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elcome to the eleventh year of Big Sky Debate! These three volumes represent our efforts to combine the best of research oriented handbooks and teaching tools in the same product. Our materials are guaranteed to be cut for this topic, in the months and days before the season begins, guaranteeing that you will have the most relevant, most thought-provoking research available on the topic. Whether it is for education, competition, or both, we believe that Big Sky Briefs will benefit your program, and we appreciate your support.

The role of handbooks is not without controversy. Some coaches feel that the material limits student exploration and discovery, while others contend that handbook evidence is rarely useful. In our view, the best debate handbooks open doors for students, by providing source material, useful models, and fodder for those early practice rounds at the start of the season. Novice debaters can find the material helpful as they struggle with terms and concepts, and more experienced debaters can use handbooks to fill in research gaps as they acquaint themselves with the topic. No one should expect any debate handbook to carry them through a season of competition—one of the critical skills that debaters must acquire is independent research, and an effective handbook will facilitate and encourage that.

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Many thanks to the people who helped make this project possible. Our summer staffer Rachael Green made invaluable contributions. Finally, the biggest thanks go out to you, the customers who have chosen (once again) to purchase Big Sky Debate materials.

Enjoy the books and good luck to all of you this season! Thanks for being a part of something that is very exciting for us.

-- Pogie and Norm

**Big Sky Debate**

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Lunar Helium-3 Mining Affirmative

**Plan**: The UFSG should lead the development of an international plan to extract Helium-3 from the moon, per the Bilder ’10 plan.

**Advantage 1. LUNAR HELIUM 3 WILL PROVIDE CLEAN, EFFICIENT ENERGY TO REPLACE OIL BEFORE THE DEVASTATING IMPACT OF PEAK OIL**

**A. $15 BILLION OVER 15 YEARS WILL BE ENOUGH TO MAKE HE-3 POWER PRODUCTION A REALITY-Dillow ‘11**

[Clay; staff writer; Former Apollo Astronaut and Senator Says Mining Helium on the Moon Could Solve The Global Energy Crisis; Popular Science; 05 May 2011; <http://www.popsci.com/science/article/2011-05/former-apollo-astronaut-says-moon-mining-could-solve-global-energy-crisis;> retrieved 28 Jun 2011]

Former astronaut, Apollo moonwalker, geologist and former Senator Harrison Schmitt has a modest plan to solve the world’s energy problems. All we need is $15 billion over 15 years and some fusion reactors that have yet to be invented. And we’ll need a moon base.

Schmitt’s idea isn’t novel--he thinks the U.S. should go back to the moon, this time to mine the surface for helium-3, an isotope of helium that is rare on earth but relatively bountiful on the moon. The Russians have been talking about mining helium-3 from the moon for years, but they’ve never put forth a viable plan. Schmitt thinks his, all things considered, is pretty realistic.

So how does Schmitt’s plan break down? We’ll need $5 billion for a helium-3 fusion demonstration plant, because as of right now no such thing exists. We’ll also need to invest $5 billion more in a heavy-lift rocket capable of launching regular moon missions, something akin to the Apollo-era Saturn V.

A moon base for mining the stuff would cost another $2.5 billion, and though Schmitt didn’t really specify in his recent presentation to a petroleum conference, the other $2.5 billion could easily be chalked up to operating costs in an endeavor of this magnitude.

**B. THERE COULD BE TEN TIMES THE ENERGY OF ALL FOSSIL FUEL SOURCE ON THE EARTH IN LUNAR HE-3-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

He-3 is a component of the "solar wind" comprised of gas and charged particles continuously emitted by the sun into the solar system in the course of its thermonuclear fusion processes.1 2

During more than four billion years in which the solar wind has impacted the Moon, significant amounts of He-3, in addition to particles of other ionized components of the solar wind, have

become embedded in the Moon's regolith-the loose and dusty upper layer of rocks and soil comprising much of the Moon's surface.13 While He-3 constitutes only a minute proportion of the lunar regolith, 14 it is estimated that, altogether, there may be as much as one million metric tons of He-3 potentially recoverable from the Moon's surface.'5 This amount of He-3 is theoretically equivalent to ten times the energy content of all of the coal, oil,and natural gas economically recoverable on Earth. 16 Since the Earth, unlike the Moon, possesses a magnetic field and atmosphere that deflect the solar wind, He-3 is rarely found naturally on Earth.1 7 The small amounts of He-3 available for research and experiment on Earth are derived principally from the decay of tritium used in thermonuclear weapons.

**C. HE-3 IS THE ONLY ALTERNATIVE TO MODERN ENERGY SOURCES AND PRESENTS NO SIGNIFICANT ENGINEERING CHALLENGES-Oberg ‘06**

[James; Moonscam: Russians try to sell the moon for foreign cash; The Space Review; 06 Feb 2006; [http://www.thespacereview.com/article/551/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F551%2F1%3B&sa=D&sntz=1&usg=AFQjCNFzN1OlUBiT7bKD8COoMUdpaJ8UQQ) retrieved 20 Jun 2011]

Space geologist Erik Galimov, a member of the Russian Academy of Sciences, added that immediate steps must be taken to explore potential mining sites. “We should start geological survey, make maps of blocs exposed to the Sun, and design experimental installations if we want to start the production of helium-3 on the Moon in 15–20 years,” he said.

“There is nothing difficult from the engineer’s point of view in the production of helium-3,” he continued. “It is only a matter of investments.”

He calculates that an area of 10–15 square kilometers with the depth of three meters will be enough for producing one ton of helium-3. Engineers will have to remove and purify three meters of sand, enrich helium-3, and liquidify it for the delivery to the Earth.

“It is much easier to develop resources on the Moon than to produce oil on the Earth,” Galimov continued. “The Moon should become part of the Earth economy, as helium-3 is the only alternative to modern energy sources, which will ensure the normal environmental future of the planet,” he said.

**D. PEAK OIL WILL COLLAPSE AGRICULTURE AND THE ECONOMY BEFORE WARS OVER DWINDLING OIL SUPPLIES BEGIN-Swartz '08**

[Mimi; “The Gospel According to Matthew;” Texas Monthly; February 2008]

But here is Matthew R. Simmons, the head of one of the largest investment banking firms in the world, stabbing at his salad greens and heatedly discussing the chaos to come when, as he has long predicted, global oil production peaks and for the rest of our time on earth we struggle and suffer and barely endure under a diminishing supply of fuel until it disappears entirely. This idea is known as "peak oil," and Simmons is its most fervent, and fearsome, apostle. As he puts it, "I don't see why people are so worried about global warming destroying the planet--peak oil will take care of that."

Slashing through his entrée, barely stop-ping for breath, he describes a bleak future, in which demand for oil will always surpass supply, the price will continue to rise--"so fast your he ad will spin"--and all sorts of problems in our carbon-dependent world will ensue. As fuel shortfalls complicate global delivery routes and leave farmers unable to run their tractors, we will face massive food shortages. Products made with petroleum, from asphalt and plastic to fabrics and computer chips, will also become scarcer and scarcer. Standards of living will fall, and people will not be able to pay their debts. Lending will tighten, and eventually there will be major defaults. Growth will cease, and hoarding will set in as oil becomes increasingly rare. Then, according to Simmons, the wars will begin. That is the peak oil scenario.

**Advantage 2: Nuclear Terrorism**

**A. HE-3 IS THE PREDOMINANT TECHNOLOGY USED TO PREVENT NUCLEAR TERRORISM IN THE US-Hagan ‘10**

[William; Acting Director, Domestic Nuclear Detection Office, Department of Homeland Security; "Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis”; 22 April 2010; <http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/042210_Hagan.pdf;> retrieved 17 Jul 2011]

The United States’ supply of He-3 has traditionally come from the decay of tritium, which the nation previously produced in large quantities as part of the U.S. nuclear weapons enterprise. The suspension of U.S. production of tritium in the late 1980s, however, resulted in a reduction in the amount of He-3 available for harvest. Currently, a significant portion of He-3 is used for neutron detection to aid in the prevention of nuclear terrorism. He-3 has become the overwhelmingly predominant technology used for this purpose; the Departments of Homeland Security, Defense (DoD), and Energy(DOE) each have nuclear detection programs that use He-3-based sensors.

**B. A SINGLE ACT OF NUCLEAR TERRORISM COULD UNDERMINE THE PROHIBITION AGAINST THE USE OF NUKES, UNLEASHING A FULL SCALE WAR, DESTROYING HUMAN CIVILIZATION-Morgan ‘09**

[Dennis Ray; World on Fire: Two Scenarios of the Destruction of Human Civilization and Possible Extinction of the Human Race; Futures; December 2009; pgs. 683-93]

In a remarkable website on nuclear war, Carol Moore asks the question “Is Nuclear War Inevitable??” In Section , Moore points out what most terrorists obviously already know about the nuclear tensions between powerful countries. No doubt, they’ve figured out that the best way to escalate these tensions into nuclear war is to set off a nuclear exchange. As Moore points out, all that militant terrorists would have to do is get their hands on one small nuclear bomb and explode it on either Moscow or Israel. Because of the Russian “dead hand” system, “where regional nuclear commanders would be given full powers should Moscow be destroyed,” it is likely that any attack would be blamed on the United States”

Israeli leaders and Zionist supporters have, likewise, stated for years that if Israel were to suffer a nuclear attack, whether from terrorists or a nation state, it would retaliate with the suicidal “Samson option” against all major Muslim cities in the Middle East. Furthermore, the Israeli Samson option would also include attacks on Russia and even “anti-Semitic” European cities In that case, of course, Russia would retaliate, and the U.S. would then retaliate against Russia. China would probably be involved as well, as thousands, if not tens of thousands, of nuclear warheads, many of them much more powerful than those used at Hiroshima and Nagasaki, would rain upon most of the major cities in the Northern Hemisphere. Afterwards, for years to come, massive radioactive clouds would drift throughout the Earth in the nuclear fallout, bringing death or else radiation disease that would be genetically transmitted to future generations in a nuclear winter that could last as long as a 100 years, taking a savage toll upon the environment and fragile ecosphere as well.

