleus with charge *+Ze*, where *Z* is the number of protons in the nucleus. According to the Bohr model, if the electron were to approach and bind with the atom, it would come to rest at a certain radius *a*. The electrostatic potential *V* at distance *a* from the ionic nucleus, referenced to a point infinitely far away, is:
>
> $$V = \frac{Ze}{a}$$
>
> Since the electron is negatively charged, it is drawn inwards by this positive electrostatic potential. The energy required for the electron to "climb out" and leave the atom is:

[18] www.fxsolver.com/browse/formulas/Gravitational+Binding+Energy+-+spherical+mass+of+uniform+density.

$$E = eV = \frac{Ze^2}{a}$$

This analysis is incomplete, as it leaves the distance *a* as an unknown variable. It can be made more rigorous by assigning to each electron of every chemical element a characteristic distance, chosen so that this relation agrees with experimental data.[19]

In mathematics, a Gaussian function (named after Carl Friedrich Gauss) is a function of the form:

$$f(x) = a \exp\left(-\frac{(x-b)^2}{2c^2}\right) + d$$

for arbitrary real constants *a*, *b*, *c*, *d*.

The graph of a Gaussian is a characteristic symmetric "bell curve" shape.[20]

This curve quickly falls off towards zero.

String theory was first studied in the late 1960s as a theory of the strong nuclear force before being abandoned in favor of quantum chromodynamics. Subsequently, it was realized that the very properties that made string theory unsuitable as a theory of nuclear physics made it a promising candidate for a quantum theory of gravity.[21]

In theoretical physics, quantum chromodynamics (QCD) is a theory of strong interactions, a fundamental force describing the interactions between quarks and gluons which make up hadrons such as the proton, neutron and pion. QCD is a type of quantum field theory called a non-abelian gauge theory with symmetry group SU(3). The QCD analog of electric charge is a property called *color*. Gluons are the force carrier of the theory, like photons are for the electromagnetic force quantum electrodynamics. The theory is an important part of the Standard Model of particle physics. A huge body of experimental evidence for QCD has been gathered over the years.[22]

There are several methods for generating artificial gravity, including (1) rotation, (2) linear acceleration, (3) mass, (4) magnetism, and (5) gravity generator/gravito-magnetism:[23]

A number of methods for generating artificial gravity have been proposed for many years, as well as an even larger number of science fiction

[19] en.wikipedia.org/wiki/Ionization_energy.
[20] en.wikipedia.org/wiki/Gaussian_function.
[21] en.wikipedia.org/wiki/String_theory.
[22] en.wikipedia.org/wiki/Quantum_chromodynamics.
[23] en.wikipedia.org/wiki/Artificial_gravity#Methods_for_generating_artificial_gravity.

> approaches using both real and fictitious forces. Practical outer space applications of artificial gravity for humans have not yet been built and flown, principally due to the large size of the full-scale spacecraft required to allow centripetal acceleration rotating spacecraft.[24]

Such large centripetal acceleration rotating spacecraft may be more readily built with the Moon as a mass density foundation than being without one in Space.

> Without g-force, space adaptation syndrome occurs in some humans and animals. Many adaptations occur over a few days, but over a long period of time, bone density decreases, and some of this decrease may be permanent. The minimum g-force required to avoid bone loss is not known—nearly all current experience is with g-forces of 1 g (on the surface of the Earth) or 0 g in orbit. There has been insufficient time spent on the Moon to determine whether lunar gravity is sufficient. The one-year mission experiment described above is expected to provide answers to many of the concerns identified in Beings Not Made for Space."[25]

It has been said that necessity is the mother of invention, so when humans decided to build and inhabit a laboratory in the harsh environment of space, it was only natural that innovations would follow. "Microgravity-Related Patent History," by Mark Uhran, looks back at the more than 818 patents granted since 1981. He uses patents as an indicator of value creation signifying economic growth potential.[26]

Maxwell's equations describe how charged particles give rise to electric and magnetic force per unit charge, a *field*. Particles can be stationary or moving. These, with Lorentz's equation, enable the calculation of the motion of particles in electric and magnetic fields needed for bone and human vitality as gravity changes from Earth to Moon.

Although earth, moon, and human densities differ, synergistic human relationships facilitate knowing more about biochemical processes involved in controlling human vitality as gravity changes.

Diamagnetic materials create a *magnetic field* in opposition to an externally applied magnetic field. It is a quantum mechanical effect that occurs in all materials. Most material's diamagnetism is weak, but a *superconductor* repels the magnetic field entirely. In 2009, NASA's Jet Propulsion Lab levitated mice with such fields.[27] Perhaps being active in this cyberspace facilitates synergy, levitating energy and cognition for exploring Inner and Outer Space!

****

[24] en.wikipedia.org/wiki/Artificial_gravity#Methods_for_generating_artificial_gravity.
[25] See note 16 above.
[26] www.nasa.gov/mission_pages/station/research/news/microgravity_research.html.
[27] articles.latimes.com/2009/sep/12/nation/na-floating-mice12.

