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Global Warming, Earthly Disasters, the Moon and Mars: Transfers of Knowledge (TOK)
The American Problem

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[Abstract] Global warming, disasters in increasingly more populated and infrastructure'd regions of the world, the decline side of oil, and the space endeavor are part of the overarching problem of the expansion of the human ecology. The onset of the Anthropocene Epoch and the axial shifts of a highly globalized world and global economy are challenging the United States at a time when it is declining as a leader in science, engineering, knowledge, and technology -- when it is ill-prepared to make quantum-leaping innovation. Rich multi-path transfers of knowledge lie at the crossroads of global warming and the space enterprise. They are critical to solving human ecology expansion problems during the bottleneck between two environmental-geological epochs. The United States is losing the lead in being able to contribute to these transfers of knowledge in the world system of societies. And, it is the capability of having something worth transferring in a world becoming evermore extreme that will keep the United States at the core of the world system of societies. Taking the astrosociological perspective, the author explores an important root cause of why the American lead is being lost. She outlines what must be done for the nation to regain its place as a competitive cooperator in the human prospect.

Keywords: astrosociological perspective, expansion of the human ecology, global warming, decline side of oil, disasters, environmental extremes, transfers of knowledge (TOK), Anthropocene Epoch, American academe, demise of American science, engineering, and scholarship

I. The Expansion of the Human Ecology and Three Questions in the Here and Now

IN order to understand the critical nature among transfers of knowledge among issues like global warming, disasters in increasingly populated and infrastructure'd areas, the decline side of oil, and the space endeavor, one must first understand the notion of the human ecology and its history of expansion. *The expansion of the human ecology.* What do I mean by that?

A. Introduction

The definition of the expansion of the human ecology depends on the viewpoint of the definer. For me, as a geoarchaeologist, sociologist, social psychologist, educator, and policymaker, there are many meanings bound up in that phrase. As a geoarchaeologist, I am concerned with the movements of Pleistocene and Holocene Epoch humans owing to the expansions and retreats of continental glaciation, to sea level rise, to changes in climate, to availability of resources, to diffusion of technologies, and the like. Wearing that disciplinary hat, I am primarily concerned with how humans managed to move into increasingly harsh environments and thrive. As a sociologist, I am concerned with taking what I know as an archaeologist and viewing the human experience over the millennia – from the smallest scale social phenomena to the greatest. As a social psychologist, I am concerned primarily with how groups of people function (and dysfunction) in extreme environments like refugee and disaster settings, polar winter-overs, and on space stations. As an educator, I am concerned with how national leaders promote (or don't) the training of their citizenry to meet a host of problems that impact their societies. As a policymaker, I take active roles in motivating solutions to problems. In this paper, I will be addressing the importance of transfers of knowledge among categories of phenomena that relate to the expansion of the human ecology. I will discuss central issues and obstacles of the United States remaining a competitive cooperator in making those transfers of knowledge. I will even stray into areas more reminiscent of international relations and geopolitics.

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B. The Drowning of New Orleans

During the Space 2005 American Institute of Aeronautics and Astronautics (AIAA) conference, between our sessions and meetings, we watched in horror as New Orleans drowned and saw that local, state, and federal authorities were incapable of mounting an adequate response. Tens of thousands of people were trapped in the flooded city. A Mad Max scenario began playing out as storm and post-storm hours passed. As time passed, many more thousands, those who had fled and those who had been rescued, would be refugee'd within their own country away from their New Orleans and Gulf Coast homes. Like the South Asian tsunami of the year before, this was a concrete example of natural disasters occurring in evermore populated and infrastructure'd areas, making for greater death tolls and property damages than would have been experienced in decades prior. Unlike the South Asian tsunami, Hurricane Katrina may have been a disaster event made more destructive from the effects of global warming. Because of the storm's damage to the petroleum infrastructure of the American Gulf coast, the incident was also a reminder of advanced industrial societies' precarious situation on the decline side of oil.

The Katrina disaster of New Orleans and the American Gulf Coast was a graphic example of the three most important questions facing humankind at the bottleneck between two environmental-geological epochs. Those questions are:

- How do we mitigate, adjust to, or solve for rising sea levels and other direct and indirect effects of global warming?

- How do we mitigate natural disasters that occur in parts of the world becoming evermore populated and infrastructure'd (and that may worsen as an effect of global warming)?

- How do we power the world system of increasingly numerous advanced industrial societies without petroleum?

Answering "How?" has to do with making quantum-leaping innovation and policy to match. For, the Earth is becoming more extreme and environmental realities are creating new geopolitical realities.

II. A Whole New 'Cene

The United States, indeed the world, finds itself in the unenviable position of being in a bottleneck between two geological-environmental epochs. Human beings have been there before – at the transition point between the cold Pleistocene Epoch and the warm Holocene Epoch. The downside was: Not everyone made it through the Pleistocene-Holocene bottleneck. Whole human lineages did not survive. A great many plant and animal species did not survive. Our direct ancestors who *did* survive, did so because of two main inventions: tailored clothing and horticulture, quantum-leaping innovations for the times.

Human survival depends upon innovation. And, though any innovation can be used for evil, as well as for good, the stuff that innovation comes from – science, knowledge, and scholarship – has brought us thus far. Though it didn't start out as an instrument of deliberate evil, our use of fossil fuels that ushered in industrial society has vastly foreshortened our warm Holocene Epoch that would have lasted for millions of years otherwise. It has lasted only 10,000-12,000 years, a twinkle in geological time. We are about two centuries deep into a whole new 'cene, an increasingly warmer environmental-geological epoch. Global population stands at nearly seven billion at present; 10 billion by the end of the century. The seas are rising, natural disasters are sweeping away more human lives and infrastructure than ever before, and a larger number of societies on the world stage are leapfrogging to advanced industrial status. They need fuel to run.

And, as an increasing number of societies in the world system of societies leapfrog to advanced industrialization, the Holocene Epoch has receded in the rear-view mirror, the epoch that saw us evolve from hunters-gatherers and fisherfolk, to horticulturalists and herdsmen, to plow farmers and industrialists. In that latter phase especially, humans have come to play a seminal role in fluxing the planetary environment, and global warming has been ushering in a post-Holocene epoch that has been dubbed the Anthropocene. Some think that the sunrise of the post-Holocene began in the latter part of the 18th century. In *Nature,* Paul J. Crutzen pointed to the rising concentrations of carbon dioxide and methane in air trapped in polar ice dating to the timeframe of James Watts' steam engine. Crutzen named this new 'cene, the Anthropocene (Anthropocene, Wikipedia; Crutzen 2002; Cookson 2004; Alden 2007; Stewart 2007). [1, 2, 3, 4, 5]

On this new 'cene, we may expect the phenomena at the heart of our questions about global warming, natural disasters in an increasingly populated and infrastructure'd world, and running more advanced industrial societies on the decline side of oil to converge. We may expect these phenomena to interact and intensify their effects on humanity. It follows that the social need of a global public of nearly seven billion people -- 10 billion by the end of this century -- will *increase* as the ability on the part of the world system of societies to meet the social need *erodes.* The handwriting is writ large on the wall. We must act quickly and strategically or else scenes like the drowning of New Orleans will become commonplace. Even without the devastation of storms made more powerful by global warming, many millions will be displaced without relief as oceanfront infrastructure is swept by rising sea level. Total submergence of near-beach roadways, buildings, and other infrastructure would not be required to create an enormously costly nuisance. Worldwide, "The overall economic costs to communities, livelihoods, industry and infrastructure could be nearly $950 billion under a one metre sea level rise scenario (Nuttall)." [6]

We may expect basic services to decline as saltwater intrusion occurs in fresh water aquifers at the new sea-land boundaries, waste management infrastructure is swamped, and agriculture is impacted. Tropical diseases will move into cooler climes, as recently seen with the chikungunya outbreak in northern Italy that was vectored by the tiger mosquito (Rosenthal). [7] Industries will suffer either from the loss of biodiversity or else through an efflorescence of a species, like the spruce bark beetle that is decimating millions of acres of Alaskan forests. Add to those woes, the outgassing of methane compounds from thawing polar regions and warming oceans. As that is all playing out, oil is becoming scarcer – the fuel upon which advanced industrial societies depend. And, increasingly more of those societies are coming online worldwide. The interactions of all of these and related events are changing the weather, changing the economic character of landscapes, changing the geography of our living spaces, changing the world order, and challenging the viability of life on Earth.

Watching the debacle of New Orleans back at Space 2005 from the point of view of a rehearsal for things to come, several of us in the AIAA, aerospace architects and astrosociologists primarily, began asking each other: "How can we apply what we know to prepare for extremity?" For among our number were those who understood that rich transfers of knowledge (TOK) could flow from the aerospace community to the environmental sciences and policymaking communities – and vice versa. We knew that the space enterprise had produced new materials and systems for use in the extremes of space. We knew that space-based systems held the promise of alternative energy sources. We also knew that space-based systems were responsible for the level of planetary situation awareness that we have today, as well as the level of globalization that allows an integration of worldwide vision and cooperative effort that was not possible before. Because of the globalization that we enjoy worldwide, transnational response could enable a high degree of mitigation to the challenges of the Anthropocene.

III. Global Warming and Space – Two Great Human Ecology Issues Dogged By Counter-Stories, Fairy Tales, and Pipedreams

The space enterprise and the great environmental issues of the Anthropocene are connected in other ways than materials, systems, extreme design requirements and world-class organizational potential. Global warming and space exploration, for example, are human ecology issues both dogged by naysayers, doomsayers, and soothsayers who invent counter-stories, fairy tales, and pipedreams that have little to do with scientific fact and/or do-ability.

Until recently, the global warming counter-story among the leadership in the United States has been that the phenomenon is not happening and the claims of scientists, including federal scientists, were cold-watered and even squelched. A similar counter-story was that global warming was happening, but it was owing to "natural" factors, as if the stamp of "natural" would make things all right to the public's ear like the stamp of "organic" relieves one's worries that one will eat pesticides with one's vegetables. A hard look at that counter-story begs the question with a hearty "So what?" For, social phenomena, like usage of fossil fuels, are natural phenomena, just as the Milankovitch factors are natural. A Chicxulub-level asteroid strike is "natural," too, but it killed more than half of all species on Earth including the dinosaurs.