And what many people fail to realize is what a precarious, hair-trigger basis the nuclear web rests on. Any accident, mistaken communication, false signal or “lone wolf’ act of sabotage or treason could, in a matter of a few minutes, unleash the use of nuclear weapons, and once a weapon is used, then the likelihood of a rapid escalation of nuclear attacks is quite high while the likelihood of a limited nuclear war is actually less probable since each country would act under the “use them or lose them” strategy and psychology; restraint by one power would be interpreted as a weakness by the other, which could be exploited as a window of opportunity to “win” the war.

In other words, once Pandora's Box is opened, it will spread quickly, as it will be the signal for permission for anyone to use them. Moore compares swift nuclear escalation to a room full of people embarrassed to cough. Once one does, however, “everyone else feels free to do so. The bottom line is that as long as large nation states use internal and external war to keep their disparate factions glued together and to satisfy elites’ needs for power and plunder, these nations will attempt to obtain, keep, and inevitably use nuclear weapons. And as long as large nations oppress groups who seek self-determination, some of those groups will look for any means to fight their oppressors” In other words, as long as war and aggression are backed up by the implicit threat of nuclear arms, it is only a matter of time before the escalation of violent conflict leads to the actual use of nuclear weapons, and once even just one is used, it is very likely that many, if not all, will be used, leading to horrific scenarios of global death and the destruction of much of human civilization while condemning a mutant human remnant, *if* there *is* such a remnant, to a life of unimaginable misery and suffering in a nuclear winter.

**Advantage 3: Helium-3 Will Lead to Space Exploration Critical for Human Survival**

**A. HE-3 IS THE KEY TO FUTURE SPACE EXPLORATION AND SETTLEMENT-Wakefield ‘00**

[Julie; staff writer; Researchers and space enthusiasts see helium-3 as the perfect fuel source; Space.com; 30 June 2000;<http://www.space.com/scienceastronomy/helium3_000630.html>; retrieved 01 Dec 2008]

Researchers and space enthusiasts see helium 3 as the perfect fuel source: extremely potent, nonpolluting, with virtually no radioactive by-product. Proponents claim its the fuel ofthe 21st century. The trouble is, hardly any of it is found on Earth. But there is plenty of it on the moon.

Society is straining to keep pace with energy demands, expected to increase eightfold by 2050 as the world population swells toward 12 billion. The moon just may be the answer.

"Helium 3 fusion energy may be the key to future space exploration and settlement," said Gerald Kulcinski, Director of the Fusion Technology Institute (FTI) at the University of Wisconsin at Madison.

**B. SPACE COLONIZATION OFFERS A HEDGE AGAINST HUMAN EXTINCTION AND THE LOSS OF ALL OTHER LIFE ON EARTH, PASSING BOTH A COST-BENEFIT ANALYSIS AND MORAL TEST-Baum ‘09**

[Seth; Professor of Geography; Penn State University; Cost-Benefit Analysis of Space Exploration: Some Ethical Considerations*;* Space Policy; 2009; <http://sethbaum.com/ac/2009_CBA-SpaceExploration.pdf;> retrieved 16 Jul 2011]

While space colonization would provide a hedge against these very long-term astronomical threats, it would also provide a hedge against the more immediate threats that face humanity and other species. Such threats include nuclear warfare, pandemics, anthropogenic climate change, and disruptive technology [30]. Because these threats would generally only affect life on Earth and not life elsewhere,3 self- sufficient space colonies would survive these catastrophes, enabling life to persist in the universe. For this reason, space colonization has been advocated as a means of ensuring long- term human survival. Space exploration projects can help increase the probability of long-term human survival in other ways as well: technology developed for space exploration is central to proposals to avoid threats from large comet and asteroid impacts. However, given the goal of increasing the probability of long-term human survival by a certain amount, there may be more cost-effective options than space colonization (with costs defined in terms of money, effort, or related measures). More cost-effective options may include isolated refuges on Earth to help humans survive a catastrophe [36] and materials to assist survivors, such as a how-to manual for civilization [37] or a seed bank [38]. Further analysis is necessary to determine the most cost- effective means of increasing the probability of long-term human survival. A related question also relevant to space exploration is how to make tradeoffs between increases in survival probability and other benefits. This question treats survival not as a constraint for cost-effectiveness analysis but as a benefit that can be compared with other benefits. Such comparisons require a measure of the value of human survival. However, the value of survival lacks a precise figure. In traditional money-based CBA, it is not unreasonable to assign humanity’s survival an infinite value, or a value that is sufficiently large that it dominates everything else in CBA as if it were infinite. In Catastrophe: Risk and Response [39], US Court of Appeals judge Richard Posner gave human survival a value of $600 trillion; Posner described this as a crude underestimate intended to show that, even with such an underestimate, extensive effort to avoid human extinction passes CBA. Thus, following the common approach to non-market valuation, any reasonable estimate for the value of human survival suggests that this may be an important factor in space exploration CBA.

It is of note that the priority of reducing the risk of human extinction persists in forms of CBA which value nature in an ecocentric fashion, i.e. independently of any consideration of human interests. The basic reason is that without humanity leading long-term survival efforts (which would most likely include space colonization), the rest of Earth life would perish as a result of the astronomical processes described above. This point is elaborated by futurist Bruce Tonn, who argues on ecocentric grounds for reorienting society to focus on avoiding human extinction through both immediate avoidance of catastrophe and long-term space colonization . Tonn dubs this process of surviving beyond Earth’s eventual demise ‘‘transcending oblivion.” There is thus some convergence in the recommendations of the common anthropocentric, money-based CBA and the ecocentric CBA described here. This convergence results from the fact that (in all likelihood) only humans are capable of colonizing space, and thus human survival is necessary for Earth life to transcend oblivion.

HELIUM-3 IS RAPIDLY DEPLETING

**HELIUM-3 IS RAPIDLY DWINDLING DESPITE CRITICAL NEEDS IN MANY AREAS-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; <http://www.aaas.org/news/releases/2010/0423helium3.shtml;> retrieved 20 Jun 2011]

Helium-3—a variation of the helium used in balloons—can reduce temperatures to nearly absolute zero, provide non-radioactive medical lung imaging, and detect neutrons emanating from smuggled nuclear devices. It may even be an element of a clean energy source. For decades, this non-toxic and non-corrosive gas has been in adequate supply, but now that supply is dwindling just as demand is rising dramatically.

At a AAAS-organized workshop, participants from academia, industry, government and national labs met to discuss how to meet the growing need for helium-3. The numbers tell a stark story:

This year, there’s about 12,000 liters of helium-3 available. For the next five years, about 8000 liters of helium-3 each year will accumulate from the decay of tritium, said Steve Fetter, assistant director at large in the White House Office of Science and Technology Policy (OSTP). But demand is at least 40,000 liters per year, Fetter said, and forecasts show a growing demand for helium-3 for neutron detectors, scientific research, medical imaging and other uses.

“It’s not a sustainable situation,” he said.

**INCREASED DEMAND FOR HE-3 AT BORDERS MEANS DECAYING TRITIUM CANNOT PROVIDE ENOUGH-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

That leaves one main reliable source: Decaying tritium.

While manufacturing tritium just to obtain helium-3 also is prohibitively expensive, it is a reliable byproduct of the U.S. nuclear weapons program. Tritium—which has a 12.4 year half-life and decays to helium-3—is used to boost the yield of nuclear weapons. Tritium doesn’t contribute much to the explosion, Fetter said, but rather serves as a source of neutrons. The helium-3 produced from the decay of tritium can be recovered and repurposed.

After the Cold War, the United States had tens of thousands of nuclear weapons. U.S. tritium production ended in 1988 and the number of warheads was subsequently reduced. Throughout the 1990s, the supply of helium-3 exceeded demand. By 2000, the United States had accumulated over 200,000 liters of helium-3.

But after the 9/11 terrorist attacks in 2001, the demand for helium-3 increased for neutron detectors at border points, Fetter said. Then demand began to exceed helium-3 production through decay of tritium, and the stockpile was drawn down. The United States began to make tritium again in 2007, but in limited supply. In 2008, about 79,000 liters of helium-3 were used, more than half of the existing stock. “Then we realized, we can’t go this way much longer,” Fetter said. “We have to bring demand in balance with supply.”

**TERRESTRIAL PRODUCTION OF HE-3 HAS NOT KEPT UP WITH POST 9/11 DEMAND-Dixon ‘10**

[Darius; Helium-3 Shortage Could Mean Nuke Detection ‘Disaster’; Wired; 29 April 2010; [http://www.wired.com/dangerroom/2010/04/helium-3-shortage-could-mean-nuke-detection-disaster/;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fdangerroom%2F2010%2F04%2Fhelium-3-shortage-could-mean-nuke-detection-disaster%2F%3B&sa=D&sntz=1&usg=AFQjCNE94a3FVct9SQMoUta_tr2vyQs4Gg) retrieved 20 Jun 2011]

Helium-3 is a decay product of tritium, a heavy isotope of hydrogen used to enhance the yield of nuclear weapons, but whose production stopped in 1988. The half-life decay of tritium is about 12 years, and the U.S. supply for helium-3 is fed by harvesting the gas from dismantled or refurbished nuclear weapons. However, production of helium-3 hasn’t kept pace with the exponential demand sparked by the Sept. 11 attacks.

Projected demand for the nonradioactive gas in 2010 is said to be more than 76,000 liters per year, while U.S. production is a mere 8,000 liters annually, and U.S. total supply rests at less than 48,000 liters. This shortage wasn’t identified until a workshop put on by the Department of Energy’s Office of Nuclear Physics in August 2008.

**THE LOOMING CRISIS OF HE-3 SHORTAGE HAS CAUSED THE PRICE TO GO TO $5000/LITER-Reed ‘11**

[Christina; staff writer; The Fallout of a Helium-3 Crisis; Discovery News; 19 Feb 2011; <http://news.discovery.com/earth/the-outfall-of-a-helium-3-crisis.html;> retrieved 28 Jun 2011]

Because those who use helium-3 were buying it on the cheap, there was no incentive to conserve the gas, despite the supply being cut short in 1989 with the end of the Cold War.