About the Author: Terry Tang, PhD, is the director of Research for Kepler Space Institute. He is a Life Member, American Psychological Association, licensed psychologist with National Provider Identifier and a consultant in clinical and medical, research and forensic psychology. He has 35+ years working in three California State Hospitals, two Veterans Administration Hospitals, and three private hospitals. Faculty memberships were in Human Factors, University of Southern California Study Centers in California, Asia and Marshall Islands and in Experimental & General Psychology, Chinese University of Hong Kong, Ohlone College, and Pepperdine University. He was Researcher III, California Department of Corrections; Researcher, Public Systems Research Institute, USC, and Medical Advisor, Office of Hearings & Appeals, Social Security Administration.

Editors' Notes: Dr. Terry Tang is Kepler Space Institute's Director of Research. This article uses the current ISS one-year residence study of astronauts Scott Kelly and Mikhail Kornienko to provide readers theory and guidance on Space experiment design. He uses experiments to study binding energy as examples. ***Bob Krone and Gordon Arthur.***

Industrial Production of Positronium and Its Uses

By William Mook

Abstract
Humanity is already a Kardashev Class 2 civilization on an instantaneous power basis. This article explores how humanity will make use of artificial solar flares to produce industrial quantities of positronium. This positronium will be used to make star travel with photon rockets commonplace.

Keywords: Solar energy, Kardashev, antimatter, photon rocket, interstellar travel, relativistic rocket equation, star faring civilization.

Introduction

Prometheus was the Greek god of foresight, always thinking of the future. To that end he stole fire from the gods and brought fire to humanity on the Chariot of Helios, the Sun. This article explores a modern version of this legend, based firmly in modern day engineering and scientific understanding.

Near term alternatives to humanity's legacy power system must entail some low-cost nuclear source delivered at less than \$0.01 per kWh to be competitive today. To support today's industrial economy, and more importantly, end the use of legacy fuels extracted from deep within the Earth whilst depositing their exhaust in the atmosphere, which in the end returns Earth to the Carboniferous era, requires that we produce synfuels that the market readily accepts. Synfuels made from atmospheric carbon using hydrogen extracted from water with nuclear energy to produce hydrocarbon fuels everyone is familiar with fills this bill.

This requires that 44.4 TW of primary nuclear energy be used to deliver synthetic secondary fuels at a rate of 14.8 TW all at a cost of less than \$3.8 trillion per year.

Making hydrogen from water with these nuclear processes to produce synthetic fuels from atmospheric CO_2 was considered in a previous paper.[1] This approach ends the use of legacy fuels, restores balance to our atmosphere, and sets the stage for the eventual adoption of direct hydrogen use by humanity over the next 24 years.

Achieving these price points gives us access to virtually unlimited riches! The world's oil production was said to have peaked around 2008.[2] It is no surprise that the idea spawned a banking crisis at that time. The sub-prime mortgage market was a weak link in the banking system, and was a symptom of a problem, not the cause. The root cause was lack of energy in the future to power our future industrial growth. Addressing this cause will reverse the economic decline of the industrial world while reversing our reliance on confrontational politics that rely in turn on increasing militarization of our culture.

---

[1] William Mook, "Report #1, PH240," Paper given at Stanford University, Stanford, CA, Fall 2015.
[2] Tom Whipple, "The Peak Oil Crisis: July 2008 – A Month to Remember," *Falls Church News-Press*, December 5, 2008, fcnp.com/2008/12/04/the-peak-oil-crisis-july-2008-a-month-to-remember.

What About the Future Beyond 2040 AD?

Developing low-cost nuclear power derived from

1. natural fusion – solar power;
2. artificial fusion – using 6LiD; and
3. artificial fission – using 235U & 238U, 233Th fuel cycles

is what it will take to secure economic dominance in energy, wresting it from the hands of those who lack the imagination to develop real alternatives. We now consider the physics of continuous growth in human energy use and what future energy trillionaires might consider as their next steps to maintain and enlarge their financial position by being of service to industrial humanity going forward.

To this end, I consider tapping directly into solar energy from the Sun in space. Namely, what is required to capture positronium in sufficient quantities from the Sun when produced by an artificially induced and maintained solar flares?[3]

What outputs are needed to support human industry on Earth today and far into the future? To this end, we also consider a future super civilization that operates throughout the solar system and beyond using captured positronium generated in an artificial solar flare.

Epistemology and the Kardashev Scale

In 1964 and later in 1985, the Russian astronomer Nikolai Kardashev felt that the growth of energy use in technical civilizations was an inevitable feature of progress.[4] Humanity, according to Kardashev, will one day become a super civilization of the type he envisioned. This fundamental tenet has changed radically in the 21st century with the adoption of sustainable development by the United Nations. This adoption stems from acceptance of the limits to growth epistemology promoted by the Club of Rome through the 1990s. Placing firm limits on growth is considered an acceptable way to deal with the effect that unlimited growth has upon the environment. This thinking considers humanity's present reliance upon the biosphere as a permanent fixture of both human biology and human industry.

Like the Club of Rome and the UN, Kardashev accepts that exponential growth over short periods has the capacity to alter nature radically. Where Kardashev differs from the UN is that he views exponential growth as a natural consequence of progress and considers changes not only at the level of the biosphere, but also at the level of the cosmos.

Kardashev thus constrains his considerations only by the observable limits of the cosmos and physics, rather than the much more greatly constrained limits of disturbance to our

[3] Space Science Board, *United States Space Science Program: Report to COSPAR* (Washington, DC: National Academy of Sciences-National Research Council, 1972); G. H. Share and R. J. Murphy, "The Physics of Positron Annihilation in the Solar Atmosphere," *Astrophysical Journal Supplement Series* 12/2008 (161) 2: 495.