A recent version of that counter-story is, "Global warming is happening, but just get used to it (Collier 2007, M1 & M4)." [8] Two recent books, but to different degrees, typify this counter-story: *Break Through: From the Death of Environmentalism and the Politics of Possibility* (Nordhaus and Shellenberger 2007a) [9] and *Cool It: The Skeptical Environmentalist's Guide to Global Warming* (Lomborg 2007) [10]. Bjørn Lomborg proposes that governments should address other humanitarian concerns such as hunger, disease, and poverty and says that global warming will prevent cold weather deaths (and is therefore a good thing for humankind). Reviewer author Michael Crichton thinks Lomborg's counter-story puts global warming in perspective alongside other pressing global issues. The *Publishers Weekly* review, however, tells it more like it is: "…while thoroughly referenced and convincingly argued, [Lomborg] ignores many climate studies and assumes that climate change will continue at a steady rate (not necessarily the case)." That review also nails Lomborg for gross oversimplifications, misleading generalizations, and questionable arguments. [11] My reaction is that, once global warming and its effects become a bigger blip on the world radar screen, its actual ranking among global social problems will be hard to deny. *Break Through* authors

Ted Nordhaus and Michael Shellenberger are more on the beam. They target environmentalist calls for carbon reduction policies at the expense of building higher seawalls and identifying new water and energy resources (Collier 2007). They say that global warming might bring prosperity, cooperation, and freedom, but they fall short of providing a taste of convincing examples how that might occur. But, they admit, “We don't provide a lot of answers because we really don't have them. We wrote *Break Through* not to tell our readers what to do but rather as an invitation to join us in asking the right questions and experimenting with answers (2007b).” [12] Both books’ authors take potshots at organized environmentalism with which they were formerly allied. *Wired* magazine editor Mark Horowitz says that *Break Through* might be the best thing to happen to environmentalism since Rachel Carson’s *Silent Spring* (Horowitz 2007). [13]

My take is: the *status quo* of energy capitalism (big oil, for example) has helped evolve the response of an organized environmentalism that has itself become *status quo.* Carbon reduction policies *and all the other things* will be necessary to mitigate global warming and its effects. How do the counter-stories look “on the ground?” Despite national leaders’ reluctant acceptance that global warming is occurring, in the main, the commercial and political spheres in societies throughout the world are proceeding “business as usual,” a startling paradox, held against the enormity facing the global public. This unconcerned position that nothing unusual is really happening is not driven by fabulous policy and technological mitigations that can be trotted out on stage as the last drops of oil are used and when the temperatures and geographic conditions get too intolerable. Any sufficiently well read individual can see that the mitigation efforts that political and commercial leaders currently make fall into three categories: 1) outright “greenwash,” 2) talk, no action, and 3) underfunded projects. The “business as usual” attitude is driven by the “momentum of the moment,” by elected leaders with too much to do on other issues and short attention spans, and by rich people and corporations who believe their assets will ensure that they will live very well however apocalyptic Earth and its societies may become.

Space exploration also suffers from counter-stories. As one of the few scientists who studies micro to macro social issues connected to the expansion of humanity into space environments, I have run into the tired old argument that we should ditch the space enterprise for social expenditures. But, as anyone who can surf the Internet can see, the national budget is comprised of about 30% social expenditure already, with NASA’s budget hovering below 1%, along the lines of the National Park Service’s piece of the budgetary pie. Here’s another story that I have heard since being six years old in 1959: We will soon have living and work spaces on the Moon, in Low Earth Orbit, and on Mars. National leaders trot this fairy tale out with some periodicity. However, this story remains unrealized because it always winds up “time-slipped.” Thomas Gangale gives a graphic example of the “stretch it out” counter-stories that keep this story fiction (Gangale 2006) [14]:

> At the “New Trends in Astrodynamics II” Symposium held at Princeton University in June 2005, Hayden Planetarium director Neil deGrasse Tyson, who served on the President’s Commission on Implementation of United States Space Exploration Policy (Aldridge Commission), which issued its report in 2004, gave a presentation on George W. Bush’s “New Vision for the Space Exploration Program” (not published in the symposium’s proceedings). As I recall, he discussed how the administration’s goals regarding the human exploration of the Moon and Mars would be accomplished with modest, sustainable funding. That sounds fine as far as it goes, but if funding should become an issue, i.e., when the program hits some technical snag that is more difficult than anticipated and therefore more expensive to solve, Tyson responded, “We’ll just stretch it out.”
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> …. Any technical manager understands that one budgets a certain percentage of a project’s schedule and money as “management reserve.” This is the insurance policy to handle the “unknown unknowns,” the unanticipated technical challenges. In the long run, management reserve saves money, because when it has to be spent, it keeps the project on its optimum curve.
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> “Stretching it out” costs money. The International Space Station (ISS) is a splendid example of this. The project began in 1984, and was targeted to be completed in 1994 at a cost of $14.5 billion. It is not yet completed, is considerably down-scoped from its original design (which includes modules originally designed for the Soviet Mir 2), and it is now expected to cost over $30 billion. This is just the cost overrun to the American taxpayer. In addition, the schedule slips on the American side have caused cost overruns in the Russian, European, Japanese, and Canadian components of the ISS.

At the October 2007 International Space Station National Laboratory Workshop at NASA-Ames Research Center, where I was an invited participant, I heard a variety of stories that made me wonder if my doing research for humans in space was like “moving deck chairs on the *Titanic*.” A pastiche of the various stories had it that the International Space Station would be fully operational around 2010, about the same time as the space shuttle fleet would be discontinued. From 2010 till about 2015 or 2016, the ISS would be in its fully operational timeframe, after which, the United States would discontinue its role in the station. Hanging in the air was the implication that the international ISS partners and other nations that partner with them would continue to operate the station. How would the United States get up to the ISS if the space shuttle fleet is retired in 2010 and in light that the first Orion (Crew Exploration Vehicle) manned launch is not expected until 2014? Valin Thorn of Johnson Space Center trotted out a series of viewgraphs under the flag of the Commercial Orbital Transportation System (COTS). One by one, largely artistic conceptualizations and private company names flashed up on the wall: Rocketplane Kistler, Dragon and Falcon, Dream Chaser, ARCTUS, Constellation Services International, PlanetSpace, etc. If national leaders’ stories of living and working substantially in Low Earth Orbit, on the Moon, and on Mars are recycled fairy tales, then that slide show seemed one pipedream after another to me. My advice: Americans should get used to our astronauts getting on and off the ISS on Russian and Chinese rockets. More on that later….

IV. Earth as an Extreme Environment

Several events connected to global warming are already occurring all over the world: more powerful hurricanes, droughts, coastal inundations and interior flooding, heat waves, salt water intrusions into freshwater aquifers, deforestation, ruined crops, increased populations of disease-bearing rodents and insects, die off of species important to the human food chain and other human activities, water tainted with flooded sewer lines, and air tainted with ground-level ozone and allergens. These are just the challenges we know about at present. We may expect other latent challenges to emerge. In a world becoming evermore extreme, the lag time in getting governments to underwrite environmental mitigation research and apply alternative energy sources will likely impede the timeliness to provide social needs at every level, from the individual right on up to the world system of societies. As events increase and impact a widening circle of the human family, business won’t be able to go on “as usual.” The most basic of social needs of millions, and then billions, will be a thunderous crescendo that cannot be ignored. Social needs of a global public will go under-met or unmet. To reprise Emile Durkheim, one of the fathers of sociology, the social demand in the post-Holocene world will *be* a cosmic force.

My perspective is that global warming, as well as the decline side of oil and disasters that impact evermore increasing populations and infrastructures, are phenomena that bear human ecological kinship with the problems of humans living and working in extreme environments, as the human expansion into space must solve. The Earth is inevitably becoming a more extreme world and some of the problems in the coming decades and centuries will resemble ones that concern people living and working in space environments. I am talking about thermal regulation, uncontaminated water, waste management, disease mitigation, atmospheric composition not conducive to life, and so on.

I used to take the point of view that no matter how bad global warming and its effects got, there would still be air to breathe – a consumable that humans must take with them or else manufacture in off-world environments. That was before I learned about the release of methane compound gases from permafrost (frozen ground) and from the bottoms of thermokarst lakes as they thaw, and from the seabeds as climate changes. The amount of methane compound gases that could pump into our atmosphere is staggering. “The upper part of permafrost in boreal and arctic ecosystems is estimated to contain around 750 to 950 gigatonnes of organic carbon," says the UN’s Environmental Programme report *The Global Outlook for Ice and Snow* (Nuttall). [15] "If significant permafrost warming and thawing occurs as projected, tens of thousands of teragrams of methane could be emitted from [thermokarst] lakes, an amount that greatly exceeds the 4,850 teragrams of methane currently in the atmosphere (Nuttall)." A lot more of these methane compound gases are at the bottom of the world’s oceans which, along with the methane compounds outgassing from the thawing northern polar regions, contain 3,000 times as much methane as is in the atmosphere, according to a report from the Arctic Council (Atcheson 2004). [16] Currently there are around 750 gigatonnes of organic carbon in the atmosphere. What will additional levels of atmospheric loading of methane compounds do for our respiration? Methane is a simple asphyxiant. It currently makes up two ppm of the standard dry atmosphere (McManus 1999, p. 67).” [17] We’ve obviously adapted to the 2.5 times the previous amount in the air that has been outgassed into our atmosphere since the first industrial societies have begun to appear (Weather and Climate). [18] Methane is a greenhouse gas, and the primary concern among experts at present seem to be about it making global warming more severe since it is 20 times as powerful a greenhouse gas as carbon dioxide. But, my question is: What about the impact to our atmosphere, for human and other species’ physiological respiration, if levels rise dramatically? While larger amounts in the single digits of ppm may not be an obvious problem, there may be latent challenges in relation to its breath-ability.

As we proceed further into the Anthropocene Epoch, the changes to the Earth need not be civilization dissolving nor human species ending, though many people will certainly be displaced by rising waters and many people and other species, upon whom we rely in the great web of life, will die. Humans will die from a host of causes brought on by global warming, its effects, and the decline side of oil. They will die because of issues of thermal regulation, from disease, from starvation, from other effects of poverty and homelessness, from storms, and from resource conflicts. We *can* make efforts to adapt and mitigate. But, how do we go about that? As a species, how do we survive the bottleneck between two environmental geological epochs, the Holocene-Anthropocene boundary? Do we hope for the best that adaptations and mitigations evolve in a socially organic way? Or, ought we be more survival-strategic in our approach -- taking an organized, concerted effort as a world system of societies? I vote for the latter course. Together, we can make landmark innovation and wise policy, or as I like to call it "big science, great policy." We have the means to take that course with our eyes open, having some understanding of what is happening to us.

To review the past, humans did make it past the Pleistocene-Holocene boundary, but they did so at a price. All but one human lineage, *Homo sapiens sapiens,* made it into the Holocene Epoch from the Pleistocene. All human lineages that either came before them or that co-existed with them went extinct. There were plenty of challenges before that bottleneck, too. About seventy thousand years prior to the Pleistocene-Holocene boundary, a mega-colossal volcanic eruption in what is now Indonesia, the Toba Event, caused a drop in the total human stock worldwide. At the worst-case estimate, we were down to 1,000 breeding pairs. Our ancestors were unable to understand their predicament and were not technologically sophisticated to have done anything about it even had they had an inkling. But, *we are,* although we do not yet have the full inventory of the challenges and an accurate timetable for their occurrences before us.