Helium-3 was “considered a waste product from the weapons so it was priced low,” explained Director Julie Bentz of the Nuclear Defense Policy Office of the Weapons of Mass Destruction Coordinator. She spoke today during the annual meeting of the American Association for the Advancement of Science in Washington, D.C.

The gas is part of the leftovers that come from cooking up a hydrogen bomb, which requires uranium and a dash of tritium. When the radioactive tritium decays it produces helium-3. While there are other ways of decaying tritium without needing to build a bomb to do it, the United States has recently found itself in short supply of both tritium and the resulting helium-3.

So short in fact, that last year when the looming crisis, which reporters had been covering for years, became official, the price of helium-3 went from $150 per liter to $5,000 per liter. “We think the correct price should be $1500,” Bentz said.

**INCREASED DEMAND FOR HE-3 SINCE 9/11 HAS LED TO SHORTAGE THAT CANNOT BE MET-Shea and Morgan ‘10**

[Dana and Daniel; Specialist in Science and Technology Policy, Congressional Research Service; The Helium-3 Shortage: Supply, Demand, and Options for Congress; 22 Dec 2010; <http://www.fas.org/sgp/crs/misc/R41419.pdf;> retrieved 27 Jun 2011]

The world is experiencing a shortage of helium-3, a rare isotope of helium with applications in

homeland security, national security, medicine, industry, and science. For many years the supply of helium-3 from the nuclear weapons program outstripped the demand for helium-3. The

demand was small enough that a substantial stockpile of helium-3 accumulated. After the terrorist attacks of September 11, 2001, the federal government began deploying neutron detectors at the U.S. border to help secure the nation against smuggled nuclear and radiological material. The deployment of this equipment created new demand for helium-3. Use of the polarized helium-3 medical imaging technique also increased. As a result, the size of the stockpile shrank. After several years of demand exceeding supply, a call for large quantities of helium-3 spurred federal officials to realize that insufficient helium-3 was available to meet the likely future demand.

**POLICYMAKERS FACE DIFFICULT CHOICES IN ALLOCATING EXISTING HE-3-Shea and Morgan ‘10**

[Dana and Daniel; Specialist in Science and Technology Policy, Congressional Research Service; The Helium-3 Shortage: Supply, Demand, and Options for Congress; 22 Dec 2010; <http://www.fas.org/sgp/crs/misc/R41419.pdf;> retrieved 27 Jun 2011]

Policymakers now face a number of challenging decisions. In the short term, these decisions are mainly about how to allocate a scarce resource in the face of competing priorities: science versus security, the private sector versus the public sector, and national needs versus international obligations. Applications with unique needs may pose particular challenges. For example, some types of cryogenic research can only be accomplished using helium-3, whereas in medical imaging and neutron detection, helium 3 has advantages but also alternatives. In the longer term, policymakers also face choices about how or whether to increase helium-3 supply or reduce helium-3 demand and about possible alternative mechanisms for allocating supply. It seems likely that a combination of policy approaches will be necessary.

**US POLICY IS LEADING TO SHRINKING SUPPLY OF HE-3-Firth ‘10**

[Niall; staff writer; Scientists say Earth's helium reserves 'will run out within 25 years' (and party balloons should cost £65 each); Daily Mail; 23 Aug 2010; <http://www.dailymail.co.uk/sciencetech/article-1305386/Earths-helium-reserves-run-25-years.html;> retrieved 05 Jul 2011]

It is more commonly known as the gas that fills cheap party balloons and makes your voice squeak if you inhale it.

But helium is actually a precious resource that is being squandered with Earth's reserves of it due to run out within 25 to 30 years, experts have warned.

Earth’s resources of helium are being depleted at an astonishing rate, an effect which will spell disaster for hospitals which use it to cool MRI scanners.

The world's biggest store of helium - the most commonly used inert gas - lies in a disused airfield in Amarillo, Texas, and is being sold off far too cheaply.

But in 1996, the US government passed a law which states that the facility - the US National Helium Reserve - must be completely sold off by 2015 to recoup the price of installing it.

This means that the helium, a non-renewable gas, is being quickly sold off at increasingly cheap prices, making it uneconomical to recycle.

**ONCE HE-3 IS DEPLETED, THERE IS NO WAY TO REPLACE IT-Firth ‘10**

[Niall; staff writer; Scientists say Earth's helium reserves 'will run out within 25 years' (and party balloons should cost £65 each); Daily Mail; 23 Aug 2010; <http://www.dailymail.co.uk/sciencetech/article-1305386/Earths-helium-reserves-run-25-years.html;> retrieved 05 Jul 2011]

Nobel laureate Robert Richardson, a professor of physics at Cornell University in New York, told New Scientist magazine that once our helium reserves are gone there will be no way of replacing it.

He also warned that although some substitutes can be found for some applications where helium is used, it will be impossible to use a different material for MRI scanners

He told the magazine: There are some substitutes, but it can't be replaced for cryogenics, where liquid helium cools superconducting magnets for MRI scanners.

**US PRICING OF HE-3 IS LEADING TO IT BEING SQUANDERED-Firth ‘10**

[Niall; staff writer; Scientists say Earth's helium reserves 'will run out within 25 years' (and party balloons should cost £65 each); Daily Mail; 23 Aug 2010; <http://www.dailymail.co.uk/sciencetech/article-1305386/Earths-helium-reserves-run-25-years.html;> retrieved 05 Jul 2011]

The only way to obtain more helium would be to capture it from the decay of tritium - a radioactive hydrogen isotope, which the U.S. stopped making n 1988.

The US stores around 80 per cent of the world's helium and so its decision to let it go at an extremely low price has a massive knock-on affect on its market.

But Professor Richardson said that low price of helium meant that it was being ‘squandered’ rather than being treated as a precious resource.

He said: 'The problem is that these supplies will run out in a mere 25 years, and the US government has a policy of selling helium at a ridiculously low price.'

**HE-3 IS RAPIDLY RUNNING OUT-Hsu ‘10**

[Jeremy; Congress to Address Helium-3 Shortage Hurting Scientific Research and Nuclear Security; PopSci; 19 April 2010; <http://www.popsci.com/science/article/2010-04/helium-3-shortage-hits-scientific-research-and-nuclear-security>; retrieved 9 August 2011]

A large Cold War supply of helium-3 has begun to rapidly run out, due to heavy demand from U.S. scientists who need the gas for neutron detectors and cryogenic experiments. Almost 60,000 liters of helium-3 were used in 2007 and 2008, compared to just 10,000 liters used annually about 10 years ago. A House subcommittee has been convened to search for a solution this week, New Scientist reports.

The U.S. formerly stockpiled helium-3 from the decay of tritium, the radioactive hydrogen isotope used to make nuclear weapons. That helium-3 supply stopped growing for the most part when the U.S. ceased making tritium in 1988. But in an ironic twist, the fast-growing use of neutron detectors in security systems designed to detect illegal plutonium and other nuclear materials has dramatically eaten into the helium-3 stockpile.

The shortage has slowed down the growth of quantum computing and other scientific fields which depend upon frigid conditions provided by helium-3 refrigeration. National laboratories have also been forced to develop less-sensitive neutron detectors which rely upon lithium and boron instead of helium-3.

**THOSE NEEDING HE-3 ARE FEELING A SHORTAGE PINCH-Hecht ‘10**

[Jeff; Nuclear security push bleeding cryogenic science dry; New Scientist; 19 April 2010; <http://www.newscientist.com/article/dn18789-nuclear-security-push-bleeding-cryogenic-science-dry.html> ; retrieved 9 August 2010]

Helium-3 is invaluable for some scientific instruments. But supplies have been used up in making security systems to detect dangerous nuclear materials, and production can't be increased. On Thursday, a House subcommittee will try to pin down what went wrong and how to fix the problem.

The decay of tritium, the radioactive heavy-hydrogen isotope used in nuclear weapons, long produced more helium-3 than could be used. But the US stopped making new tritium in 1988, and so the remaining supply has been dwindling as it decays. Around a decade ago, the stockpiles of tritium and helium-3 seemed adequate, with only about 10,000 litres used each year, largely in neutron detection and cryogenics.

ADVANTAGE 1: PEAK OIL WILL HAVE DEVASTATING IMPACT

**ENERGY SHORTAGES AND ECOLOGICAL CRISES COULD REDUCE HUMAN POPULATION TO LESS THAN A BILLION FOLLOWING DECADES OF WAR AND CHAOS-Heinberg ‘09**

[Richard; Faculty member of New College of California; *Powerdown: Options and Actions for a Post-Carbon World*; 2009; Kindle Edition]

A possible scenario for the collapse of our own civilization might go something like this: Energy shortages commence in the second decade of the century, leading to economic turmoil, frequent and lengthening power blackouts, and general chaos. Over the course of several years, food production plummets, resulting in widespread famine, even in formerly wealthy countries. Wars — including civil wars — rage intermittently. Meanwhile ecological crisis also tears at the social fabric, with water shortages, rising sea levels, and severe storms wreaking further havoc. While previous episodic disasters could have been dealt with by disaster management and rescue efforts, by now societies are too disorganized to mount such efforts. One after another, central governments collapse. Societies attempt to shed complexity in stages, thus buying time. Empires devolve into nations; nations into smaller regional or tribal states. But each lower stage — while initially appearing to offer a new beginning and a platform of stability — reaches its own moment of unsustainability and further collapse ensues. Between 2020 and 2100, the global population declines steeply, perhaps to fewer than one billion. By the start of the next century, the survivors’ grandchildren are entertained by stories of a great civilization of the recent past in which people flew in metal birds and got everything they wanted by pressing buttons.