[4] Nikolai Kardashev, "The Inevitability and Structure of Super Civilisations," *Proceedings of the International Astronautical Union* 1985:497.

fragile biosphere. Present thinking also enforces a dependence of industry upon the biosphere, which is ultimately dangerous to both humanity and the biosphere. This dependence of human industry on biological energy flows also requires that the vast majority of humans live at a subsistence level and that humans survive in far lesser numbers than they do today. How to bring about the implied depopulation required is an unresolved problem. Further, how desirable depopulation is as distinguished from an undesirable extinction event is not well considered. The point being, how do we stop a depopulation process from leading to our certain extinction? This seems to be an important question to answer if you support depopulation as a solution to environmental problems.

Kardashev certainly accepts that we should treat our biosphere with respect and care, but ultimately as human understanding and capability grows, we will use appropriate technology to *isolate human industry from the biosphere* regardless of industry's size. Once human industry surpasses the power level of the biosphere, which it will do at 4,000 TW in the 2150s assuming a 4% growth rate, we then create an industrial infrastructure that supports synthetic expansion of our biosphere off world. In this case, the Earth's native biosphere itself is untouched by humans except where absolutely necessary. It is important to achieve this today because we already exceed the capacity of the biosphere to support our need for oxygen as shown in Table 1.

Table 1: Oxygen Consumption Burning WTI Crude.

Component	Mass	Combustion Product Weight	Moles	Enthalpy of Formation	Joules	Oxygen
Barrel WTI Crude Oil	131.48 kg				6,140.8 MJ/barrel	461.35 kg O_2
Carbon	110.72 kg	405.99 kg CO_2	9,227.0 moles	393.5 kJ/mole	3,630.8 MJ/barrel	295.26 kg O_2
Hydrogen	20.76 kg	186.85 kg H_2O	10,380.4 moles	241.8 kJ/mole	2,510.0 MJ/barrel	166.09 kg O_2

Today, humanity masses 400 billion kg and consumes 0.54 TW in food energy. Thus, the food energy needed by humanity is 3% of our industrial energy consumption and 0.003% of all biospheric energy flows. Linking human industry to the biosphere enforces a burden on the biosphere that need not exist and magnifies humanity's impact on the biosphere. Again, supplying the oxygen for humanity and its livestock is already a burden, and the only way forward is a zero-impact philosophy.

It is interesting to note that millions of varieties of Algae contain all types of nutrients produced at an 11% photosynthetic efficiency of sunlight to biomass. With luminescent salts, solar spectrum may be modified so that colors unusable to chlorophyll may be made usable, doubling photosynthetic efficiencies to 22%. At 220 Watts/m^2, 0.54 TW of food energy requires only 2,455 square kilometers of growth area to create all the nutrients to feed cell cultures that supply 3D food printers in sufficient quantity to feed everyone a large variety of high-quality foods at reasonable prices.

Gerard O'Neill also adopted Kardashev's view in his Space Colony Studies of the 1970s.[5] This *zero impact approach* frees humanity of the constraints of Earth whilst freeing the natural biosphere of any impact at all from human activity. In the end the natural biosphere of Earth is depopulated without any decrease in human numbers as humanity becomes increasingly independent of the natural biosphere.

With this understanding in mind, Kardashev perceived that super civilizations come in three varieties:

1. civilizations that control all the power on their planet;
2. civilizations that control all the power in their star system;
3. civilizations that control all the power in their galaxy.

On this scale, Kardashev rated humanity as K = 0. Our present adherence to sustainable development will keep us at K = 0 for the foreseeable future. While appreciation of the fragility of the biosphere is commendable, and no one argues with humanity's present dependence on the biosphere and our adverse impact on it, present approaches keep humanity at K = 0. A more beneficial approach may be a *zero-impact, least-restrictive* philosophy that incorporates all the benefits of sustainability, whilst freeing us of the artificially low constraint thresholds of sustainability and enforced reliance.

Astronomer Carl Sagan noted the following relations when considering Kardashev's scale;

1. civilizations that control all the power on their planet. For the Earth this is 17.38×10^{16} Watts which Sagan rounded to 10^{16} Watts;
2. civilizations that control all the power in their star system. For the Sun this amounts to 3.83×10^{26} Watts. Sagan rounded this figure to 10^{26} Watts;
3. civilizations that control all the power in their galaxy. For the Milky Way this totals 5.00×10^{36} Watts rounded to 10^{36} Watts.

from which he derived the following equation;

$$\text{Kardashev Number (K)} = (\text{LOG}_{10}(\text{Power in Watts}) - 6)/10$$

[5] G. K. O'Neill, "Space Resources and Space Settlements," 1977 Summer Study at NASA Ames Research Center.

Figure 1: An H-bomb explosion an example of K = +2 energy use. From *Operation Ivy*, produced by the US Department of Defense and the US Atomic Energy Commission, released in 1952, and available via standard creative common license. Narration by Reed Hadley. An 11-megaton explosion produces 4.6×10^{16} Joules released in picosecond reaction times, which exceeds the power output of the sun.