I often write about paradigm shifts. One paradigm shift we Anthropocene Epoch humans need to make is to start thinking about our world as a planet in space. Sure, many of us who are scientists and engineers do that already. But, there are others who need to adopt that attitude. Even more importantly, leaders of nations, regions, states, and provinces and city fathers and mothers and the general public need to make that cognitive transition. I suppose a shorthand way of getting them to do that is to encourage them to think about Earth as an off-world environment. It certainly is becoming more extreme than how it was before, and if the 2007 Greenland ice sheet melt rate is any indication, it is becoming more extreme fairly rapidly.

Global warming and its effects and the decline side of oil combined with the increase of advanced industrialization in the world system of societies…. All the problems that pertain to these human ecological expansion issues concern coping with living and working in extreme environments. Space environments are extreme environments. One innovation in one sector can inform innovation in the other sectors.

V. Space-based Innovations: Big Science

Innovation is critical to our survival, just as tailored clothing and horticulture and all the other landmark innovations were. The innovations that will help us move past the transition point from the Holocene to the Anthropocene will, by necessity, connect substantially to space-based systems. A variety of mitigation systems are possible because of space-based systems.

A. A Tsunami Warning System

Satellite imagery is at the heart of space geodesist Geoffrey Blewitt's concept that could detect killer tsunamis in about 15 minutes' time (Blewitt *et al.* 2006).[19] Blewitt's concept works by measuring GPS satellite radio signals as they are broadcast during an undersea earthquake by GPS ground stations positioned around the globe. By accurately knowing the location of Global Positioning System satellites, how far GPS ground stations move during an earthquake, relative to the earthquake, one can then calculate how big the earthquake is and how large a tsunami might be produced by it. Blewitt and collaborators at the Nevada Bureau of Mines and Geology and at the University of Nevada-Reno came up with the concept after analyzing GPS measurements from the South Asian tsunami. A minimum of five GPS satellites are required to be in view of the ground station to accurately and swiftly predict the size of an earthquake. In practice, this condition is almost always satisfied. There are already enough GPS ground stations in place that could contribute to the concept, if put into practice.

B. Solar-to-Microwave Electricity and Hydrogen Production; Disaster Mitigation

Another space-based system holds the promise of alternative energy sources and their spin-offs. Entrepreneurial engineers with Space Island Group have described how components used on NASA's space shuttles, other launch vehicles, and on communications satellites can be used to construct in space very large structures of solar power satellites, solar reflectors, low-cost living quarters in orbit able to comfortably house several hundred workers, who, among other tasks, will assemble and maintain orbiting solar satellites and solar reflectors. Constellations of these structures could run up to several kilometers wide. These constellations would be serviced by low-cost manned and unmanned launch vehicles. The power generation technology is based on converting sunlight collected on orbit into microwaves and beaming them to ground stations for conversion into electricity (Space Island Group). [20]

These arrays, orbiting at 22,300 miles above the Earth, the same orbit used by modern communications satellites, will allow solar satellites to send their energy down to a specific spot on Earth 24 hours a day. Space Island Group argues that the technology has been around for decades to generate electricity from space, and the only thing holding up its use for alternative energy has been the *status quo* structures of energy and capitalism. They argue that conversion of 90% of world power needs to solar power generators could be completed by 2050, giving several decades to make an adjustment to this new technology. The group has been actively engaged in arranging financing through contracts with China, India, and Kyoto Protocol signatory nations and a World Bank loan (*Business 2.0* 2006, 82; Meyers 2006).[21, 22]

Being able to direct low-level microwaves and sunlight as Space Island Group conceptualizes would lead to many spin-offs from its primary mission of alternative energy production. Besides uses in agriculture and forestry, the group points to the cover story from the October 2004 issue of *Scientific American.* The story's author, Ross N. Hoffman, recounted his NASA-funded study of how the microwave beams from solar satellites could be used to steer hurricanes away from coastal cities by warming the air on one side or the other of its path (Hoffman 2004). [23] Inspired by Hoffman's work, Space Island Group is attempting to place a solar satellite prototype devoted to hurricane control in orbit by 2012. Another spin-off of Space Island Group conceptualizations is the mass production of hydrogen fuel from seawater, which I will address more below.

C. Helium-3 Fusion Reactor Fuel

Another energy source from space (helium-3 fusion reactor fuel from the Moon) still requires a good deal of research and development, if the helium-3 gas reserves can be found on the Moon and delivered to Earth. Nuclear fusion is the holy grail of the nuclear power community. Electricity from nuclear fusion reaction is preferable to the fission reaction of nuclear power plants, for reasons discussed in a moment. The helium-3 isotope is rare on Earth, but is expected to have been deposited on the lunar surface in quantity over billions of years by the solar wind, the high-speed stream of charged particles flowing from the sun. Fusion research has been ongoing since the mid-20th century, first as a weapon of mass destruction, followed by interest in its possibilities as a means of power generation. The initial (D-T) reaction of interest was hydrogen-2 (deuterium) and hydrogen-3 (tritium) fusing to form helium-4 and expelling a high-speed neutron.

As Thomas Gangale and I have described elsewhere (Dudley-Flores & Gangale 2007), [24] the excess neutron constitutes a source of intense particle radiation. This is not particularly a concern in a thermonuclear weapon, where the intent is to inflict damage, and is even desirable in applications where the preferred kill mechanism is enhanced radiation versus heat and blast damage (the so-called neutron bomb). However, if the D-T reaction were to be sustained and controlled as a power source, it would necessitate heavy shielding; the excess neutron, having no electric charge, is not subject to being controlled by a magnetic field. Over time, as the shielding material absorbs neutrons, its non-radioactive nuclides are transmuted into radioactive ones, creating a waste problem. So, researchers have settled on helium-3 as a more practical fusion reaction for power generation. The reaction produces a helium-4 nucleus, which is non-radioactive, and a proton, which is positively charged and easily channeled by a magnetic field into useful energy.

The problem is that only a few hundred kilograms of helium-3 are known to exist on Earth. While the isotope appears more plentiful on the lunar surface, some skeptics question whether it exists in concentrations that would be commercially feasible to extract. It might be as ridiculously costly and technologically difficult to retrieve as the other half of the world's oil supply that stays in the ground in the form of droplets in reservoir rock. Another barrier to commercial feasibility is getting more energy out of the reaction than is put into it to create the conditions for the reaction and to control it. Fusion only occurs at temperatures of several million degrees Celsius, an environment in which the electrostatic repulsion of nuclei is overcome and collisions can occur (claims for cold fusion reactions have not been reproduced).

Thirty years ago, it was said that commercial fusion power generation was twenty to fifty years in the future. That claim is still being made. So, it would appear that development of fusion energy has been standing still. No matter, a new race for the Moon for alternative energy is being touted in the press, although it remains to be seen whether any vigorous Moon effort, either born of competition or of cooperation, is on the horizon. The Return-to-the-Moon to install some beachhead infrastructure might hold value for the United States just because other nation-states covet the Moon for an alternative energy source. Spokespersons from China and Russia both have mentioned building lunar bases for the purpose of bringing helium-3 to Earth for use in fusion power plants.

D. The Problem of Air Transportation in the Post-Petroleum World

The airlines do not seem to have a place in the post-petroleum world if the paucity of alternative fuel research for air transportation is any indication. Few conversations about this have made the radar screen of the Internet. These are conversations that need to take place at the soonest. The globalized world is not just dependent on fast communications and information processing, but on rapid air travel and cargo services. What could possibly replace the JP-4 guzzling airlines that may lend their own unique carbon footprint on the warming globe (Walsh 2007)? [25] Some research is being done on biofuels for airliners (Peak Oil: Info & Strategies). [26] Barring upgrading slower dirigible and ocean liner systems, one solution for fast air transit is *even faster air transit.*

The rocket plane, long on the aerospace engineer's design board, is fueled by liquid hydrogen. However, as with the hydrogen-powered car, it currently takes a great deal of energy to make liquid hydrogen fuel. A viable commercial rocket plane is not yet on the horizon, but not without a lot of effort to get it off the ground. To date, the rocket plane, a single-stage-to-orbit (SSTO) launch vehicle has proven to be too challenging. The first of these was the Ronald Reagan-hawked *Orient Express,* also known as the X-30 and National Aerospace Plane (NASP). It began as a Defense Advanced Research Projects Agency (DARPA) project called Copper Canyon that ran from 1982 to 1985. Reagan took the wraps off of it in his 1986 "State of the Union" address, at which point the program became the X-30 NASP, funded by NASA, and the United States Department of Defense. Rockwell International won the competition as prime contractor. Aircraft commentator John Pike wrote (1997): [27]

> The assertions that NASP will have airplane-like operating characteristics, with lower costs and fast turnaround times on the ground, are assumptions, rather than conclusions based on detailed analysis…. [U]ltimately proponents were unable to save it from termination [in 1993]….
>
> The Hypersonic Systems Technology Program (HySTP), initiated in late 1994, was designed to transfer the accomplishments made in hypersonic technologies by the National Aero-Space Plane (NASP) program into a technology development program.

As Thomas Gangale detailed, on January 27, 1995, the Air Force terminated its participation in HySTP, ending "the last gasp of NASP." [28] On July 2, 1996, NASA selected Lockheed Martin to design, build, and test the X-33, a subscale technology demonstrator for a next-generation, commercially operated space launch vehicle named VentureStar. The X-33 was to flight test a range of technologies needed for SSTO reusable launch vehicles (RLVs). Construction of the prototype was about 85% complete when NASA canceled the program in 2001, after a long series of technical problems such as flight instability and excessive weight. NASA had invested $912 million in the project before cancellation and Lockheed Martin a further $357 million. Here to be seen was the perfect partnership of a government agency that wanted to get out of the launch operations business as a cost center and a corporation that wanted to get into the business as a profit center; yet the technical challenges put their goals beyond the resources they were willing to risk.

Even if government and commerce could solve the technical problems of a rocket plane, they would still be stuck with the problem of the fuel source – hydrogen. That is a breakthrough still flying a holding pattern. Creating hydrogen fuel for cars and rocket planes from electricity generated by natural gas, coal, or oil, to split water into hydrogen and oxygen, costs more than it is worth. However, this situation might change if Space Island Group has its way. The group maintains that if solar satellite receiving antennas were built to float on the ocean off the East, West and Gulf Coasts of the U.S., the low-cost electricity generated could produce all the hydrogen needed for transportation (Space Island Group). [29]

VI. Great Policy: Space-based Systems

In the Anthropocene Epoch, geopolitical realities are tracking very closely with environmental realities. The geopolitical lay of the land is changing with the changing Earth. Those societies best able to make the innovations to enable their citizens to not only survive, but to enjoy a high standard of living, will be "core" in the world system of societies.