**PEAK OIL, FOLLOWED BY PEAK DEBT WILL LEAD TO A SECOND GREAT DEPRESSION IN THE NEXT 20 YEARS-Worth ‘10**

[Robert; attorney; *Peak Oil and the Second Great Depression (2010-2030): A Survival Guide for Investors and Savers After Peak Oil* ; 2010; Kindle Edition]

The coming two decades, 2010 to 2030, will very likely one day be known as, “The Second Great Depression.” Or worse. Why am I so pessimistic? Well, two things. The first is “Peak Oil.” The second is what I refer to as Peak Debt. Peak Oil is the point of maximum global oil production which will be followed by decade after decade of gradual production declines. Everyone accepts the fact that oil won’t last forever. It is, as they say, a “finite resource.” But oil in the ground is not like gas in your gas tank, which flows at a given rate and then is basically gone in the instant that you use the last drop. Rather, oil production will “Peak,” i.e. reach a maximum global production rate, and then gradually decline as one by one the great producing oil fields that remain in the world run dry. The actual peak will only be known conclusively in hindsight, after a decade or so of continued production declines. Initially, these production declines will be attributed to some “temporary” factor, such as the current depressed economic environment. The facts, however, are clear. In 2005, crude oil production rose to an all-time high level of 73.8 million barrels a day (EIA, rolling 12 month average). Despite this record level of production, oil prices jumped to $40 a barrel, a price considered high at the time.

**PEAK OIL WILL UNRAVEL THE FOUNDATION OF WORLD CAPITALISM AND THE ENSUING CONFLICTS OVER RESOURCES THREATEN HUMAN CIVILIZATION--Li '08**

[Minqi; “An Age of Transition: The United States, China, Peak Oil, and the Demise of Neoliberalism;” Monthly Review; April 2008]

If world oil production and the production of other fossil fuels reach their peak and start to decline in the coming years, then the global capitalist economy will face an unprecedented crisis that it will find difficult to overcome.

The rapid depletion of fossil fuels is only one among many serious environmental problems the world is confronting today. The capitalist economic system is based on production for profit and capital accumulation. In a global capitalist economy, the competition between individual capitalists, corporations, and capitalist states forces each of them constantly to pursue accumulation of capital on increasingly larger scales.

Therefore, under capitalism, there is a tendency for material production and consumption to expand incessantly. After centuries of relentless accumulation, the world's nonrenewable resources are being rapidly depleted and the earth's ecological system is now on the verge of collapse. The survival of the human civilization is at stake.

**INCREASE OF PRICE OF CRUDE OIL IS SIGN OF THE ECONOMIC PLAGUE COMING FROM OIL SCARCITY--Nelson '07**

[Ronald G.; “'Peak Oil' is only a matter of time;” Pipeline & Gas Journal; February 2007; Wilson Databases]

The steady increase in crude oil price during this decade is the first indicator of the 'economic plague' that may be visited on developed societies around the world. The developing countries still rely heavily on animal and human power for transportation, so they may be spared this "crude awakening" and actually better prepared to eke out an existence in a world of perpetually shrinking crude oil supplies.

The second indicator is the scramble under way by China, India, the UK, the U.S. and other countries to secure oil supplies in foreign countries. At the same time, oil-producing countries are taking steps to nationalize their indigenous oil reserves, as is happening in several South American countries including Venezuela, Colombia and Bolivia. Russia is moving in a similar direction to increase control of its oil. Saudi Arabia is expanding its petroleum-based industries and power-generating capacity to serve its own domestic needs.

**PEAK OIL WILL CREATE DEVASTATING ECONOMIC CRISES--Canada and the World Backgrounder '07**

[“Peak Oil;” Canada and the World Backgrounder; May 2007; Wilson Databases]

On a wider scale, oil supply interruptions have triggered major economic slumps:

\* In 1973, a war in the Middle East prompted Arab countries to halt supplies of oil to the United States. That triggered a recession;

\* In 1979-80 the Islamic revolution in Iran shut down that country's oil supply and a recession followed.

In these cases the amount of oil removed from the market was only nine percent and four percent of total supply, respectively. Yet, the economic crises that followed were devastating.

So, we already have a clear picture of what the passing of Hubbert's Peak will look like.

ADVANTAGE 1: HELIUM-3 IS CLEAN, RENEWABLE ENERGY

**HE-3 IS A NON-RADIOACTIVE, CLEAN FUEL-Irvine ‘06**

[Dean; Mining the Moon for a Nuclear Future; CNN; 18 Dec 2006; [http://articles.cnn.com/2006-12-18/tech/fs.moonmining\_1\_helium-3-moon-base-nuclear-fusion?\_s=PM:TECH;](http://www.google.com/url?q=http%3A%2F%2Farticles.cnn.com%2F2006-12-18%2Ftech%2Ffs.moonmining_1_helium-3-moon-base-nuclear-fusion%3F_s%3DPM%3ATECH%3B&sa=D&sntz=1&usg=AFQjCNH8Nj6g6MqwJmGADn-evKhByeqxcg) retrieved 20 Jun 2011]

The substance that has such large potential is an isotope called helium-3, a form of helium but with only one neutron instead of two.

It is extremely rare on earth as it is created during very active nuclear reactions, most commonly found on the surface of the sun, but here can only be found as a by-product of the maintenance of nuclear weapons.

Experts have estimated that the moon is a rich depository of the isotope with possible reserves that stretch meters down into the lunar soil that have been carried there by solar winds.

What makes helium-3 so attractive as an alternative future fuel source is its environmentally friendly credentials, as it does not produce radioactive waste.

**HE-3 WOULD DIMINISH BOTH THE ENVIRONMENTAL IMPACT OF FOSSIL FUELS AND THE PROLIFERATION DANGER OF NUCLEAR ENERGY-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

While the technological and economic feasibility of fusion based nuclear energy, particularly fusion reactors utilizing He-3 as fuel, is still uncertain and contested, and its commercial realization at best decades away,5 the implications of such a development could be far-reaching and profound. Fusion energy could significantly reduce the world's heavy dependence on fossil fuels, which are associated with environmental pollution, greenhouse gas emissions, and global warming-not to mention their rising price and role in recurrent geopolitical and economic tensions. Fusion energy could also provide a safer alternative to many countries' growing reliance on energy generated from nuclear fission reactors, which hold the potential dangers of nuclear accidents, terrorism, weapons proliferation, and radioactive waste disposal. Moreover, in contrast to the prospect of depletion of terrestrial fossil fuels, it is estimated that there is sufficient He-3 present on the Moon to meet humanity's rapidly growing energy needs for many centuries to come.6 Thus, despite the problematic future of He-3-based fusion energy, it is not surprising that the United States and other major powers are beginning to position themselves to ensure their future access to lunar He-3 resources.

**HE-3 IS MORE EFFICIENT &CLEANER THAN OTHER SOURCES OF FUSION FUEL-D’Souza and Otalvaro ‘06**

[Marsha and Diana; Worchester Polytechnic Institute; HARVESTING HELIUM-3 FROM THE MOON; 17 Feb 2006; retrieved 28 Jun 2011 <http://www.wpi.edu/Pubs/E-project/Available/E-project-031306-122626/unrestricted/IQP.pdf;>]

He-3 is especially promising as a fusion fuel due to the low levels of radioactive waste produced by its reaction with deuterium and also because of the impressively high efficiencies. 99% of the energy is released as charged particles, thus being converted immediately into electricity. In contrast, other nuclear reactions in which energy is derived from the heat produced by the reaction are less efficient because of mechanical constraints in efficiencies.

**MINING HE-3 WILL BE AFFORDABLE AND PRODUCE ENOUGH FOR OUR ENERGY NEEDS-Schmitt ‘04**

[Harrison; staff writer; Mining the Moon; Popular Mechanics; October 2004;<http://www.popularmechanics.com/science/air_space/1283056.html>; retrieved 27 Jun 2011]

Samples collected in 1969 by Neil Armstrong during the first lunar landing showed that helium-3 concentrations in lunar soil are at least 13 parts per billion (ppb) by weight. Levels may range from 20 to 30 ppb in undisturbed soils. Quantities as small as 20 ppb may seem too trivial to consider. But at a projected value of $40,000 per ounce, 220 pounds of helium-3 would be worth about $141 million.

Because the concentration of helium-3 is extremely low, it would be necessary to process large amounts of rock and soil to isolate the material. Digging a patch of lunar surface roughly three-quarters of a square mile to a depth of about 9 ft. should yield about 220 pounds of helium-3--enough to power a city the size of Dallas or Detroit for a year.

Although considerable lunar soil would have to be processed, the mining costs would not be high by terrestrial standards. Automated machines, perhaps like those shown in the illustrations on the lead page, might perform the work. Extracting the isotope would not be particularly difficult. Heating and agitation release gases trapped in the soil. As the vapors are cooled to absolute zero, the various gases present sequentially separate out of the mix. In the final step, special membranes would separate helium-3 from ordinary helium.

**A MINING OPERATION FOR HE-3 WOULD PRODUCE 300 TIMES THE ENERGY IT USES-Schriber ‘08**

[Michael; How moon rocks could power the future; MSNBC; 13 Aug 2008;<http://www.msnbc.msn.com/id/26179944/>; retrieved 27 Jun 2011]

"Helium-3 is present on the moon, but in very small concentration levels, meaning that many hundreds of millions of tons of soil must be processed to extract a ton of helium-3," said Paul Spudis of the Lunar and Planetary Institute, a NASA-funded research institution.

This extraction requires heating lunar dust particles to around 1,300 degrees Fahrenheit (700 degrees Celsius), Spudis said.

Kulcinski and his colleagues have designed rovers that could move along the surface, scraping up lunar soil and heating it with concentrated sunlight.

Such a mining operation would retrieve 300 times more energy than it uses (including all the energy to fly to the moon and back), Kulcinski estimates. In comparison, mining coal returns 15-20 times the energy put in. His team has estimated that it might cost around $800 million to bring back each ton of lunar helium-3.