Expansion of the Kardashev Scale across Human Experience

It is interesting to note that the basal metabolic rate in humans averages 72.7 Watts and that a modified Kardashev Number of 0 is an energy rate of the minimum viable population of humans (around 14,000 persons). Also, the metabolic rate of a single mammalian cell is 3×10^{-10} Watts, and a Kardashev Number of -1 equals the power of 1 million cells the size of the smallest multi-celled organisms. A Kardashev Number of -2 equals the power of a Kinesin protein walking along a cytoskeleton filament.

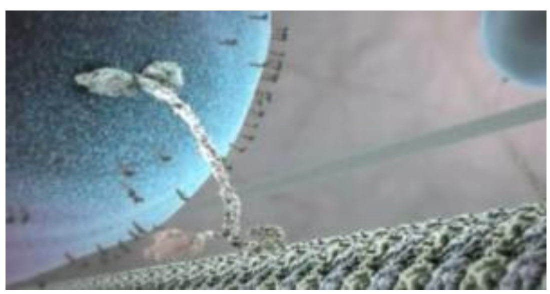


Figure 2: Kinesin an example of K = -2 energy use. From *Inner Life of the Cell: Mitochondria Animation Conception and Scientific Content*, by Alain Viel and Robert A. Lue (Cambridge, MA: Harvard University Press, 2006). © 2006, the Presidents and Fellows of Harvard College, available via standard creative common license Animation by John Liebler/XVIVO.

Humanity's Kardashev Rating

Humanity's current Kardashev Number, based on average industrial energy flows, is K = 0.7236, whilst the proposed rate of use for synfuel previously outlined has a Kardashev Number of K = 0.7647. Other numbers of interest include the metabolic rate of humanity, which is 0.54 TW. This translates to K = 0.5732 and makes hardly any difference in our total at present. At a 4% per year growth rate in industry (far higher than the natural 1.15% growth rate in human numbers), it will take humanity until 2178 AD to reach a Kardashev

Number of K = 1 on a continuous basis and until 2765 AD to reach a Kardashev Number of K = 2 on a continuous basis.

The biosphere's 4 quadrillion watts of power represents K = 0.96, which is 5.7% of the amount of sunlight intercepted by Earth in space. At 4% annual growth in continuous industrial energy production, humanity will achieve this level of energy use by 2154 AD. Yet if we ignore the present rate of continuous power production on Earth and look at instantaneous power production, *we have already exceeded the power output of the Sun* for very brief periods. By this measure, we are a Kardashev 2.5+ civilization, using Kardashev 0 political and economic systems to manage our affairs. This is a problem for humanity generally, and leads predictably to a common mode failure that could lead to our extinction.

One aspect of legacy fuel use is the amount of biospheric energy needed to support oxygen production on Earth so that we can burn our legacy carbon fuels. Even if fuels were unlimited in supply, the atmosphere is not. Consider that a barrel of West Texas Intermediate crude oil masses 131.48 kg. When a barrel is burned, this produces 405.99 kg of CO_2 and 461.35 kg of oxygen in the process (see Table 1). The energy released by burning the crude oil products totals 6.1 GJ per barrel. The amount of sunlight needed to make this much oxygen requires 194.1 GJ of biosphere energy, which in turn requires nearly 4 TJ of sunlight. Today's rate of energy consumption using legacy fuels exceeds the current capacity of the biosphere to add oxygen, which explains both of Keeling's curves: the famous CO_2 and the less well known O_2 curve.[6]

The Power of the Sun

As noted above, the power output of the Sun is 3.83×10^{26} Watts. When converted at high efficiencies to positronium, this power level will not exceed 4 million tons of positronium each second at present levels of solar luminosity. Less than half a gram per second is required to meet our present energy needs. Synthetic increases in luminosity combined with increasingly efficient collection could maintain solar conditions on the planets whilst exceeding the limits described here.

Now, Gerard O'Neill and Stanford, with NASA support, have estimated that it takes 10 metric tons of material and 10,000 Watts to support a person in deep space indefinitely using total recycling in a synthetic biosphere.[7] Mark Roth, MD, has developed procedures to place mammals in reversible suspended animation using small quantities of H_2S.[8] These methods might be extended to indefinite terms. Rindler has solved the Tsiolkovky

---

[6] R. Keeling and H. Graven, "Two Decades of Atmospheric O_2 Measurements and Their Implications," Scripps Institution of Oceanography. Paper presented at the NOAA Global Monitoring Annual Conference 2012, San Diego, CA.

[7] Richard D. Johnson and Charles Holbrow, *Space Settlements: A Design Study*, NASA, SP-413 (Washington, DC; NASA, 1977).

[8] Charlie Schmidt, "Mark Roth: Profile," *Nature Biotechnology* 27 (2009): 13.

rocket equation for relativistic motion, allowing us to estimate the amount of positronium needed to supply a photon rocket.[9]

$$dV/c=\mathrm{TANH}\ (\mathrm{LN}_e(M_0/M_1))$$

With two boosts of a positronium-fueled rocket that first fires and accelerates a 10-ton payload per person to 90% light speed and then slows to rest relative to a target star some distance away, we can see that a single stage, assuming a 7% structure fraction, has 915.4 tonnes take-off weight for every person on board and that each person requires the vehicle carry a total of 853.4 tonnes of positronium. This allows a ship travelling at 90% light speed to travel 2.3 light years per year of ship time following a boost at each end that lasts 2.85 years ship time, which equals 4.00 years star time, whilst traversing 1.26 light years distance, a distance of 2.52 light years overall traversed in boost, with the remainder coasting. Once at the terminus, a flare similar to a solar flare is formed, and is used to recharge the rocket's positronium propellant if desired, or to support an extrasolar human civilization. A trip to Alpha Centauri entails a 10-month ship time coasting phase and takes 3.72 years ship time each way. A 49-light-year trip takes 28 years ship time at this speed.