When I say "core," I am making reference to the "core-periphery" schema of Immanuel Wallerstein, a sociologist who is also considered among the top international relations experts in the United States and the world. World Systems Theory views the world connected by a complex network of economic exchange relationships — i.e., a "world-economy" or "world-system," in which the dichotomy of capital and labor, and the accumulation of capital by competing actors (including, but not limited to, nation-states) account for conflicts. An enduring division among core, semi-periphery and periphery areas marks this world-economy. External areas that have managed to remain outside the world-system, enter it at the peripheral stage. There is an institutionally stabilized division of labor between core and periphery, and their economic exchanges are unequal. While the core has a high level of technological development and manufactures complex products, the role of the periphery is to supply raw materials, agricultural products, and cheap labor for the expanding actors of the core. The intermediary zone, the *semi-periphery*, acts as a periphery to the core, and a core to the periphery. At the end of the twentieth century, this zone was characterized by Eastern Europe, China, and Brazil (Immanuel Wallerstein, Wikipedia). [30]

The United States is fast receding from the core and becoming a "semi-peripheral" society in the twenty-first century. A core society is, generally speaking, "first world," and a semi-peripheral society is "second world" under an older schema. I explain why this is occurring, herein, and in the following sections.

Which societies will be core as our world changes can be glimpsed through their operational readiness to meet the challenges of the Anthropocene Epoch. This operational readiness can be defined broadly by their space capabilities. That is because space capability is on the leading edge of the expansion of the human ecology. The science and technology that occurs on that leading edge is representative of the level of scientific and technological ability to create landmark innovation. A collateral diagnostic of a society's ability to meet Anthropocene Epoch challenges at this leading edge is the degree of willingness to partner with other space capable nations.

The space capable societies are: the United States, Russia, China, India, and the European Union. The cooperation of these national actors in space has laid the groundwork for their integrated response to other problems of the expansion of the human ecology. As Thomas Gangale and I have written elsewhere, their cooperation on the International Space Station (Dudley-Flores & Gangale) [31]

> has continued a paradigm shift that began with the Apollo-Soyuz Test Project. That paradigm shift was the transition from a competition in space between the Soviet Union/Russia and the United States to a stance of cooperation. The Apollo-Soyuz Test Project (July 1975) was the first joint flight of the American and Soviet space programs.[†] The Test Project allowed for the synchronization between American and Soviet/Russian space technology that informed the NASA-Mir collaboration (1994-1998). Similarly paradigm-shifting has been the European Space Agency's (ESA) and NASA's Spacelab collaborations that have continued intermittently on board space shuttle flights between 1983 into the early 2000s. Also, beneficial have been the many international inputs through the American and Russian sides by other national space programs. A salient example is Italy's Harmony Module that will connect Japan's Kibo Laboratory Module and the European Space Agency's Columbus Module to the International Space Station (the latter module a collaboration among French, German, and Italian companies and facilities).

Cooperation is quite evident in the Russian long-duration Humans-to-Mars effort, which is an international, inter-agency, inter-corporate array of projects. It is a "make-work" enterprise made possible through the auspices of an international non-proliferation program, the International Science and Technology Center (ISTC), that spends a few million dollars a year on former Soviet scientists and engineers to keep them from leaking their weaponizable expertise and materiel to "evil axis" states and terror warlords. The ISTC is an intergovernmental organization headquartered in Moscow, Russia, and whose governing board is chaired by an American, the Director of the Center for Global Security Research at the Department of Energy's Lawrence Livermore National Laboratory. NASA and the ESA are partners in this "transgovernmental" organization and Boeing is the big industry player. As "make-work" as the arrangement is and how it started, it has become a "fake it till you make it" enterprise. From its Mars "spaceship" experiments in the late 1990s till present at the Institute for Biomedical Problems in Moscow, Russian IBMP spokespersons have continued to talk about leading an expedition to Mars *ca.* 2030 with international cooperation.

China (that has also been a contributor to the International Science and Technology Center) has also wanted to participate aboard the International Space Station. But, the way to collaboration, as Thomas Gangale and I have previously pointed out, has been full of ups and downs owing to various events (Dudley-Flores & Gangale)**:** [32]

[†] It was the last Apollo flight and last manned space launch until the flight of the first space shuttle in April 1981.

- During the 1990s. Hughes Electronic Corporation gave China key information to assist them in determining why their rockets tended to fail soon after launch. Hughes was not accused by the U.S. State Department until late 2002.
- 1996. Loral Space and Communications Corporation forwarded a report on a Chinese rocket to the Chinese government without U.S. State Department clearance, prompting a federal grand jury investigation.
- April 2002. Sales of satellite technology to China increased, prompting the U.S. State Department to loosen rules on export of scientific satellite projects to the PRC.
- Six months later. Chinese head of state Jiang Zemin met with President George W. Bush to discuss easing bans on the transfer of satellite technology if China reduced its sales of missile technology to third parties. They did not reach an agreement, but talks continued.
- March 28, 2003. A missile fired by the Iraqis hit a shopping mall in Kuwait. The weapon was a modified Chinese-made Silkworm rocket (Knight). [33]
- On 11 January 2007, China used a ground-based medium-range ballistic missile to destroy its Feng Yun 1C polar orbit weather satellite. Taiwan's senior politicians registered the most protest. U.S. spy satellites observe the Taiwan Straits, which are useful to coordinating any defense of Taiwan in the case of a Chinese invasion.[34]

Yet, the American Century is behind us and the 21st century will be characterized by China's rising star. Estimates are that China's gross domestic product (GDP) will surpass that of the United States in 30 to 40 years (Pesek 2005). [35] Meanwhile, its developing manned space program has caused barely a stir in the U.S. I don't find this surprising. As the American knowledge base has dropped, American journalism, across the board, has devolved into "infotainment" rather than intelligent news reportage. The infotainers have little knowledge of how to report on space endeavors. Who can forget the CNN daytime coverage on 27 March 2004 of a NASA unpiloted test vehicle? The anchor commented, "It exceeded the sound of speed." This was a remarkable feat since she also wrapped with "It carried no fuel on board." American journalists reporting its first mission, *Shenzhou 5,* piloted by Yáng Lìwěi on 15-16 October 2003, shrugged it off as repeating something the Soviet Union and the United States had accomplished four decades earlier. And, anyway, the Shenzhou system was based on the Russian Soyuz technology. As has become usual, this was mis-reportage. The Shenzhou design is not your grandma's Soyuz design. It is based, not on mid-20th century, but on turn of the 21st century, technology. It is more versatile than the Soyuz spacecraft that the Soviet Union/Russia has flown for four decades. The orbital module at the front of the Shenzhou is reported to be capable of being connected to others as building blocks for a small orbital station or as add-on modules to a larger station (Jones 2006). [36] China is also reported to be interested in lunar and Mars exploration (McDonald 2003). [37]

The Chinese "are advancing whether or not the U.S. or others are teaming with them," Vincent Sabathier, Senior Fellow and Director of Space Initiatives at the Center for Strategic and International Studies (CSIS, Washington, D.C.) has said (David). [38] But, in fact, others are teaming with them. China has more than 50 projects in space cooperation with Russia alone, to include an upcoming Mars probe scheduled for a 2009 launch date (MSNBC). [39] The European Space Agency has already teamed with the China National Space Administration (CNSA), in 2003 and 2004, on the Double Star satellites that study the Earth's magnetosphere. And, the United States will soon be partnering with China in quite a reliant way. Despite earlier American political squeamishness about partnering with China on outer space production, NASA Administrator Michael Griffin went to China in late September 2006. China can latch up to the International Space Station because of a ready and willing docking port on the Russian segment of the station (the APAS-89 docking adapter). The gap between the end of space shuttle flights and takeoffs of the, as yet, unbuilt Orion (Crew Exploration Vehicle) could be filled by Shenzhou spacecraft rather than rely solely on the Russians' Soyuz spacecraft.

If that gap widens any further, America may be able to book passage with India to where it wants to go in space. India has had a steady-growth space program and has cooperated with the European Space Agency, NASA, Soviet and Russian space programs, and smaller national space agencies since the 1960s. It has made great progress. In January 2007, the Indian Space Research Organization (ISRO) mastered "splashdown" technology in the Bay of Bengal. ISRO has announced plans to launch an all-Indian crew into space by 2014.

The European Space Agency has spent very little budget on manned spaceflight, collaborating with the United States and Russia to get its astronauts to space. It has shown little interest in lunar endeavors, but has a timeline established for a European Mars mission scheduled by or around 2030. It is working on a counterpart of the Orion (Crew Exploration Vehicle) and other "beyond Low Earth Orbit" designs with Russia. The ESA is probably the most collaborative of all the space agencies. As an active collaborator, however, it is bedeviled by time slippages on both American and Russian sides for a similar reason: funding issues. The whims of Congress concerning the NASA space shuttle budget have systematically left Europe cooling its heels on partnered projects. And, since the collapse of the Soviet Union, the Russian space agency is left running laps until it can amass the cash to proceed on space projects.

Time slippages owing to poor funding on an Earth growing evermore extreme are not survival-strategic for humankind. *Money is time* in a globally warming decline-side-of-oil world where mitigating systems, that include space-based systems, are needed sooner rather than later.

In the meantime, technological progress in Europe and Asia rockets. We may count on sophisticated applications making it into the systems of all substantially participating partners in the space endeavor. While the United States copes with essentially trying to re-engineer the Apollo design system, trying to recoup lost decades of system evolution in a matter of years, bringing it up to date to where it would have been had the United States not stepped back from the Moon during the Nixon years, a collaborating China, India, Russia, and Europe could trot out the Cadillac, Rolls Royce, and BMW of manned spacecraft. In the meantime, the people who worked on the Apollo system have aged out – or are dead. That means that much of the living expertise is gone, and the later generational expertise is not there among the fewer, brighter minds available to the United States.

To "spin" the gap, to make it sound like the United States is "A-OK," we trot out viewgraphs of systems prepared by entrepreneurial firms, many who come out of the Internet/computer industry, who tend to view simulation as good as reality. And, with "boards of youngsters who try to teach grandma to suck eggs (Steding 2007)." [40] Instead of spinning the gap, the United States needs to *span* the gap. I will discuss what needs to be done overall further along in this report. But, first, I would like to discuss another defining indicator of operational readiness to meet the challenges of the Anthropocene Epoch. That is the ability to control and use water.