ADVANTAGE 1: HUGE AMOUNT OF HE-3 ON THE MOON

**THERE SHOULD BE LARGE AMOUNTS OF HE-3 ON THE MOON-Lasker ‘06**

[John; Race to the Moon for Nuclear Fuel; Wired; 15 Dec 2006; <http://www.wired.com/science/space/news/2006/12/72276;> retrieved 20 Jun 2011]

Helium-3 is considered a safe, environmentally friendly fuel candidate for these generators, and while it is scarce on Earth it is plentiful on the moon.

As a result, scientists have begun to consider the practicality of mining lunar Helium-3 as a replacement for fossil fuels.

"After four-and-half-billion years, there should be large amounts of helium-3 on the moon," said Gerald Kulcinski, a professor who leads the Fusion Technology Institute at the University of Wisconsin at Madison.

**THERE ARE MILLIONS OF TONS OF HE-3 ON THE MOON AND ONLY A SMALL AMOUNT WOULD POWER THE US FOR A YEAR-Lasker ‘06**

[John; Race to the Moon for Nuclear Fuel; Wired; 15 Dec 2006; [http://www.wired.com/science/space/news/2006/12/72276;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fscience%2Fspace%2Fnews%2F2006%2F12%2F72276%3B&sa=D&sntz=1&usg=AFQjCNFERWiSVAOTIPn_rE1oOxEG4BvDAg) retrieved 20 Jun 2011]

While still theoretical, nuclear fusion is touted as a safer, more sustainable way to generate nuclear energy: Fusion plants produce much less radioactive waste, especially if powered by helium-3. But experts say commercial-sized fusion reactors are at least 50 years away.

The isotope is extremely rare on Earth but abundant on the moon. Some experts estimate there a millions of tons in lunar soil -- and that a single Space-Shuttle load would power the entire United States for a year.

**CHINESE EXPLORATION HAS DISCOVERED VAST AMOUNTS OF HE-3 ON THE MOON SURFACE-Asian News International ‘09**

[Helium-3 on Moon may provide humans with millions of tons of nuclear energy; Asian News International; 16 Aug 2009]

After circling the Moon for nearly 18 months, China's Chang'e 1 spacecraft has successfully achieved four scientific targets that include detection of helium-3, a crucial element for nuclear fusion, which may provide humans with millions of tons of nuclear energy in the future. The identification of helium-3 came about by the exploration of the soil layer on the Moon, a pioneering work that has not been done by any other country. The Chang'e 1, using microwave technology, measured the depth of the soil layer across the moon. One of the focuses of the soil examination was to detect how much helium-3, a crucial element for nuclear fusion, is on the moon. Since the fossil energy on Earth might be exhausted in a century or less, mankind has to find an alternative energy source. Nuclear fusion would be an important option. There is an abundance of helium-3, perhaps millions of tons, on the moon, which could be used to generate energy once the technology matures.

ADVANTAGE 1: SMALL AMOUNT OF HELIUM-3 WILL MEET ENERGY NEEDS

**ONE SHUTTLE PAYLOAD FULL WOULD PROVIDE ALL US ENERGY NEEDS FOR A YEAR-Irvine ‘06**

[Dean; Mining the Moon for a Nuclear Future; CNN; 18 Dec 2006; [http://articles.cnn.com/2006-12-18/tech/fs.moonmining\_1\_helium-3-moon-base-nuclear-fusion?\_s=PM:TECH;](http://www.google.com/url?q=http%3A%2F%2Farticles.cnn.com%2F2006-12-18%2Ftech%2Ffs.moonmining_1_helium-3-moon-base-nuclear-fusion%3F_s%3DPM%3ATECH%3B&sa=D&sntz=1&usg=AFQjCNH8Nj6g6MqwJmGADn-evKhByeqxcg) retrieved 20 Jun 2011]

However, while mining helium-3 from the moon will be one challenge, extracting energy from it is another, as it relies on nuclear fusion, rather than fission used in today's nuclear reactors.

Scientists have been working to prove nuclear fusion works but much of it still remains theoretical. It is thought to be at least 50 years from being proven to work on a large scale.

The potential, though, is enormous. It has been estimated that about 25 tons of helium-3, equal to just one payload of a space shuttle, would provide enough energy for the U.S. for a year at current consumption levels.

**40 TONS OF HE-3 WOULD PRODUCE ENOUGH ENERGY FOR AMERICA’S ANNUAL ELECTRICITY NEEDS-Liu and Carmichael ‘07**

[Melinda and Mary; staff writers; To Reach for the Moon; Newsweek; 12 Feb 2007]

National pride is a big force behind China's moon program, but not the only one. The Chinese are aiming to do more than "just set up a flag or pick up a piece of rock," says Ye Zili of China's Space Science Society. What are they after? A limitless source of clean, safe energy to feed their voracious economy. The stable isotope helium 3 (3He), a potential fuel for nuclear fusion, was first found in moon rocks brought back by the Apollo missions. It is one constituent of the "solar wind" constantly given off by the Sun. The stuff bounces off Earth's magnetic field, but the moon has no magnetic field, and its surface has been soaking up 3He for billions of years. If you could dig it up and put it into a fusion reactor you would get ordinary helium 4 (as in balloons), ordinary hydrogen (as in H2O) and an abundance of radioactivity-free energy. According to Gerald Kulcinski, director of the Fusion Technology Institute at the University of Wisconsin at Madison, a mere 40 tons would be roughly enough to serve America's electrical needs for a year.

**THREE SPACE SHUTTLE MISSIONS COULD BRING ENOUGH FUEL FOR ALL THE HUMANS ON THE WORLD-Hepeng ‘06**

[Jia; He Asked for the Moon and Got It; China Daily; 26 July 2006; <http://www.chinadaily.com.cn/cndy/2006-07/26/content_649325.htm;> retrieved 28 Jun 2011]

Helium-3, an isotope of the element Helium, is an ideal fuel for nuclear fusion power, the next generation of nuclear power. Nuclear fusion creates four times as much energy as nuclear fission, the current form of commercialized nuclear power. Nuclear fusion does not produce environmental problems like radioactive nuclear waste.

"Currently nuclear fusion technology is not mature, but once it is commercialized, fuel supply will become a problem," Ouyang added.

It is estimated that reserves of Helium-3 across the Earth amount to just 15 tons, while 100 tons of Helium-3 will be needed each year if nuclear fusion technology is applied to meet global energy demands.

The moon on the other hand has reserves estimated at between 1 to 5 million tons.

"Each year three space shuttle missions could bring enough fuel for all human beings across the world," said Ouyang.

**100 KILOGRAMS OF HE-3 IS WORTH $140 MILLION AND COULD BE EASILY MINED-Johnstone ‘11**

[Bruce; Astronaut Has $15 Billion Plan to Mine the Moon; Leader-Post; 03 May 2011; <http://www.leaderpost.com/technology/Astronaut+billion+plan+mine+moon/4718531/story.html;> retrieved 28 Jun 2011]

What Schmitt helped discover during his 75-hour sojourn on Taurus-Littrow, a lunar valley deeper than the Grand Canyon bordered by mountains up to 7,000-feet (2,133metres) high, was the mixed layer of material called regolith contained small amounts of helium-3.

"Helium-3 is a nearly ideal fuel for fusion nuclear power . It's ideal because it produces little or no radioactive waste, unlike almost all other nuclear systems.''

Containing 20 parts per billion of helium-3, about 100 kg of He-3 could provide sufficient fuel to allow a fusion reactor to generate 1,000 megawatts (MW) of power for a year, Schmitt said.

"That 100 kg could be produced by mining the lunar regolith to a depth of three metres and an area of about two square kilometres,'' Schmitt said. The value of that energy is about $140 million (based the energy equivalent in coal at today's prices).

**TWO SPACE SHUTTLE-SIZED LOADS OF HE-3 WOULD POWER ¼ OF THE EARTH FOR A FULL YEAR-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

During the past several years, the United States and three of the world's other leading space powers, Russia, China, and India,have each announced their intent to establish a base on the

Moon, in part with the purpose-or, in the case of the United States, at least the exploratory goal-of seeking to mine and bring to Earth helium-3 ("He-3"), an isotope' of helium rarely found naturally on Earth but believed to be present in large amounts as a component of the lunar soil.2 The potential value of He-3 is that it is theoretically an ideal fuel for thermonuclear fusion power reactors, which could serve as a virtually limitless source of safe and non-polluting energy.3 For example, it is estimated that forty tons of liquefied He-3 brought from the Moon to the Earth-about the amount that would comfortably fit in the cargo bays of two current U.S. space shuttles-would

provide sufficient fuel for He-3 fusion reactors to meet the full electrical needs of the United States, or one quarter of the entire world's electrical needs, for an entire year.

ADVANTAGE 1: LUNAR HELIUM-3 CAN REDUCE OUR RELIANCE ON FOSSIL FUELS

**ONE OF THE MOST IMPORTANT REASONS FOR A MOON MISSION IS TO END RELIANCE ON FOSSIL FUELS-Irvine ‘06**

[Dean; Mining the Moon for a Nuclear Future; CNN; 18 Dec 2006; <http://articles.cnn.com/2006-12-18/tech/fs.moonmining_1_helium-3-moon-base-nuclear-fusion?_s=PM:TECH;> retrieved 20 Jun 2011]

The race to return to the moon is on. Earlier this month NASA unveiled its mission statement to revisit earth's satellite and create a permanent base there. While it may become the jumping off point for further exploration of our solar system and beyond, there are more earthly prizes in sight, with some scientists believing that it has the potential to solve the world's dependence on fossil fuels.

Mining the moon for fuel used in nuclear fusion reactors is among NASA's 200-plus set of mission goals and could precipitate another reason for other countries and private investors to join future lunar exploration.

**HE-3 COULD SOLVE THE WORLD’S ENERGY CRISIS-Oberg ‘06**

[James; Moonscam: Russians try to sell the moon for foreign cash; The Space Review; 06 Feb 2006; <http://www.thespacereview.com/article/551/1;> retrieved 20 Jun 2011]

With NASA’s return to the Moon plans struggling with severe budget constraints, advocates of expanded human spaceflight both inside the agency and outside it have been encouraged by a blitz of publicity from Russia concerning their own plans to build a Moon base in the next ten to fifteen years. The vision of the 1960’s “Moon Race” and the astronomical funding levels it engendered is bound to cheer up today’s spaceflight advocates.