Figure 3: Solar Eruption. From Goddard Spaceflight Center 2014. Published by Goddard Media Studios. Publicly available via creative common license from NASA's Goddard Space Flight Center/SDO

The point of this calculation is that a Kardashev 2 civilization should have the capacity to remove 87,941 persons per second from the solar system by tapping all of the Sun's output. That is 27.7 trillion persons per year. With a natural rate of growth of 1.15% per year, this represents the population limit of the Sun, for a Kardashev Type 2 civilization of 2.4 quadrillion persons. This is the K = 2 limit to growth within our solar system. We will

[9] Charles W. Misner, Kip S. Thorne, and John A. Wheeler, *Gravitation* (San Francisco: Freeman 1973), Section 6.2.

not reach this population level before 3125 AD, well after we reach Kardashev Type 2 status (which we have already achieved with our technology on an instantaneous basis). Thus it is likely that human numbers will stabilize and fall in the future as large numbers of people decide to seek their fortunes off-world.[10]

A more important calculation for us today is the rate of positronium production needed to maintain stable numbers of people within the solar system today.

$$\text{Rate of positronium use} = 7.4 \times 10^9 \times 0.0115 \times 853.4 / (8766 \times 3600) = 2301 \text{ metric tons/second}$$

This is the rate of positronium needed to remove people from the solar system at a rate that maintains human population on Earth today. This rate of power use totals 0.05% of the Sun's output. It is also about a million times the energy intercepted by Earth from the Sun. Removing people into interstellar spacecraft at double the peak rate of population growth reverses population growth on Earth and allows us to reduce numbers on Earth to any level desired within thirty years or less, without reducing absolute human numbers. Those in transit are time dilated and in suspended animation. So, they are not reproducing. They do, however, face the risks of interstellar travel.

Fermi Paradox

Enrico Fermi, considering these facts following the first atom bomb test, asked, "Where are they? The Extra Terrestrial Intelligences (ETIs)[11] The physics of evolution presumably operates everywhere. Science is the same everywhere. We have the capacity to travel to the stars with atomic energy. Where are they? There are several answers possible. The thinking today is that there are those ETIs that refuse to constrain growth and become extinct through environmental collapse or thermonuclear war. In that case, we will not see them. There are also those that do constrain growth along the lines of sustainable growth promoted today by the UN. In this case, the thinking goes there are no ETIs because they're permanently in balance with the natures of their home worlds, and there are no super civilizations, none, as Kardashev imagined.

Yet there is always a Gaussian distribution around any mean in living systems. So, there must be other answers to Fermi's question! Some super civilizations must exist even if the majority do not become super civilizations. Given the nature of exponential growth, we still must answer Fermi's question! Where are they?

Another answer that makes sense is that the operation of the speed of light limit, in combination with time dilation and advanced suspended animation, limits the rate of growth of mobile populations! Since there is an inexorable increase of probability of vehicle loss with distance for mobile populations, an exponential drop off in the density of any super civilization as it moves away from its home world is expected. This means that the human affected zone around Sol, once humans create a super civilization in the

[10] Natalie Angier, "A One-Way Trip to Mars? Many Would Sign Up," *New York Times*, December 8, 2014.
[11] Charles Krauthammer, "Are We Alone in the Universe?" *Washington Post*, December 29, 2011.

future, is limited in all practical senses to about a 1,000 light year radius of Sol. The rate of drop off depends on the dangers of high speed interstellar flight.

Freeman Dyson in 1960 outlined what a super civilization might look like to astronomers.[12] The Kepler Space Telescope may have found evidence of such a super civilization nearby.[13]

Positronium Production in the Sun

Positron annihilation radiation from solar flares was first observed by Chupp in 1973.[14] In 2004, Share[15] showed that positrons are produced naturally in the Sun from the interaction of particles within solar flares. Could long-lived solar flares be induced and maintained in the solar photosphere to produce a stream of positronium which is then used by humanity?

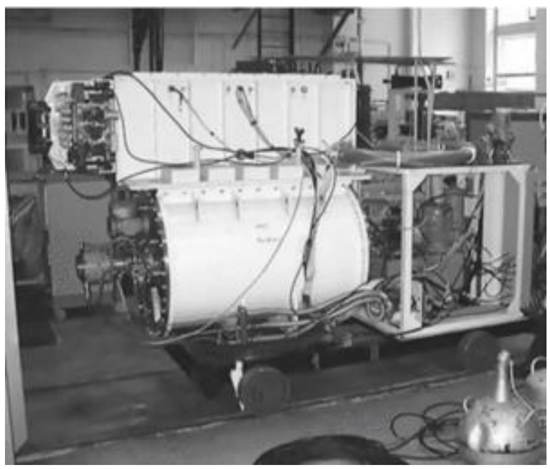


Figure 4: LM-4 Nuclear Pumped Laser Module. Eksperimentalnyy kompleks LM/IGR Ustroystvo i printsip raboty. Proceedings of the 2nd International Conference "Physics of Nuclear-Excited Plasma and Problems of Nuclear- Pumped Lasers," Arzamas-16, 1995 vol. 2, 172-78. Photo produced by Russian Federal Nuclear Center and excluded from copyright by the Supreme Court of the Russian Federation, plenum decision no. 15/2006, point 22, as a public work.