VII. Big Science and Great Policy: Control of Water

Other indicators of operational readiness for the challenges of the Anthropocene Epoch are a society's ability to control and use water, and collaterally, its role in an ever growing interconnected electrical "hypergrid." Such a long line transmission worldwide electrical grid could be heavily based on control and usage of water (but that would also include the input of other power generation systems). Water-based power generators today are mostly dams, but could soon include more on- and offshore tidal electrical generation stations.

Asia and Europe have been making great strides in the control of water. In the meantime, the United States' water control infrastructure has appreciably deteriorated – which is diagnostic of where we stack up in terms of water control.

In Asia, governments have been determined to build dams, with or without international aid, according to *New Scientist* magazine. Just after the public inauguration of Three Gorges Dam in China, the countries along the Mekong, which include Vietnam, Thailand, Laos and Cambodia, announced the formation of a new organization to begin dam-building on the river. According to Fred Pearce (1995a, 25), [41] author of the *New Scientist* piece, "India persisted with the controversial Sardar Sarovar Dam on the Narmada river, despite losing World Bank support. And late last year [1994], it resumed construction of the 250-metre high Tehri Dam in the headwaters of the Ganges. Malaysia…announced the go-ahead for a 230-metre high dam in the rainforest of Borneo." China's Three Gorges Dam across the Yangtze River, 2 kilometers across and about 200 meters high, becomes fully operational in 2011 and represents the largest hydroelectric power station in the world. The amount of steel that has gone into its construction has raised world steel prices. Pearce reminds us that "Of the world's 30 largest rivers, apart from those flowing into the Arctic, most have dams across them, holding back substantial parts of their flow. They include the Ganges, Parana, Tocantins (a major tributary of the Amazon), Columbia, Zambezi, Niger, Danube, Nile and Indus. After the Yangtze has been dammed, engineers will be left with only two major rivers to plug: the Zaire and the main stem of the Amazon."

Though Europe is not building more giant dams, it has invested itself in various cutting edge water control projects. The largest tidal power station in the world is in northern France on the Rance estuary and was built back in 1966. There are eight main sites in the United Kingdom where tidal power stations could be built, including the Severn, Dee, Solway and Humber estuaries (Tidal Power). [42] Both dams and tideworks have considerable environmental impacts. Dams displace people and flood infrastructure, including archaeological remains. Onshore tideworks can change estuary currents that can alter the ecosystem of the estuary. Offshore tideworks don't have the environmental impact downsides as onshore tideworks and operate like undersea windmill farms. A transnational entity, Marine Current Turbines, Ltd. (MCT), a company registered in the U.K. wants to market its offshore tideworks scheme to North America, Southeast Asia, Austrialia, and New Zealand

The Netherlands and the U.K. lead the edge on flood barriers. These flood barriers do not produce electrical power. They protect highly populated and infrastructure'd areas against flooding through storm surge. The Dutch

Maeslant Barrier (or Maeslantkering) is on the main route to the port of Rotterdam. It holds the distinction of being the largest moving structure on Earth. It is comprised of two floating gates constructed on the levees on each bank of the waterway. A sill was placed at the bottom of the waterway. Next built were the two 22-meter high and 210-meter long steel gates. Then, 237-meter-long steel trusses were welded to the gates. Standing upright, these arms are as high as the Eiffel Tower. The main purpose of the arms is transmitting the storm surge forces, exerted on the gates while closed, to one single joint at the rear of each gate. These ball-shaped joints let the gates move freely under the influences of water, wind, and waves, and are not unlike the action of the human body's ball and socket joints. They are the largest such joints in the world, with a diameter of 10 meters, manufactured at Škoda Works in the Czech Republic (Maeslantkering). [43] The Thames River Barrier, 523 meters wide, is of a somewhat different design, but serves the same purpose. The amount of sea level rise expected during the 2030-2050 timeframe will make it necessary to replace the Thames Barrier with a 16-kilometer-long barrier across the Thames from Sheerness in Kent to Southend in Essex (Thames Barrier). [44]

Italy is getting in on the policy and technology of storm surge protection. In order to protect Venice from storm surges from the Adriatic Sea, the Italian Government is building a series of floodgates at three inlets along the lagoon surrounding the city. These gates, will rest on the sea floor and swing upward in response to rising tides. MIT professors advising on the project describe it thusly (Brehm 2002): [45]

> The project is a series of 79 gates - each about 30 meters high, 20 meters wide and four to five meters thick - to be installed on the bottom of the sea at inlets at Lido, Malamocco and Chioggia. Forty of the panels will stretch across Lido, the widest of the inlets. When a tide of 1.4 meters or higher is predicted, the hollow gates will fill with air and rise, creating a barrier to the seawater.

How ironic that American professors advise on sophisticated technological solutions in Europe. Why is it that such American expertise is not sought out for use here in the United States? America's place in water control has been dismal though there have been many American disasters concerning water-related infrastructure – not just along the American Gulf Coast. Official reports about the nation's infrastructure should also serve as a wake-up call.

Public works infrastructures in the United States relating to water are crumbling. The condition of the nation's nearly 600,000 bridges is in doubt. A 2003 survey found that a third of all bridges in major urban areas were considered structurally deficient or functionally obsolete (*Nightly Business Report,* Part 1). [46] Nothing demonstrated that finding quite so vividly as the collapse of the Interstate 35 West Mississippi River Bridge on August 1, 2007. The eight-lane, 1,907-foot steel truss arch bridge carried traffic on Interstate 35 West across the Mississippi River into Minneapolis, Minnesota. At the time of the collapse, the bridge was 40 years old. During evening rush hour, the main spans of the bridge fell into the river and onto its banks. Thirteen people died and many more were injured (Mississippi River Bridge). [47]

In May 1994, Daniel Beard, the commissioner of the US Government's Bureau of Reclamation, which built the Hoover and Grand Coulee dams and many others, announced that "the dam-building era in the US is over." He told delegates at a meeting of the International Commission on Irrigation and Drainage that most projects cost 50 percent more than predicted and that "often, project benefits were never realized (Pearce 1995a)." [48] If official reports on American water control pertaining to locks, dams, and levees hold water, it rather sounds like we should get back into the water control infrastructure business, and get it right this time around.

If the control of water is an essential mitigation in a globally warming world, the United States is starting from a weak position if its deteriorating locks, dams, and levees are any indication. The 200-odd locks that make up the Mississippi and Ohio Rivers and their tributaries are 50 years old on average. The project to upgrade the series of locks and dams on the Ohio River, one of the major waterways used in distributing bulk goods and materials throughout the nation, was started in 2000 and won't likely be finalized until 2009. According to the U.S. Army Corps of Engineers, "[O]ne of the problems in a multi-year construction project like this is getting consistent funding from Congress (Part 2)." That's not all, say the American Society of Civil Engineers. "Of the 79,000 dams in the United States, more than 10,000…have a high-hazard risk of failure (*Nightly Business Report,* Part 4)."

When the U.S. Army Corps of Engineers inspected some 2,000 levees in 2007, 122 were deemed "at risk of failure." Nineteen of those are on the Sacramento River in California. The thousand miles of Sacramento River Delta levees were built less robustly than the ones in New Orleans, experts say. Moreover, they are sand-based and come right up to an earthquake fault line. A major levee break would put the city of Sacramento 20 feet under water in places. And, though its citizenry would have a better chance of evacuating than occurred for those in New Orleans during Hurricane Katrina, a major failure could disrupt California's water delivery system for up to two years

(California Council on Science and Technology). [49] A harbinger of things to come: Just 20 days after the bridge collapse in Minnesota, a levee was breached in Sacramento (CBS News 2007). [50]

VIII. The Hypergrid and the Changing Social Ecology

Mentioned in passing, above, connection of a worldwide power grid (the hypergrid) is already in progress as large regional grids anticipate intercontinental linkages. I first heard of the hypergrid in conversation with R. Buckminster Fuller during a conference on the future of Alaska and the Arctic in Anchorage in the late 1970s. This worldwide power grid linking continents was a conceptualization of Fuller's who said that the world's power needs could be satisfied by the great Arctic rivers from the Lena to the Mackenzie in conjunction with long distance electrical transmission technology (Fuller 1979; Pearce 1995b, 388; Fuller, Global Energy Network Institute). [51,52,53] Fuller's dream is still alive, not only because of the many disciples who followed his work, but also because of sheer necessity in a world where an increasingly number of societies are leapfrogging to industrial status on the decline side of oil.

It is true that many people stand to perish as a consequence of global warming and its effects and because of the decline side of oil. At the same time, the global population (currently nearly 7 billion people) is increasing. Barring any substantial die offs, conservative estimates have the planetary population at around 10 billion at the end of the twenty-first century. As more homes become electrified in a shaping global version of the Tennessee Valley Authority (TVA) and New Deal, 7 to 10 billion people will use enormous amounts of electricity.

What is more, as the decline side of oil downwardly steepens, the demand on power grids will be heavier than just a growing number of users requiring household and worksite electricity for the typical uses experienced today. The demands on grids will see another sort of mathematics at work beyond the exponential curve of swelling planetary population. We must factor in the numbers of additional appliances and systems that will require recharging and/or steady sources of electrical power. I am talking about the more portable power plants and sources involved in personal and mass rail transportation. All-electric vehicles, like General Motors' EV1, was tested in California, where it was a big hit among its experimental drivers, and was ultimately upgraded for 110-160 miles per charge. Lithium ion batteries could increase that range to 300 miles per charge (Paine 2006). [54] It is likely that the demand for electricity for personal transportation in the form of electrified automobiles, combined with a growing number of people worldwide wanting their own vehicles, will drive the completion of the hypergrid (Dudley-Flores & Gangale). [55]

Electrifying mass rail transportation involves large capital projects; existing railbeds are more difficult to transition over to accommodate electrical systems. On the decline side of oil, trains that run on diesel and their wheel and track infrastructure will have to be replaced by various magnetic and electric propulsion systems that take specialized infrastructure. While this has been done to some degree in Europe and Asia, the United States is woefully behind deploying these systems.

Rising sea level, the decline side of oil, an increasing number of advanced industrial societies, more people and their infrastructures, the need for scientific and technological solutions, including space-based systems…. If humanity is to survive and thrive, we must make quantum-leaping innovation. I like to think that human groups and nations will make that innovation. However, I wonder if *my nation* will be heavily involved in it.