At a seminar on space research at Moscow’s Bauman State Technological University on January 25, a leading Russian space official proclaimed that a moon base could solve the world’s energy crisis by mining the isotope helium-3, potentially a valuable fuel for nuclear fusion power plants. “We are planning to build a permanent base on the moon by 2015 and by 2020 we can begin the industrial-scale delivery… of the rare isotope helium-3,” Nikolay Sevastianov announced.

**WE DO NOT LACK THE ENGINEERING TO CREATE POWER FROM HE-3; WE LACK THE HE-3-Schmitt ‘04**

[Harrison; staff writer; Mining the Moon; Popular Mechanics; October 2004;<http://www.popularmechanics.com/science/air_space/1283056.html>; retrieved 27 Jun 2011]

It is not a lack of engineering skill that prevents us from using helium-3 to meet our energy needs, but a lack of the isotope itself. Vast quantities of helium originate in the sun, a small part of which is helium-3, rather than the more common helium-4. Both types of helium are transformed as they travel toward Earth as part of the solar wind. The precious isotope never arrives because Earth's magnetic field pushes it away. Fortunately, the conditions that make helium-3 rare on Earth are absent on the moon, where it has accumulated on the surface and been mixed with the debris layer of dust and rock, or regolith, by constant meteor strikes. And there it waits for the taking.

An aggressive program to mine helium-3 from the surface of the moon would not only represent an economically practical justification for permanent human settlements; it could yield enormous benefits back on Earth.

**RECOVERABLE LUNAR HE-3 OFFERS MORE ENERGY THAN TEN TIMES THE KNOWN FOSSIL FUEL RESERVES ON EARTH- D’Souza and Otalvaro ‘06**

[Marsha and Diana; Worchester Polytechnic Institute; HARVESTING HELIUM-3 FROM THE MOON; 17 Feb 2006; retrieved 28 Jun 2011 <http://www.wpi.edu/Pubs/E-project/Available/E-project-031306-122626/unrestricted/IQP.pdf;>]

The idea of mining and getting the He-3 to Earth is very attractive, as has been recognized by the scientists at the University of Wisconsin, because of its efficiency and potential. He-3 is considered to have a value of about $1 billion a ton on Earth, and its energy potential is considered to be 10 times more than what is contained in all the known recoverable fossil fuels on Earth, and about twice that is contained in the uranium which is used in fast breeder reactors (Lewis, 1990). Another fascinating estimation is that 25 metric tons of He-3 reacted with deuterium would have provided all the electricity used in the United States in 1986.

**HE-3 WOULD PROVIDE THE WORLD WITH PLENTIFUL ENERGY-Dillow ‘11**

[Clay; Former Apollo Astronaut and Senator Says Mining Helium on the Moon Could Solve The Global Energy Crisis; PopSci; 5 May 2011; <http://www.popsci.com/science/article/2011-05/former-apollo-astronaut-says-moon-mining-could-solve-global-energy-crisis>; retrieved 9 August 2011]

Back to the Moon? Apollo 11. Former Apollo astronaut Harrison Schmitt thinks we should go back to the moon, this time to tap its reserves of helium-3. NASA

Former astronaut, Apollo moonwalker, geologist and former Senator Harrison Schmitt has a modest plan to solve the world’s energy problems. All we need is $15 billion over 15 years and some fusion reactors that have yet to be invented. And we’ll need a moon base.

Schmitt’s idea isn’t novel--he thinks the U.S. should go back to the moon, this time to mine the surface for helium-3, an isotope of helium that is rare on earth but relatively bountiful on the moon. The Russians have been talking about mining helium-3 from the moon for years, but they’ve never put forth a viable plan. Schmitt thinks his, all things considered, is pretty realistic.

**HE-3 WOULD HAVE TREMENDOUS ADVANTAGES IF WE CAN DO THE AFFIRMATIVE PLAN -Williams ‘07**

[Mark; Mining the Moon; MIT Technology Review; 23 August 2007; <http://www.technologyreview.com/printer_friendly_article.aspx?id=19296>; retrieved 9 August 2011]

Still, Kulcinski's reactor proves only the theoretical feasibility and advantages of He3-He3 fusion, with commercial viability lying decades in the future. "Currently," he says, "the Department of Energy will tell us, 'We'll make fusion work. But you're never going to go back to the moon, and that's the only way you'll get massive amounts of helium-3. So forget it.' Meanwhile, the NASA folks tell us, 'We can get the helium-3. But you'll never get fusion to work.' So DOE doesn't think NASA can do its job, NASA doesn't think that DOE can do its job, and we're in between trying to get the two to work together." Right now, Kulcinski's funding comes from two wealthy individuals who are, he says, only interested in the research and without expectation of financial profit.

Overall, then, helium-3 is not the low-hanging fruit among potential fuels to create practical fusion power, and it's one that we will have to reach the moon to pluck. That said, if pure He3-based fusion power is realizable, it would have immense advantages.

ADVANTAGE 2: HE-3 SHORTAGE IMPACTS NUCLEAR DETECTION

**THE SHORTAGE OF HE-3 IS SO SEVERE THAT THE COAST GUARD AND TSA DETECTION WILL BE IMPACTED-Dixon ‘10**

[Darius; Helium-3 Shortage Could Mean Nuke Detection ‘Disaster’; Wired; 29 April 2010; [http://www.wired.com/dangerroom/2010/04/helium-3-shortage-could-mean-nuke-detection-disaster/;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fdangerroom%2F2010%2F04%2Fhelium-3-shortage-could-mean-nuke-detection-disaster%2F%3B&sa=D&sntz=1&usg=AFQjCNE94a3FVct9SQMoUta_tr2vyQs4Gg) retrieved 20 Jun 2011]

Helium-3 neutron-detector systems were incorporated into many nuclear reactors designed and built General Electric, to measure power levels and initiate protective measures. Thomas R. Anderson, a representative from GE Energy, said his company has supplied more than 35,000 detectors around the world to monitor nuclear smuggling.

The shortage is so severe, explained Dr. William K. Hagan, acting director of the Domestic Nuclear Detection Office at DHS, that even handheld and backpack detectors used by the U.S. Coast Guard, Customs and Border Protection, and Transportation Security Administration would be affected. According to the hearing’s charter, U.S. exports of the precious gas have ceased, and the International Atomic Energy Agency has been informed that it must diversify its helium-3 sources used for their nuclear-nonproliferation work.

**US PRICING OF HE-3 IS LEADING TO IT BEING SQUANDERED-Firth ‘10**

[Niall; staff writer; Scientists say Earth's helium reserves 'will run out within 25 years' (and party balloons should cost £65 each); Daily Mail; 23 Aug 2010; <http://www.dailymail.co.uk/sciencetech/article-1305386/Earths-helium-reserves-run-25-years.html;> retrieved 05 Jul 2011]

The only way to obtain more helium would be to capture it from the decay of tritium - a radioactive hydrogen isotope, which the U.S. stopped making n 1988.

The US stores around 80 per cent of the world's helium and so its decision to let it go at an extremely low price has a massive knock-on affect on its market.

But Professor Richardson said that low price of helium meant that it was being ‘squandered’ rather than being treated as a precious resource.

He said: 'The problem is that these supplies will run out in a mere 25 years, and the US government has a policy of selling helium at a ridiculously low price.'

**DEMAND FOR HE-3 IMPACTS NUCLEAR PROLIFERATION EFFORTS-Homeland Security Newswire ‘11**

[Helium-3 shortage endangers nuclear detection capabilities; Homeland Security Newswire; 28 February 2011; <http://www.homelandsecuritynewswire.com/helium-3-shortage-endangers-nuclear-detection-capabilities>; retrieved 9 August 2011]

Demand for radiation detectors has surged as a result of increased efforts to stop nuclear proliferation and terrorism, but production of helium-3, a critical element in nuclear detection technology, has not kept pace and existing stockpiles are quickly dwindling.

Helium-3 is primarily used in security applications as it is highly sensitive to the neutrons that are emitted by plutonium. Roughly 80 percent of helium-3 supplies are used for national security.

According to Wired’s Danger Room, helium-3 does not naturally occur in large quantities and it represents less than 0.0002 percent of all helium.

ADVANTAGE 2: HELIUM-3 IS CRITICAL FOR DETECTING NUCLEAR WEAPONS

**80% OF HE-3 USED IN THE US IS FOR HOMELAND SECURITY TO DETECT SMUGGLED NUKES-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

About 80% of the helium-3 used in the United States is for homeland security, as it can detect neutrons emitted from plutonium that might be smuggled across international borders. Beyond monitoring for smuggled nuclear materials, helium-3 is used for basic research, oil and gas exploration, and medical lung imaging. Its unique properties may someday make it useful in nuclear fusion, said Fetter, who’s on leave from the School of Public Policy at the University of Maryland.

But helium-3, composed of two protons and one neutron, is exceedingly rare on Earth. It is found in the air at seven parts per trillion; such low concentrations make it too expensive to extract. It is believed to exist in larger quantities on the moon.

**HE-3 IS USED FOR BORDER SECURITY ALL OVER THE WORLD-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

The need for helium-3 in border protection is shared by other countries. At the AAAS workshop, Stephen White, nuclear and technology adviser at the British Defence staff at the British Embassy in Washington, D.C., said that the United Kingdom has “12,000 miles of shore to protect” and portal monitoring is the primary use of helium-3. White said that the U.K. also uses helium-3 for science and medical applications, and that they’re not looking to expand their uses of the gas.

Richard Kouzes, a laboratory fellow in the Pacific Northwest National Laboratory in Richland, Washington, said that alternatives for helium-3 for national security had to fit certain parameters. For instance, neutron detection systems have to physically fit into existing detection systems, which use long tubes containing helium-3.