The photosphere is a natural basis for controlled excitonic matter. Nonlinear optical effects in the plasma can be exploited to create self-sustaining structures that exhibit Boolean interactions and may undergo controlled replication. Once made to occur in the

---

[12] Freeman J. Dyson, "Search for Artificial Stellar Sources of Infra-Red Radiation," *Science* 131 (3414): 1667-68.
[13] Ross Anderson, "The Most Mysterious Star in our Galaxy," *The Atlantic*, October 13, 2015; T. S. Boyajian et al., "Planet Hunters X. KIC 8462852: Where's the flux?" *Solar and Stellar Astrophysics*, September 14, 2015.
[14] Space Science Board, *Report to COSPAR*.
[15] Share and Murphy, "The Physics of Positron Annihilation."

solar atmosphere, the process is then controlled by radio waves. According to Stephen Wolfram, it does not take a lot of technology or a lot of evolution to do computations as complex as anything. Wolfram also points out that computing is a new kind of science as important as calculus, and its broad application will change the way we view the world.[16]

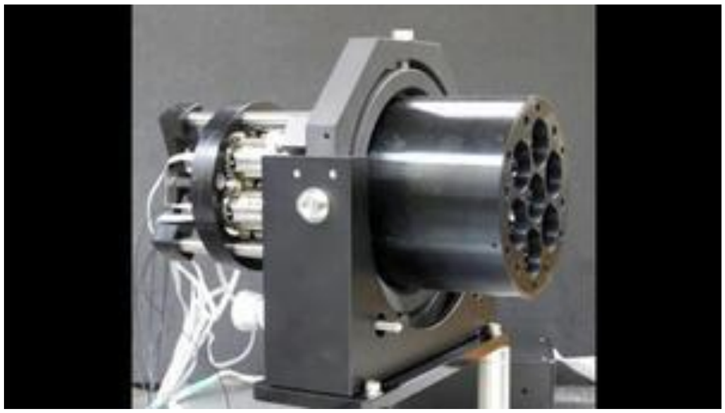


Figure 5: EXCALIBUR Space-based nuclear pumped X-ray laser. © DARPA. Images, photographs, audio, and video files and other works created by DARPA or its systems engineering and technical assistance contractors (© DARPA) and posted on the DARPA website may be used for educational or informational purposes, including, for example, photo collections, textbooks, public exhibits, web pages.

Projecting patterns of gamma rays to induce a pattern of excited plasma in the solar atmosphere from a series of powerful laser blasts produces a synthetic solar flare. Nuclear pumped lasers[17] delivered to the solar surface provides this. This engineered pattern interacts in a nonlinear way to implement a computing platform in the solar surface itself. This pattern self-replicates and evolves in a manner similar to those described by John Conway in his computer based "Game of Life" to produce steady streams of positronium like Bill Gosper's Glider Gun. Just as interacting patterns on a surface that follow a few simple rules may carry out a computation to maintain a structure as complex as anything, humanity, as described here, produces a pattern on the solar surface to maintain a permanent solar flare that efficiently generates a controlled stream of positronium that is received by a receiving station at Earth Sol Lagrange Point 1, converting our instantaneous K = 2 status to a permanent one.

At 90 TJ/gram, a flow of 192 milligrams of positronium per second is required to produce 17.3 TW. To produce 44.4 TW requires 493 milligrams per second. These streams may then be sent to GEO and LEO satellites to generate powerful laser pulses that are received on Earth. Alternatively, positronium may be compressed and stored as a Bose-Einstein condensate at high density, and maintained in a stable form by active quantum-

[16] Stephen Wolfram, *A New Kind of Science* (Champaign, IL: Wolfram Research, 2002).
[17] S. P. Melnikov, *Lasers with Nuclear Pumping* (New York: Springer Science + Business Media, 2015); T. E. Repetti, "Application of Reactor-Pumped Lasers to Power Beaming" Report Number: EGG-PHY-9978 (Idaho Falls: EG and G Idaho, 1991).

level controls. If this seems overly optimistic, one should consider that Cooper Pairs that are responsible for superconductivity are Bose Einstein condensates as well. Confining 4.4 x 10^{27} positronium pairs per cc creates a bulk material that has the same density as iron. At this density, separation between pairs is 4.8 Ångstroms. This is almost ten times the Bohr radius of 0.53 Ångstroms of Ps at 13.6 eV.[18]

The Program

Candle flames persist even though the fuel and oxidizer that flow through them changes constantly. The Great Red Spot of Jupiter has been present on that planet since 1655 AD. This shows that nature can maintain vortices and other immaterial objects persistently over long periods. So, even while the solar environment precludes solid and even liquid materials, the nature of the solar photosphere is such that it can be manipulated with intense light sources in useful ways. By creating light sources with fusion reactions in the photosphere, a feedback loop is possible in the nonlinear optical materials created, and a self-replicating machine made of structured interacting plasma becomes possible. The plasma patterns would then be controlled by more gentle microwave beams from an orbiting radio telescope.