My worry stems from what I have witnessed as a scientist who has made part of her living as an educator for the past 30 years. My worry also stems from understanding that geopolitical realities are tied to environmental realities, geopolitical realities morphing just as quickly as the environment changes. Some environmental realities are "socially ecological" in nature. Take, for instance, the one-world global economy we now enjoy. As Thomas Gangale and I have often pointed out, when the global economy materialized, the United States became a country of *working-class* people, left behind at home by elite Americans who went abroad in the world marketplace. For those who run multinational (transnational) corporations, the world market is their "country" to which they owe their primary allegiance. In their hurry to take over the world, they have become men and women without a country – without America, that is. They have left their countrymen and women behind. It is no wonder that ordinary Americans suffer for lack of adequate jobs, without adequate healthcare, and without adequate education. It is beyond the scope of this report to give a full treatment of that situation. However, I would like to focus on the condition of American education, where the geese that lay the golden eggs of innovation are hatched.

I have spoken about various indicators of operational readiness for the challenges of the Anthropocene Epoch: a society's place among space-capable nations, its willingness to cooperate in space with other nations, its ranking in its ability to control water, and its role in a worldwide power grid. But, the prime determinate of "core-hood" in the world system of societies is in a society's degree of understanding that its institution of education is absolutely key to that society's operational readiness to meet the challenges of the Anthropocene Epoch. Education is a society's most important industry. How well a society understands this fact will be expressed in how well its institution of education is maintained.

IX. Great Policy: Education

A. The Gathering Storm in Review

For transfers of knowledge (TOK) to transfer to anywhere, national knowledge bases must be able to *add value* to the solutions of the problems of the Anthropocene and to its international partners cooperating on the solutions. America is in trouble on that note. This is a very big deal and every scientist, engineer, scholar, and educator should be talking about it to those in leadership positions at every echelon every chance they get.

To review, which nations are "core" will be defined by those societies most able to meet the challenges of global warming, decline side of oil, and disasters in ever increasingly populated and infrastructure'd areas. (This includes things like their role in the functionality of a worldwide power-grid and leadership in space-based systems). A jockeying process is occurring in the here and now with societies re-assorting as core, semi-periphery, periphery, and external according to their operational readiness for the realities of the Anthropocene Epoch. The United States cannot remain a core (first world) society if it does not engage in a vigorous civil space program and other knowledge projects and programs that relate to energy, disaster mitigation and extreme environmental adaptation for a human stock that is approaching 10 billion persons by the end of the 21st century – in short, attend to the expansion of the human ecology on this world and off-world.

So, here we are, at the dawn of the Anthropocene Epoch and America is falling away from the core of world societies. That is because we are starting from a weakened position regarding our knowledge base and the technological things we can do. No amount of public relations, advertising, and Hollywood "spin" can alter the hard reality of epochal climate change and the decline side of oil and the impact it has on people and societies. Unlike the Space Race of the Cold War, this time, Americans are not merely engaged in a race with other nations to upgrade our science, knowledge, and technology base in order to briefly touch down on some beachhead like the Moon a few times and proclaim victory. We, along with other humans, are in the bottleneck of epochal climate change. This time around, we are in a race for our survival on an Earth growing evermore extreme. It is as important to lead in this race as well as it is to cooperate with the other runners. In a world where the human species is in a fight for its survival, if we Americans do nothing, we may be assured that the first thing to go will be our ability to sustain our level of subsistence – our modes and standard of living -- and then, we will lose our ability to function as a nation. That, in turn, ties to our place in an interdependent world system of societies where some are more unequally interdependent than others.

What can the United States do to ensure that it remains a core society and therefore a useful teamplayer against the challenges of the Anthropocene? The answers to that lie in the insight of those who have taught in the colleges and universities of the United States over the past several decades. Their historical memory is essential in this matter.

B. A Paucity of "Smarts"

At the dawn of the Anthropocene Epoch, when science and technology and innovative policymaking can provide the means to mitigate and adapt to the new natural scheme of things, the United States is falling behind China, India, and the offshore research and development (R&D) abilities of multinational companies. A National Academies Press report, pointedly entitled *Rising Above the Gathering Storm,* addressed the problem of the decline of innovation in the United States and in its ability to be competitive in the world market (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. 2007). [56] The authors focused mainly on the effects of globalization and a global economy that have enabled the rise of an increasing number of advanced industrial societies in the world system of societies. The decline side of oil received some lip service with the advisory that there was need of federal funding for energy research. But, the panel that authored this revealing report noted that one of its number *protested* that particular recommendation on the basis that private funding was doing a good enough job.

The National Academies Press report provided fairly good information on the decline of innovation in the United States as compared to the rest of the world. It stressed the importance of the United States being a competitive cooperator in the world system of societies. But, its fatal flaws were:

- It did not factor in the impact of global warming and its effects; and

- It only made recommendations about beefing up science and mathematics in K-12, and about *encouraging* science, mathematics, and engineering in academe and among young researchers. The report did not address the source "mechanics" of the problem at the postsecondary level.

In short, its scope of insight and, therefore, advisories are of limited use to policymakers and those charged with applying the recommendations. As Earth becomes more extreme, the dark picture painted about American innovation by the National Academies Press panel will fade to black. That will happen unless an important "root cause" of the decline in American innovation is understood and addressed. In the United States, the *industry* that produces "the smarts," its network of postsecondary institutions, both public and private, is a former shadow of itself.

American K-12 education generates "the smarts," too. And, it is also in terrible shape. However, it is beyond the scope of my report here to outline just how bad a shape K-12 is in. For a good hard look at that travesty, my former professor, Dr. Donald C. Orlich, has discussed this in depth in his book *School Reform: The Great American Brain Robbery* (2006). [57] He also offers critical recommendations. Those recommendations should be heeded. For, eventually, K-12 students, who would become America's scientists, engineers, scholars, and educators, go on to college. There, they are "ginned up" to take jobs in the labor force requiring high-level skills, or else processed further in graduate and professional programs. But, for several decades now, getting to college, getting properly educated, and choosing to work in American academe has become problematic. All issues are problems that have greatly undermined the ability of the United States to be a "value adder" among competitive world societies that are facing the challenges of the Anthropocene Epoch.

The failure of the Space Exploration Initiative (SEI) of the 1980s should have been a wake-up call. NASA and the industries that would have been involved in building the infrastructures to loft missions to Mars told then-Vice President Dan Quayle that there was not enough brainpower in the United States to make the effort. Americans surely had "the smarts" during the earlier decades that saw it going to the Moon. What had happened by the 1980s to lend credence to the assertion that there wasn't enough scientific and technological knowledge to ramp up for a large-scale science and technology and policy project like going to Mars? The answer to this has something to do with stepping away from the Moon in the first place.

C. Sweatshop Universities – America For Dummies

President Richard Nixon's Administration ended the Apollo program that made the United States a space-capable society and one respected for its science and technology. But, the Nixon Administration ended more than a space program. Ramping up to human Mars exploration would have laid the groundwork for "big science, great policy" answers to not only issues of long-duration space exploration, but also to alternative energy sources, epochal climate change offset, and disaster mitigation.

It was not to be. The decisions of the Nixon Administration "dumbed down" American postsecondary education as a consequence of the lapse of the Apollo program and the follow-on science and technology events that *did not* happen in the 1980s and 1990s. The Apollo Era had stimulated knowledge production and technological advancement because the federal government poured money into colleges and universities to grease the engines of prestige on the America-to-the-Moon front during the Cold War. Over the course of time, the American postsecondary student body swelled owing to new demographic realities and changes in the economic profile of the United States that were in part owing to the changes wrought by Apollo Era technological advancements and forward thinking. An increasing number of women and minorities gained access to colleges and universities, as well as those who might otherwise have pursued careers in manufacturing. As a result, when Apollo-driven federal money (and oversight) disappeared from academe, the impact on colleges and universities was greater than if America had never gone to the Moon. Postsecondary administrators free-reined a new kind of governance called the "corporate model" [‡] to manage the loss. In the absence of federal funds, academic administrators increasingly raised student tuitions and invented creative ways to teach whole new armies of students with professors on starvation wages.

There are reasons why the impact of this "corporate model" has largely gone unnoticed till now. Among the greatest reasons has been that the United States, through the sheer momentum of its lead in science, knowledge, and technology, sailed into the Anthropocene Epoch out in front of the pack (Committee on Prospering in the Global

[‡] Also called the "privatization of academe"

Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. 2007, 206):

> The dominant position of the United States depended substantially on our own strong commitment to science and technology and on the comparative weakness of much of the rest of the world. But the age of relatively unchallenged US leadership is ending. The importance of sustaining our investments is underscored by the challenges of the 21st century: the rise of emerging markets, innovation-based economic development, the global innovation enterprise, the new global labor market, and an aging population with expanding entitlements.

Add to that: global warming and its effects, and the decline side of oil….

The latent dysfunction of the corporate model of American academe is that it has robbed funds and resources from academic faculties and has created a new and dangerous profile for the American brain trust. The plurality of postsecondary teachers in the national aggregate is without adequate salaries, health benefits, retirement funds, office space, laboratory and equipment access, travel funding for national and international conferencing with colleagues in the various disciplines, and other resources. The American profession of "professor," has become, in the main, a sweatshop affair in both private and public Academe, with postsecondary teachers being paid by the piece – by the semester, by the year, by the course, or even by the filled seats in the classroom. A recent figure generated by the American Association of University Professors from an analysis of federal records put the American sweatshop professoriate at 70% (Finder 2007). [58] This analysis is a little like number-crunching rape statistics from federal records. At the end of the day, much goes under-reported. The actual number of sweatshop professors likely rises higher nationwide from one semester/term to the next because of the usage of semester/term contracts and the shifting whim of college and university administrators from one semester/term to the next. And, when university administrators can get away with it, to get "more bang for their buck," they pay graduate students and upper-level undergraduates even worse starvation wages to teach college courses.

What all of this means is that less than 30% of college teachers in the national aggregate have the "right stuff" to make innovations to keep the United States among the core in the world system of societies. The rest are kept on short pay, short rations, short of benefits, and the promise of shortened lives living out their years not unlike migrant farmworkers before the advent of César Chavez. With professors so devalued, it is little wonder that they are not heard when they speak to policymakers. The disaster of New Orleans is a graphic example of professors and scientists being ignored.

What began as a kind of emergency measure in the post-Apollo years has become a way of using postsecondary funds for other things than teaching America's students, like constructing steepening tiers of administrators, building college presidential "legacy" edifices on campuses, and expanding personal empires. The already rigid Medieval Era military-like ranking system of tenured assistant, associate, and full professors has been made more rigid with a division between small have and large have-not castes, those who can access the ranking system and those who don't have a prayer – not because the latter are "bad professor" material, but because of the sheer structural violence of the situation.