**HE-3 IS CRITICAL TO PREVENT NUCLEAR SMUGGLING-Dixon ‘10**

[Darius; Helium-3 Shortage Could Mean Nuke Detection ‘Disaster’; Wired; 29 April 2010; <http://www.wired.com/dangerroom/2010/04/helium-3-shortage-could-mean-nuke-detection-disaster/;> retrieved 20 Jun 2011]

Stopping nuclear smuggling is already tough. But it’s about to get a lot harder. Helium-3, a crucial ingredient in neutron-particle-detection technology, is in extremely short supply.

Rep. Brad Miller (D-North Carolina), chairman of the House Subcommittee on Investigations and Oversight, chided the Departments of Energy and Homeland Security at a hearing on the issue late last week, suggesting that they created a preventable “disaster.” The Energy Department is the sole American supplier of helium-3, and DHS is supposed to take the lead in spotting and stopping illicit nuclear material.

**SHORTAGES AND UNCERTAINTY MAKE IT UNCLEAR WHETHER US CAN MEET SECURITY DEMANDS FOR HE-3-Shea and Morgan ‘10**

[Dana and Daniel; Specialist in Science and Technology Policy, Congressional Research Service; The Helium-3 Shortage: Supply, Demand, and Options for Congress; 22 Dec 2010; <http://www.fas.org/sgp/crs/misc/R41419.pdf;> retrieved 27 Jun 2011]

The demand for helium-3 has increased dramatically since 2001. Prior to 2001, the demand was

approximately 8,000 liters per year, which was less than the new supply from tritium decay. After

2001, the demand increased, reaching approximately 80,000 liters in 2008. Projections show

demand continuing at above the available new supply for at least the next several years. See

Figure 2. These projections contain many variables and therefore considerable uncertainty. Some estimates project much higher non-governmental demand, perhaps more than 100,000 liters in FY2011 and FY2012.52 Some estimates appear to measure helium-3 quantities at nonstandard pressures. Because liters are a volume measure, and all gases change volume depending on their pressure, inconsistency in measurement has the potential to create confusion when amounts projected by different analysts are added. Perhaps most important, given such a large mismatch between supply and demand, users are likely to seek out alternative technologies, reschedule planned projects, and make other changes that reduce demand below what it would be in the absence of a shortage. It is unclear whether the available estimates reflect (or indeed, could reflect) these likely changes. Similarly, it is unclear whether federal agencies and the private sector can reduce demand sufficiently to match the current helium-3 supply and still meet priorities for security, science, and other applications.

**HE-3 IS CRITICALLY IMPORTANT FOR SCIENTIFIC RESEARCH, MEDICINE, AND BORDER SECURITY-Reed ‘11**

[Christina; staff writer; The Fallout of a Helium-3 Crisis; Discovery News; 19 Feb 2011; <http://news.discovery.com/earth/the-outfall-of-a-helium-3-crisis.html;> retrieved 28 Jun 2011]

The United States is currently recovering from a helium isotope crisis that last year sent low-temperature physicists scrambling, sky-rocketed the cost of hospital MRIs, and threw national security staff out on a search mission for alternate ways to detect dirty bombs.

“Everybody was freaking out, going into closets and digging out what you could,” said low-temperature physicist Marcius Extavour, who is currently serving as a science policy fellow at the U.S. Senate Committee on Energy.

While it’s a different kind of helium than what’s used for party balloons, the gas inflated an amazing rate of discoveries that led to four Nobel prizes in physics, a see-through method of looking at lungs and a backpack of equipment that border security patrols can wear to check whether cargo coming into the country carries nuclear material.

But the isotope, helium-3, like many rare Earth elements, has been in high demand with only limited supply.

ADVANTAGE 2: NUCLEAR TERRORISM IS A HUGE THREAT

**A SMALL NUCLEAR EXPLOSION IN A US SEAPORT WOULD KILL AS MANY AS A MILLION PEOPLE AND COST $1.2 TRILLION IN GLOBAL TRADE-Medalia ‘05**

[Jonathan; Specialist in National Defense; Congressional Research Service; Terrorist Nuclear Attacks on Seaports: Threat and Response; 24 Jan 2005]

Terrorists have tried to obtain weapons of mass destruction (WMD) — chemical, biological, radiological, and nuclear weapons. While it would probably be more difficult for terrorists to obtain or fabricate a nuclear weapon than other WMD, an attack using a nuclear weapon merits consideration because it would have much higher consequence. U.S. seaports could be targets for terrorist attack. A terrorist Hiroshima-sized nuclear bomb (15 kilotons, the equivalent of 15,000 tons of TNT) detonated in a port would destroy buildings out to a mile or two; start fires, especially in a port that handled petroleum and chemicals; spread fallout over many square miles; disrupt commerce; and kill many people. Many ports are in major cities. By one estimate, a 10- to 20-kiloton

weapon detonated in a major seaport would kill 50,000 to 1 million people and would result in direct property damage of $50 to $500 billion, losses due to trade disruption of $100 billion to $200 billion, and indirect costs of $300 billion to $1.2 trillion.

**TERRORISTS ARE INTERESTED IN ATTACKING A PORT, WHICH WOULD DEVASTATE THE GLOBAL ECONOMY-Medalia ‘05**

[Jonathan; Specialist in National Defense; Congressional Research Service; Terrorist Nuclear Attacks on Seaports: Threat and Response; 24 Jan 2005]

Terrorists might try to smuggle a bomb into a U.S. port in many ways, but containers may offer an attractive route. A container is a metal box, typically 8 ft wide by 8½ ft high by 20 ft or 40 ft long, that can be used on and moved between a tractor-trailer, a rail car, or a ship. Much global cargo moves by container. Nearly 9 million containers a year enter the United States by ship.2 Customs and Border Protection (CBP) screens data for all containers, and reportedly inspects about 6 percent of them.3 Containers could easily hold a nuclear weapon. Many believe that ports and containers are vulnerable. An FBI official stated, “The intelligence that we have certainly points to the ports as a key vulnerability of the United States and of a key interest to certain terrorist groups....”4 CBP

Commissioner Robert Bonner believes an attack using a nuclear bomb in a container would halt container shipments, leading to “devastating” consequences for the global economy. ...”5 People can, however, find ways to minimize economic problems.

**THE GREATEST THREAT TO AMERICAN AND GLOBAL SECURITY IS NUCLEAR TERRORISM-Golan-Villela ‘11**

[Rob; ACA Fellow; Don’t Skimp on Funding to Prevent Nuclear Terrorism; Arms Control Association; 02 Mar 2011; <http://www.armscontrol.org/issuebriefs/PreventNuclearTerrorism;> retrieved 19 Jul 2011]

There is an overwhelming, bipartisan consensus among America’s leaders that nuclear terrorism is one of the most dangerous threats facing the United States and the world today. Unfortunately, the new leadership of the House of Representatives has lumped federal programs designed to prevent this danger in with the rest of its targets for budget cuts, proposing to slash their funding by over 20 percent. This is a big mistake, and the Senate and the White House should work aggressively to ensure that these cuts are not turned into law.

Leaders of both parties and the military agree on the magnitude of this issue. Secretary of Defense Robert Gates has said, “Every senior leader, when you’re asked what keeps you awake at night, it’s the thought of a terrorist ending up with a weapon of mass destruction, especially nuclear.” President Barack Obama has called the prospect of nuclear terrorism “the most immediate and extreme threat to global security.” And according to former President George W. Bush, “The biggest threat facing this country is weapons of mass destruction in the hands of a terrorist network.”

**THERE IS A VAST QUANTITY OF NUCLEAR MATERIAL AVAILABLE; SECURITY IS CRITICAL-Golan-Villela ‘11**

[Rob; ACA Fellow; Don’t Skimp on Funding to Prevent Nuclear Terrorism; Arms Control Association; 02 Mar 2011; <http://www.armscontrol.org/issuebriefs/PreventNuclearTerrorism;> retrieved 19 Jul 2011]

In testimony last month, General James Clapper, Director of National Intelligence, stated that “the time when only a few states had access to the most dangerous technologies is well past… Some terror groups remain interested in acquiring CBRN [chemical, biological, radiological and nuclear] materials and threaten to use them. Poorly secured stocks of CBRN provide potential source material for terror attacks.”

In its final report, the bipartisan Commission on the Prevention of WMD Proliferation and Terrorism warned that al-Qaeda is “actively intent on conducting a nuclear attack against the United States” and that it has been seeking nuclear weapons-usable material ever since the 1990s. “It is therefore imperative,” the commission argued, “that authorities secure nuclear weapons and materials at their source.”

According to the International Panel on Fissile Materials, the global stockpile of highly enriched uranium (HEU) in 2010 was roughly 1,475 tons, or enough to make more than 60,000 nuclear weapons. Likewise, the panel estimates the global stockpile of separated plutonium to be about 485 tons. The quality of security over these materials is uneven, varying widely across countries and regions. The sheer quantity of materials explains why a concerted effort is required to make nuclear security a major international priority.

ADVANTAGE 3: HELIUM-3 WILL POWER SPACE EXPLORATION/COLONIZATION

**HE-3 WILL INCREASE SPACE EXPLORATION, ENCOURAGE TOURISM, AND LEAD TO PLANETARY DEFENSE-Schmitt ‘04**

[Harrison; staff writer; Mining the Moon; Popular Mechanics; October 2004;<http://www.popularmechanics.com/science/air_space/1283056.html>; retrieved 27 Jun 2011]

Returning to the moon would be a worthwhile pursuit even if obtaining helium-3 were the only goal. But over time the pioneering venture would pay more valuable dividends. Settlements established for helium-3 mining would branch out into other activities that support space exploration. Even with the next generation of Saturns, it will not be economical to lift the massive quantities of oxygen, water and structural materials needed to create permanent human settlements in space. We must acquire the technical skills to extract these vital materials from locally available resources. Mining the moon for helium-3 would offer a unique opportunity to acquire those resources as byproducts. Other opportunities might be possible through the sale of low-cost access to space. These additional, launch-related businesses will include providing services for government-funded lunar and planetary exploration, astronomical observatories, national defense, and long-term, on-call protection from the impacts of asteroids and comets. Space and lunar tourism also will be enabled by the existence of low-cost, highly reliable rockets.