How Humanity May Structure Plasma in the Solar Photosphere.

The project involves two satellites at a minimum. One is the receiver, operating at Earth Sol Lagrange Point 1, and it also provides microwave and laser control signals. This satellite operates at 1.5 million km from Earth. Two is the transmitter flare forming device, which flies past Jupiter and is gravity boosted into an orbit that falls into the Sun at a point near the solar surface where the line between the Earth's center of gravity and the Sun's center of gravity intersects the surface.

Satellite 2 is a flare-forming device that becomes the positronium transmitter. It consists of a number of self-contained X-ray lasers, each pumped by a small nuclear charge shining through a tantalum synthetic hologram carefully oriented above the photosphere. When fired, each satellite projects structured patterns of light into the photosphere. Interacting plasma is formed there whilst other satellites set the pattern's initial program.

Satellite 1 is the positronium receiver, which consists of a Ioffe-Penning trap of an appropriate size operating at L1. Initial designs call for the creation of high-intensity positronium beams that beam positrons and electrons to reforming satellites in geosynchronous orbit. These geosynchronous satellites then beam laser energy to receivers on Earth that replace the nuclear system described in my first paper. Ultimately, just as hydrogen replaces hydrocarbons once vastly lower cost hydrocarbons are made with very low-cost hydrogen, so too will hydrogen be replaced by laser beams and later positronium once positronium comes in at a vastly lower cost than nuclear energy made more conventionally.

Transitioning from our present hydrocarbon legacy fuels we will proceed as follows;

1 Synthetic Alkanes – $10.00/MWh – 20 TW – Terrestrial

[18] Nouredine Zettili, *Quantum Mechanics: Concepts and Applications* (New York: John Wiley, 2009), 35-36.

2 Hydrogen (protons) – \$1.00/MWh – 400 TW – Advanced Terrestrial
3 Lasers (photons) – \$0.10/MWh – 80 PW – Interplanetary
4 Anti-matter (positronium) – \$0.01/MWh – 160 ZW – Interstellar

Satellite 1, at Lagrange Point 1, also operates as a research lab that develops positronium storage technologies and other techniques that make more efficient use of positronium. The entire program is completed in ten years at a cost of less than \$100 billion, radically reducing energy costs and transforming human industry in the process.

Collecting \$3.8 trillion for primary fuel replacement each year, over a 50-year period, discounted at 5% per year, and supporting a 4% growth in energy demand, this project has a present value of \$148.95 trillion the day the process switches on. Using Toshiba 4S reactors to produce hydrogen that is then used to convert atmospheric CO_2 to hydrocarbon fuels costs less than \$15 trillion. Using even more advanced technologies described here involves the construction of two satellites, creating nearly free energy in the process. The revenue, when valued as an annuity, when used to support bank debt in a stable central bank, allows the annuity to be leveraged 50 to 1 in a banking system (the Federal Reserve carries loans with a 53 to 1 leverage as of 2008). This supports up to \$7,447.5 trillion in loan activity. This is an amount sufficient to end the financial crisis within our banking system at present and support 4% industrial growth throughout the world indefinitely. Further efficiencies are gained by collecting the \$6.0 trillion from end users of energy. This allows these amounts to be increased proportionately to support the industries that develop appliances vehicles and industrial equipment to make use of positronium directly.

****

About William Mook, PE: Bill Mook was trained in aerospace engineering, and worked for 16 years in alternative energy and space commerce technology. For a full bio, see www.vimeo.com/user1527401.

Editors' Notes: We thank William Mook for applying his high level of Space Engineering knowledge to fundamental aspects of humanity's future expansion not just to the Solar system but into the cosmos. The Space Community needs the long range scientific thinking of William Mook. Drawing on Russian Astronomer Nikolai Kardashev's work in the 20th Century, Mook hypothesizes the future capture of solar power and create artificial fission to meet humanity's needs and to facilitate interstellar travel. ***Bob Krone and Gordon Arthur.***

Journal of Space Philosophy (JSP) Board of Editors

Kepler Space Institute is honored to have 42 of the world's Space Community professionals as members of the Board of Editors for the Journal of Space Philosophy. We are proud to announce the addition of two new Editors to our Board:

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) to determine the relevance to the Vision and Goals of Kepler Space Institute; (2) to help the author(s) improve the article in substance and style or recommend references; and (3) to 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, Kepler Space Institute 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. We grieve The passing of Dr. Ben-Jacob in 2015.
For Bio Info: Google Eshel Ben-Jacob.

5. 

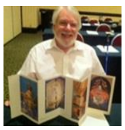
BLOOM, Howard K., Author, Scientist, Founder Space Development Group, Publicist, Author on Human Evolution, Science, Technology, and Space. Photo by Luigi Novi.

For Bio Info: [www.en.wikipedia.org/wiki/Howard_Bloom.](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.

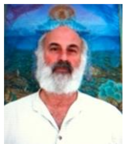
9. 

DOWNING, Lawrence G., DMin, Senior Pastor, Space Faith and Spirituality Pioneer, University Professor.

For Bio Info: See Issue 1.1, Article 11.