The 2005-convened Commission for the Future of Higher Education within the U.S. Department of Education "blamed the victim" by claiming that professors spend more time on research than on inventing innovative new teaching techniques. *And, just how many professors are spending time on research?* That commission's report seemed to gloss over the fact that the main bulk of America's academicians are non-tenured professors and the situation "on the ground" for them allows them to do very little research. Further examination shows that this "finding" is less of a finding than a regurgitation of an anecdotally-based theme in journalist Charles J. Sykes' 1989 book, *ProfScam:Professors and the Demise of Higher Education.* [59] The American Association of University Professors (AAUP) complained that "Excessive use of, and inadequate compensation and professional support for, such contingent faculty exploits these colleagues and undermines academic freedom, academic quality, and professional standards (American Association of University Professors)." [60] That is a much-too-polite way of saying that the majority of the American brain trust is being robbed of job security, adequate wages, access to offices, laboratories, and libraries. The AAUP has yet to paint the picture concerning what kind of damage that is doing so that the public and politicians can understand it. The AAUP language is geared toward their erudite membership. As a former academic scientist who holds a public office, I am speaking from experience when I say that most American politicians don't know what terms like "academic freedom" mean and what the consequences are when it is undermined.

D. The Goose That Lays the Golden Eggs

Somehow, the message needs to be sent to leaders in words that they can understand. Academic administrators like the ease of hiring, firing, and changing course offerings on a whim that heavy teaching cadres of non-tenured faculty allow. They will not readily give this power up without stringent state and federal intervention. Politicians will understand the issue in the parlance of "term limits." Increasingly more, state legislatures have come to see how term limits kill institutional memory and experience in state governments. The non-tenured American professoriate, in the main, variously have "term limits" of about four and a half months, nine months, and three years if they are lucky. Sometimes, those term limits are even shorter, as when non-tenured professors run afoul of administrators for things as trivial as a disagreement over grading policy. Academic term limits are killing the knowledge bank upon which the nation and the world depend. In plain-speak, post-Apollo academic governance practices are "killing the goose that lays the golden eggs."

Just how important is that goose? The American postsecondary education system is the place where deficiencies in poor K-12 training are remediated. It reproduces the American knowledge base that goes on to benefit the world and the United States' place in it. It creates "first-tier" innovation in American science, technology, and values. The venues that receive postsecondary graduates – for-profit companies, non-profit organizations, government laboratories, etc. – are "second-tier" innovators that expect to be continuously fed by an academe they presume to be sophisticated and reliable. However, thirty-plus years of the post-Apollo corporate model of American academe has been the thing that has dragged down America's innovation production machinery, not professors focusing too much on research rather than their teaching. If anything, academe can't hire up every sufficiently credentialed scholar, scientist, and engineer fast enough to do all the research that they can and also to teach, and state and federal governments can't step in quickly enough with the funds, resources, and oversight to make sure that those academicians are secure in their livings and have adequate access to resources to do their jobs.

On a related note, it will take laser-like oversight to end wide-scale age discrimination in academe that is shamelessly practiced in order to hire less costly, less expertise-laden "junior" professors into most academic positions, and that admits mostly young people into doctoral programs who are less experienced and who are less trouble for elite tenured professors to mold into their own images. These discriminatory practices keep those scholars, scientists, and engineers with two- and three-generation-depth innovation expertise levels from passing on their knowledge to young people and enhancing academic environments. *This is the way knowledge is lost.* And, in a world becoming more severe, we cannot afford to lose knowledge. The challenges are very great. The responses to these challenges will come from insights that can only derive from a humanity that extends itself into new frontiers, which comes up with workable new ideas that derive from the cross-pollination across multiple disciplines working the problems of being on those new frontiers. The existing brainpower must be supported and channeled properly in order to engage the "big science, great policy" projects that face humanity.

E. The Nature of Innovation and How It Is Stymied

In the main, innovation takes time and some degree of comfort and security for those doing the innovations. I have had a front-row seat on what it means to make innovation. Over the years, I have made a good bit of innovation. I have had a hand in diplomatic projects requiring outside-the box thinking; I have made archaeological and geographic discoveries; and I have generated important new social and behavioral findings. I do a fair amount of writing and preparing lectures and presentations. For me, it takes eight to twelve hours of quality time in the day-to-day for these kind of activities that are necessary to the incubation of innovation. I am most productive when I am able to have this kind of time. This is representative of the quality time needed by most innovators to make their innovations.

Innovators must have adequacy and surety in their salaries and their benefits to be afforded at least a few days a week with this sort of "quality time" to make innovations in their disciplines. This is why tenure-track and tenured professors in state universities generally only teach two to three courses a semester, with the choice of teaching more during winter and summer intersessions. They have office and laboratory space and other resources to do innovation work and prepare lectures and presentations; and they generally have some amount of travel funds to conference throughout the world to meet with others in their disciplines to exchange and cross-fertilize ideas that lead to future innovation.

Innovators must be secure in their writing, research, and other innovation work. The institution of tenure was imported from Europe to the United States for the purpose of keeping boards of trustees and administrators from dismissing innovators out of hand if their findings did not toady up to prevailing opinion or if university donors found them offensive. When professors are non-tenured (adjunct, contingent, transient, part-time, temporary), when they are completely off the tenure-track, they lack one or more or all of those things that generate innovation within academe. Non-tenured professors often keep office hours with students out of the trunks of their cars because they are not afforded adequate office space to meet with students. They usually have to buy their own teaching, research, and writing supplies. They spend a lot of time on the road traveling between two to three colleges and universities, teaching as many as seven courses a semester to make as much money as their tenure-track colleagues make in a month teaching two to three courses. They usually do not have health benefits. Sometimes their salaries are held back for six to eight weeks from the onset of a term or semester before they can receive a paycheck. They go hungry in lieu of the expense of gasoline to get to the teaching jobs.

I tell the story of the main bulk of the American professoriate in order to paint the fine details of the picture of what it means to be non-tenured. Recall: more than 70% of America's professor-innovators are non-tenured. With the challenges facing the United States and the world that pose threats to civilization and to the species, this is like sending troops into combat without body armor, bullets for their weapons, and the other things needed to win the day. This is not the operational paradigm for the knowledge production machinery of a core society. This is the operational paradigm for a loser society. And, this is a root cause of why the United States is becoming a second-world (semiperiphery) nation.

F. The Great American Brain Drain

The United States must reconfigure how colleges and universities do business -- forcing the few thousand topmost postsecondary administrators at the helm of our postsecondary institutions to serve the national and global interests -- rather than serving themselves. The "numbers" reveal our situation. According to the National Academies Press Report, the US share of scientists and engineers will continue to decline (216): [61]

- Other nations will have larger numbers of students receiving undergraduate degrees in science and engineering.
- In 2000, more than 25 countries had a higher percentage of 24-year-olds with degrees in science and engineering than did the United States.
- The number of American graduate degrees awarded in science and engineering will decline.
- The number of new doctorates in science and engineering peaked in the United States in 1998.
- By 2010, China will produce more science and engineering doctorates than the United States does.
- The US share of world science and engineering doctorates granted will fall to about 15% by 2010, down from more than 50% in 1970.

Studies pooh-poohing the worth of Chinese undergraduate engineering degrees on the basis that they typically involve two- to three-year programs as opposed to the traditional four-year American curriculum are essentially without firepower. Europe has traditionally had three-year bachelor's degree programs. The United States could have two- to three-year science, mathematics, engineering, and other bachelor's programs, too, if much of the general education and elective requirements were handled in K-12. Much of what now passes as general education requirements in the United States is remediating deficiencies of students coming into college from poor K-12 careers.

The National Academies Press report shows that the US share of world scientific output will continue to decline (215):

- The share of US patents granted to US inventors is already declining, although the absolute number of patents to US inventors continues to increase.
- US researchers' scientific publishing will decline as authors from other nations increase their output.
- The number of scientific papers published by US researchers reached a plateau in 1992.
- Europe surpassed the United States in the mid-1990s as the world's largest producer of scientific literature.
- If current trends continue, publications from the Asia Pacific region could outstrip those from the United States within the next 6 or 7 years.

An increasing number of graduate students from abroad who used to stay in the United States to employ their expertise after their graduate studies at American universities were completed are going back home to India, China, and other countries where they can make good livings and where the standards of living are increasing. An increasing number of foreign students look to their own countries or other lands than the United States to get their academic degrees. Our ability to attract the best international researchers will continue to decline. According to the National Academies Press report, "From 2002 to 2003, 1,300 international students enrolled in US science and engineering graduate programs. In each of the 3 years before that, the number had risen by more than 10,000 (216)."

In the meantime, American unemployment is rising and its standard of living is falling. What this means for American postsecondary students is, after they claw their way through one or more degrees, working two and three jobs that stretch their programs out past the traditional time limits to earn those degrees,[§] there is little skilled work to be had. Americans with bachelor's degrees or higher have joined the military forces at both enlisted and officer ranks in order to have jobs. It is either that or "flip hamburgers" in labor-intensive service industries. American companies enthusiastically contribute to the problem by shipping skilled jobs offshore where foreign workers can make a good living on lower salaries than Americans can in the United States. Worse still, American companies manage to import in droves of high tech labor. On one hand, this is a response to an inability to find enough technical talent within the United States and an unwillingness to contribute to the training of American workers. The other hand slaps us in the face. After the high tech laborers make a nest egg, they return to their country of origin where they open businesses and live well on less.

The National Academies Press report stated (12-13):

> It is easy to be complacent about US competitiveness and preeminence in science and technology. We have led the world for decades, and we continue to do so in many research fields today. But the world is changing rapidly, and our advantages are no longer unique. Some will argue that this is a problem for market forces to resolve—but that is exactly the concern. Market forces are *already at work* moving jobs to countries with less costly, often better educated, highly motivated workforces and friendlier tax policies.

Can you hear it? That powerful sucking sound is the Great American Brain Drain. Our brain pool is leaking away and drying up. When it comes down to it, it has to do with the condition of American academe. And, that is a big part of why China, India, Europe, and the offshore research and development (R&D) facilities of multinational companies are outpacing the United States in science and technology. And, that is why other societies will be at the core of the "big science, great policy" mitigations of global warming and natural disasters in an increasingly populated and infrastructure'd world on the decline side of oil.

G. Smarten Up America: Assemble the Knowledge Troops

The "big science, great policy" approach, that includes space-based mitigations, will require state and federal executives, legislators, and the public to reclaim their authority over the knowledge production machinery of American society. They must make sure America's colleges and universities are in a condition to create knowledge and to turn out knowledge workers to face the challenges of an Earth becoming more extreme. For, the kind of "first tier" knowledge needed to mitigate global warming, disasters, and the decline side of oil cannot be manufactured in the current sweatshops of American academe that are so especially typified by the public state systems.