10. 

FITZPATRICK, Susan Beaman, DBA, Vice Chairman, Oak Family Advisors, LLC based in Chicago. Her DBA was earned with the University of South Australia in Zurich Switzerland, where she studied under the supervision of Dr. Bob Krone. She is an international Health Expert specializing in health risk management. She has consulted with governments, public and private providers, and within health systems projects sponsored by the World Bank, World Health Organisation and the UK's National Health Service (NHS). Susan's research interests include management capacity development and the implementation of complex innovations and programs. She has been a keynote speaker at industry symposiums and professional organizations such as the National Risk Manager's Association, Excess Surplus Lines Claims Association, American Hospital Association, The American Bar Association, and State Chambers of Commerce. Kepler Space Institute is proud to have her in the *Journal of Space Philosophy* Board of Editors.

11  **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.

12.  **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.

13.  **ISAACSON, Joel D., PhD,** *Nature's Cosmic Intelligence*, pioneer of RD Cellular Automata since the 1960s.

For Bio Info: See Issue 1.1, Article 7 (Fall 2012).

14.  **IVEY, Janet,** is a Nashville TV Treasure and a friend of Kepler Space Institute. Her Janet's Planet show is the recipient of 12 Regional Emmys, 5 Gracie Allen Awards. She is an Ambassador of Buzz Aldrin's Share Science Foundation. Your Google search will take you to delightful images and video clips of her teaching and entertaining children about Space.

15.  **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.

16.  **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.

17.  **KIKER, Edward, General Engineer, GS-13,** Office of the Chief Scientist, U.S. 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.

18.  **KRONE, Bob, PhD,** *Journal of Space Philosophy* Editor in Chief, President, Kepler Space Institute (KSI), sponsor of this Journal.

For Bio Info: www.bobkrone.com/node/103.

19. 

LIVINGSTON, David, PhD, Founder and host, *The Space Show*.

For Bio Info: www.thespaceshow.com.

20. 

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.

21. 

MATULA, Thomas L., PhD, Business and Management Professor, Lunar Commercial scholar.

For Bio Info: www.trident.edu/dr-thomas-matula.

22. 

MAYNARD, Elliott, PhD, Founder, ArcoCielos Research Center, Sedona Arizona, www.arcocielos.com.

For Bio Info: www.fasiwalkers.com/featured/ElliottMaynard.html.

23. 

MITCHELL, Edgar Dean, ScD, Captain, U.S. Navy (Ret), Apollo 14 Astronaut, sixth person to walk on the Moon, Founder Institute of Noetic Sciences.

For Bio Info: Google Edgar Mitchell.

24. 

MOOK, William, PE, Trained in aerospace engineering, 15 years in alternative energy, Space Commerce Technology.

For Bio Info: www.vimeo.com/user1527401.

25. 

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. We grieve Declan's passing in 2015.

26. 

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.

27. 

PALMA, Bernardino, Historian, Portuguese Age of Discovery.

For Bio Info: See Issue 1.1, Article 8 (Fall 2012).

28. 

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/.

29. 

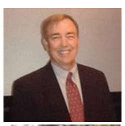
ROBINSON, George S., III, LLD, Space law pioneer and international space expert. Smithsonian Institute Legal Counsel.

For Bio Info: See Issue 1.1 Article 14.

30. 

SCHORER, Lonnie Jones, *Kids to Space* author and teacher. Architect, aviator.

For Bio Info: See Issue 1.1, Article 17 (Fall 2012).

31. 

SCHRUNK, David, MD, Aerospace engineer, Founder, Quality Laws Institute, KSI Faculty.

For Bio Info: See Issue 1.1, Article 18 (Fall 2012).

32. 

SCHWAB, Martin, PhD, International Space author, KSI Faculty, Aerospace Technology Working Group.

For Bio Info: See Issue1.1, Article 21 (Fall 2012).

33. 

SCOTT, Winston E., American Astronaut, Vice President for Development, Florida Institute of Technology.

For Bio Info: www.en.wikipedia.org/wiki/Winston_E.Scott.

34. 

STEPHANOU, Stephen E., PhD, Emeritus Professor of Systems Technology, University of Southern California, Los Angeles, California, USA.

For Bio Info: See Issue 2.2, Article 26 (Fall, 2013).

35.

TANG, Terry, PhD, Kepler Space Institute Director of Research.

For Bio Info: See Issue 1.1, Article 24 (Fall 2012).

36.

THORBURN, Stephanie Lynne, Author, Astrosociology.

For Bio Info: See Issue 1.1, Article 12 (Fall 2012 & Fall 2015).

37.

WERBOS, Paul, PhD, U.S. National Science Foundation, Space scholar.

For Bio Info: See Issue 1.1, Article 19 (Fall 2012).

38.

WHITE, Frank, MSc, Founder, The Overview Effect Institute.

For Bio Info: See Issue 1.1, Article 9 (Fall 2012 & Spring 2015).

39.

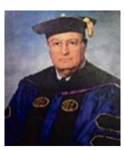
WILKINS, John, PhD, Professor of Space Settlements.

40.

WOLFE, Steven, Space advocate and author of the 2013 Space novel, *The Obligation.*

For Bio Info: See Issue 2.2, Article 26 (Fall 2013 & Spring 2015).

41.



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.

42.

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