It might take federal legislation like the Emergency Conservation Work Act of 1933 that launched the Civilian Conservation Corps to get America's large armies of unemployed, under-employed, and overworked academic scholars, scientists, and engineers to work on the large-scale science and policy projects necessary for the survival of advanced industrial civilization and humanity. Where the Civilian Conservation Corps focused on putting the armies of unemployed young American men to work on decimated American forests, a science, knowledge, technology, and policy innovation corps could harness America's unemployed and under-employed *mature* brain trust to work on and teach about global warming, the decline side of oil, disaster mitigation, long-duration spaceflight, and all the other things we hold as necessary and desirable for civilization and humanity to endure. Development of a large cadre of "knowledge troops" to engage these challenges would mean that there would have to be:

- Easy accessibility to every level of education, K-12 through postdoctoral opportunities for people of all ages

[§] In California where I taught last, I was shocked that my undergraduates could not earn their bachelor's degrees within a standard four-year period. Their programs stretched out five, six, and even seven years. This was in part because they had to work so many jobs to pay for their education and the high cost of living in the areas surrounding the colleges, and in part to college administrators offering the least amount of courses during an academic year that they could and still keep the colleges running while jacking up tuitions. To offer an optimal number of courses would require hiring more tenure-track professors. Hiring more tenure-track professors would reduce the level of funding for legacy-building projects.

- Funds and resources to and state and federal oversight over American postsecondary institutions to hire into secure teaching and /or research positions the 70% or more of the American professoriate who are not now in secure positions -- and the unknown percentage who are actually *unemployed*

- Reduction in unemployment by purposefully hiring individuals into all sectors of the American work force that can address “big science, great policy” concerns

Rational social investment like this, that meshes with “big science, great policy” concerns, is how the United States and other societies can make it past the bottleneck between two epochs and succeed in the Anthropocene. Unless the United States takes action along these lines, it will not remain a “first world” core society for long.

H. Moon Shot: Piercing the Corporate Academic Veil

Academe has typically been a “black box” for politicians. Its ways and means originate in the Middle Ages and seem esoteric to anyone on the outside. In the United States, that condition worsened after astronauts landed on the Moon. Such a lofty goal won, academic production no longer particularly served the national interests in a Space Race and a Cold War. Legislators and state and federal executives turned their attentions elsewhere, abdicating their authority in large part over American academe and allowing colleges and universities to govern themselves without much oversight. Without feet to the fire and without the influx of “national interest” funds, the horizons of academic administrators have shrunk to the confines of their campuses, behind the window dressing of an intellectual façade, where unchecked, their personal empire building has proceeded at the expense of cultivating the American brain trust. When criticized about their expenditures, those administrators in the large public academic systems typically retort that their hands are tied because of a paucity of state and federal funding.

Now, loftier goals loom: overwhelming threats to civilization, including American civilization, and even human survival – goals that would now not seem so insurmountable had the level of science and technological progress been able to multiply from the height of the Apollo Era. Now, where is America’s “knowledge troops” needed to engage the problems? My message here is: if policymakers do not start looking at academe as the most important industry in the United States and penetrate the corporate veil that a few thousand top postsecondary administrators have erected around their activities, then America will not lead in the contributions to the “big science, great policies” problems of the world. Those who mitigate those problems will *lead* the world system of societies.

America must make much more social investment in its citizenry if people are to survive and become active participants in “big science, great policy” concerns. But, no social investment will matter much if American academe is not reconfigured to train the knowledge workers to engage the great human ecology issues of the dawn of the Anthropocene Epoch. That reconfiguration could begin if leaders expected more out of American academe in relation to the national and global interest. Among the investments that must be made in postsecondary institutions is the investment of stringent state and federal oversight over them. The Return-to-the-Moon effort poses the opportunity for another Apollo Era to rev up America’s knowledge production machinery. But, a new such era must not be allowed to go the way of Apollo, which was, once a benchmark was won, the effort was abandoned.

Space-based technical and policy innovations are of the kind that most closely resemble and/or lead to the kind of innovation to meet the direct and indirect effects of global warming, developing alternative energy, and offsetting natural disasters. And, there are many benchmarks to be won. *If the effort can get off the ground….* Quite likely China, Russia, India, and the European Union acting together will loft the permanent space infrastructure in Low Earth Orbit and on the Moon that will be of practical value to humans in the near future.

I. Why Space-Based Systems Are Important

Detractors of space expenditures will argue: What is returning to the Moon and the other things, if, alongside those accomplishments, the poor, the elderly, the disabled, the sick, and the incarcerated are left in extreme circumstances, the last to receive relief, many to die as they did in New Orleans? I say to these detractors that returning to the Moon directly bears on such concerns. Because the Earth is becoming more extreme, space-based systems are not frivolities. Somehow, Americans need to be made to understand this, and the old baseless argument that wrongfully pits space expenditures against social investments swept away for good. An increased social investment of Americans into the challenges of the Anthropocene Epoch would solve the problem of educating the public about space-based systems. As our ancestors who made it past the Pleistocene-Holocene bottleneck proved, the process of expanding the human ecology into increasingly hostile regions is essential to our survival and vitality as a species. It would be a mistake to attempt to tease apart an engagement with space from social investment. They are two sides of the same coin.

The engagement with space means invigoration of American science, technology, and scholarship and boldness in policymaking, the "big science, great policy" needed to mitigate the challenges at the dawn of the Anthropocene Epoch. First of all, on-orbit space platforms (i.e., satellites, space stations) are necessary for monitoring the worsening condition of the planet, in ways that cannot be done adequately from the Earth's surface alone, and in order to plan technological mitigations and to levy informed policymaking mitigations. In this vein, a recent controversy has raged over the federal government's downscaling of a system of planned American climate monitoring satellites to take the place of aging satellite systems soon to go offline. This downscaled system means that scientists in the Pentagon, with the National Oceanic and Atmospheric Administration (NOAA), and with NASA will have to depend upon European satellites for much of their climate data.

Secondly, a variety of disaster warning and mitigation systems are possible because of space-based systems. I previously mentioned the work of Geoffrey Blewitt and his colleagues concerning a tsunami detection and warning system.

Thirdly, space-based systems hold the promise of alternative energy sources and their spin-offs. Like solar-to-microwave-to-electrical generation systems and like cheap hydrogen fuel production. It is critical that we develop the means to produce cheap, plentiful hydrogen fuel. If aircraft cannot be successfully adapted to biofuels, rapid transportation, especially between continents, is going to disappear. With the needs of a world population edging up to 10 billion over the next nine decades, that in and of itself could be a disaster.

The challenges that are unfolding are enormous, but if not rapidly catastrophic, gradual extremity presents the opportunity to create a sense among individuals and societies that "we are in this together, we must pull together" that may be expected to grow into a deeper social consciousness about the interconnectivity of us all. Our quest for alternative energy sources and mitigations of and adaptations to environmental challenges may be expected to penetrate the capitalist paradigm, and transform it as the ecology of capital moves out of the oilfield to other venues – inevitably to locations off the Earth. A co-development will be new technologies, and thus, new technological means of production. Our chance to make it past the Holocene-Anthropocene bottleneck successfully lies in the possibility that the extremity will be gradual and that we will have the good sense to act with all due haste.

However, if we maintain the *status quo* and if the extremity occurs with a rapidity that will outstrip our means to act, then the upbeat conceptualizations of high-tech entrepreneurs, policymakers, and financiers – for water control, for effective carbon monitoring policies, for alternative energy sources, etc. -- will have as much specie as the rumors of Hitler's *Wunderwaffen* to the ears of Berliners who were being overrun by the Soviet Army at the end of World War II. Only by enabling innovators and innovation can the time of the ticking clock that is this new epoch be told.

X. Conclusion

We find ourselves in a new geological-environmental epoch; truly a new world where being bold and brave in thought and deed is required. World environment becoming more extreme offers opportunities for knowledge transfer to richly occur among the several issues of the expansion of the human ecology: global warming, worsening disasters in evermore populated and infrastructure'd areas, decline side of oil as an increasing number of advanced industrial societies come online in the world system of societies, and space-based systems. These are survival-level challenges that are generating a demand for knowledge workers as never before – not simply because of the greater outcry of an increasing global public in direr need – but also because of the need to formulate a response to the epochal change in a collective and organized way over many societies and large numbers of people. In the effort to meet the challenges of the Anthropocene world, a vast number of science and technology workers will have to be strategically mobilized through their training and labor.

The machinery of training and labor must be overhauled. In the United States, and perhaps elsewhere, this will require a new operating paradigm for colleges and universities. Jobs must be purposefully created that address the national and global need. The act of mobilizing such a large skilled labor force to meet the issues of the Anthropocene likely would have the latent, spin-off function of responding to social needs with ways and means that exceed how those needs have been met thus far. In the long run, if we act quickly, cooperatively, and strategically, the human prospect could improve beyond what it has ever been.

Without factoring in the impact of global warming and its effects, the National Academies Press report has warned the nation (Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. 2007, 12-13):

> Without a renewed effort to bolster the foundations of our competitiveness, we can expect to lose our privileged position. For the first time in generations, the nation's children could face poorer prospects than their parents and grandparents did. We owe our current prosperity, security, and good health to the investments of past generations, and we are obliged to renew those commitments in education, research, and innovation policies to ensure that the American people continue to benefit from the remarkable opportunities provided by the rapid development of the global economy and its not inconsiderable underpinning in science and technology.

But, realizing the greater interdependence of world societies on one another as never before, the National Academies Press report asserted (222):

> It is important to recognize that all nations in the global economy are now inextricably linked. Just as global health, environmental, and security issues affect everyone, so are we all dependent on the continued growth of other economies. It is clearly in America's interest for China, India, the EU, Japan, and other nations to succeed. Their failure would pose a far greater threat to US prosperity and security than would their success. In the global economy, no nation can prosper in isolation. However, it is the thesis of this report that it is important that such global prosperity be shared by the citizens of the United States (222).

To get "our share," we must be able to hold up our end of the log with knowledge transfers that are meaningful, that offer quantum-leaping innovation. We must take the internal initiatives in order to lead in the "big science, great policy" innovations that are needed. The time to take action was yesterday, but we will have to settle for now. I am optimistic that if we act, we will emerge better Americans, better stewards of the Earth and all the other places in space that we venture -- and, in time, a better species.

In the meantime, the old lesson that global warming and its interrelated phenomena are reviewing humankind over is this: innovation permits the engagement of challenges of evermore extreme environments. In our current and future situation, this means proactively adapting to and mitigating our environmental depredations and also venturing further away from the Earth in order to expand the human ecology. Undoubtedly, great suffering lies ahead, but also great opportunities. We became fully human during the Pleistocene Epoch. There is the chance that we will become *fully humane* during the Anthropocene Epoch. In meeting adversity, we meet who we will become as a species.

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