**HE-3 IS IDEAL FOR POWERING SPACECRAFT FOR INTERSTELLAR TRAVEL-Wakefield ‘00**

[Julie; staff writer; Researchers and space enthusiasts see helium-3 as the perfect fuel source; Space.com; 30 June 2000;<http://www.space.com/scienceastronomy/helium3_000630.html>; retrieved 01 Dec 2008]

In contrast, helium 3 fusion would produce little residual radioactivity. Helium 3, an isotope of the familiar helium used to inflate balloons and blimps, has a nucleus with two protons and one neutron. A nuclear reactor based on the fusion of helium 3 and deuterium, which has a single nuclear proton and neutron, would produce every few neutrons -- about 1 percent of the number generated by the deuterium-tritium reaction. "You could safely build a helium 3 plant in the middle of a big city," Kulcinski said.

Helium 3 fusion is also ideal for powering spacecraft and interstellar travel. While offering the high performance power of fusion -- "a classic Buck Rogers propulsion system" -- helium3 rockets would require less radioactive shielding, lightening the load, said Robert Frisbee, an advanced propulsion engineer at NASA's Jet Propulsion Laboratory in Pasadena California.

Recently Kulcinski's team reports progress toward making helium 3 fusion possible. Inside a lab chamber, the Wisconsin researchers have produced protons from a steady-state deuterium-helium3 plasma at a rate of 2.6 million reactions per second. That's fast enough to produce fusion power but not churn out electricity. "It's proof of principle, but a long way from producing electricity or making a power source out of it," Kulcinski said. He will present the results in Amsterdam in mid July at the Fourth International Conference on Exploration and Utilization of the Moon.

**HE-3 INITIATIVE WOULD LEAD TO THE FIRST HUMAN MISSION TO MARS BY 2025-Johnstone ‘11**

[Bruce; Astronaut Has $15 Billion Plan to Mine the Moon; Leader-Post; 03 May 2011; <http://www.leaderpost.com/technology/Astronaut+billion+plan+mine+moon/4718531/story.html;> retrieved 28 Jun 2011]

Schmitt believes the commercial feasibility of He-3 as a fuel source for nuclear fusion could be proven with a $5-billion US demonstration plant. Another $5 billion US could "re-create" the Saturn V-class launch vehicle or rockets used to propel the Apollo astronauts into space.

The lunar settlement required to mine the He-3 -"basically a company town on the moon" -would cost another $2.5 billion US. As an added bonus, the helium-3 initiative would also help the U.S. send human beings to Mars.

"I believe the first human mission to Mars could be launched in 2025 because the development of the helium-3 initiative would also develop just about everything we would need to do in order to start that process of going to Mars -large rockets, the ability to work and live on another space body and the like.''

**HE-3 PROJECT WILL LEAD TO HUMANS ON MARS BY 2025, WITH BETTER AND SAFER TECHNOLOGY-Johnstone ‘11**

[Bruce; Astronaut Has $15 Billion Plan to Mine the Moon; Leader-Post; 03 May 2011; <http://www.leaderpost.com/technology/Astronaut+billion+plan+mine+moon/4718531/story.html;> retrieved 28 Jun 2011]

Schmitt, who also served a sixyear stint as U.S. senator starting in 1977, said the He-3 project could also jump-start the U.S.-planned mission to Mars for 2030.

"Having an upgraded heavy-lift launch vehicle, like the Saturn V, would be a major part of what you'd require for a Mars expedition. In addition, becoming really familiar with living and working in space on the moon . would certainly give you the experience base you need to do that on Mars."

Not only that, but the helium-3 project could provide the fuel to get a manned mission to Mars.

"(Helium-3) also is an ideal rocket fuel. Fusion rockets to allow you to accelerate and decelerate on the way to Mars would shorten the timeframe that human beings are exposed to radiation in space."

In fact, if the He-3 project goes ahead, it would almost certainly expedite the manned mission to Mars. "If you got going aggressively and successively on a helium-3 initiative . then you would be putting yourself in a position that by 2025 you could have the first Mars mission going as well.''

ADVANTAGE 3: SPACE EXPLORATION CRITICAL FOR HUMAN SURVIVAL

**THE SURVIVAL OF HUMANITY DEPENDS ON SPACE EXPLORATION; THE THREAT OF PLANETARY DISASTER IS AN EVER-GROWING THREAT-Hui ‘06**

[Sylvia; AP reporter; Hawking: Space Exploration A Necessity; 13 June 2006; Houston Chronicle; <http://www.chron.com/disp/story.mpl/space/3965730.html;> retrieved 16 Jul 2011]

The survival of the human race depends on its ability to find new homes elsewhere in the universe because there's an increasing risk that a disaster will destroy Earth, world-renowned physicist Stephen Hawking said today.

Humans could have a permanent base on the moon in 20 years and a colony on Mars in the next 40 years, the British scientist told a news conference.

"We won't find anywhere as nice as Earth unless we go to another star system," added Hawking, who came to Hong Kong to a rock star's welcome Monday. Tickets for his lecture Wednesday were sold out.

Hawking said that if humans can avoid killing themselves in the next 100 years, they should have space settlements that can continue without support from Earth.

"It is important for the human race to spread out into space for the survival of the species," Hawking said. "Life on Earth is at the ever-increasing risk of being wiped out by a disaster, such as sudden global warming, nuclear war, a genetically engineered virus or other dangers we have not yet thought of."

**WE MUST DEVELOP A LUNAR BASE AS INSURANCE FOR THE SURVIVAL OF HUMANITY AND TO PREVENT THE POTENTIAL, INCALCULABLE LOSS OF ALL FUTURE GENERATIONS- Shapiro ‘07**

[Robert; Professor Emeritus and Senior Research Scientist in the Chemistry Department of New York University; Why the Moon? Human survival!; The Space Review; 19 Mar 2007; <http://www.thespacereview.com/article/832/1> retrieved 16 Jul 2011]

I am not writing here to add my voice to the chorus of Moon-bashers, but to express my astonishment that NASA, and most supporters of space, have overlooked the one goal that, even if taken alone, would justify the massive cost of a permanent lunar base: insuring the survival of our species, and of the civilization that sustains us.

Each year I insure my home for perhaps one percent of its value, and use a smaller amount to rent a safe deposit box to store valuable documents. What value do we place on our entire scientific, medical, and technical literature, together with our literary, artistic, and musical heritage? To raise the stakes, let me add the value of our own lives and those of all of our unborn descendents. This possibility was described eloquently more than two decades ago by Johnathan Schell in his anti-nuclear was treatise *The Fate of the Earth*. In his words: “But although the untimely death of everyone in the world would in itself constitute an unimaginably huge loss, it would bring with it a separate, distinct loss that would be in a sense even huger-the cancellation of all future generations of human beings.”

Of course, we have been hearing predictions of Doomsday for years, and we are still here. According to geologists, the eruption of Mt. Toba in Indonesia 71,000 years ago darkened the sky for years. The event caused killed much of plant life on the planet. The famine that resulted caused a severe drop in the human population of that time. The Black Death of the 14th century killed perhaps one-third of the population of Europe and the great flu epidemic of 1918 claimed an estimated 40 million victims. Despite these disasters, and others such as global wars, humanity has muddled through and even prospered. Why should things be different now? The answer is simple. Our prospects have worsened because we have come to a unique place in human history.

**EVEN SINGLE DISASTERS MAY CAUSE A CASCADE OF OTHER DISASTROUS EVENTS; WE NEED A BUFFER OFF THE PLANET TO INSURE THE SURVIVAL OF HUMANITY-Shapiro ‘07**

[Robert; Professor Emeritus and Senior Research Scientist in the Chemistry Department of New York University; Why the Moon? Human survival!; The Space Review; 19 Mar 2007; <http://www.thespacereview.com/article/832/1> retrieved 16 Jul 2011]

We may also expect that single disasters may trigger a cascade of others. For example, my local power company has circulated a card advising its customers to assemble “at least a three-day supply of water and non-perishable food” as part of a “family emergency preparedness plan”. But what would we do, in urban centers, when that supply was exhausted but power and transportation had not been restored? Looting of stores and warehouses might be expected, together with an attempt by residents to flee to less populated areas where conditions might be better. Famine and civic disorder will inevitably produce casualties; unburied bodies could then lead to disease epidemics.

Considerations of this type led Dr. Martin Rees, Professor of Cosmology at Cambridge and President of the Royal Society, to publish a gloomy estimate. In his 2003 book, *Our Final Hour*, he gave civilization only a 50-percent chance of surviving until the year 2100.

When we face a brand new situation, such probabilities are impossible to calculate. Countermeasures against each individual threat can of course be taken, but we would also be prudent to back up our civilization and our species. We need to place a self-sufficient fragment of society out of harm’s way, which for practical purposes means off the Earth. A buffer of empty space would protect that sanctuary from virtually all of the catastrophes named above.

**A WIDE ARRAY OF THREATS MAKE IT UNLIKELY THAT HUMANITY WILL SURVIVE A THOUSAND YEARS WITHOUT COLONIZING SPACE-Engdahl ‘06**

[Sylvia; science author; Space and Human Survival: My Views on the Importance of Colonizing Space; 02 Nov 2006; <http://www.sylviaengdahl.com/space/survival.htm;> retrieved 16 Jul 2011]

A more urgent cause for concern is the need not to “put all our eggs in one basket,” in case the worst happens and we blow up our own planet, or make it uninhabitable by means of nuclear disaster or perhaps biological warfare. We would all like to believe this won’t happen, yet some people are seriously afraid that it will—it’s hardly an irrational fear. Peace with Russia may have drawn attention from it, yet there are other potential troublemakers, even terrorists; the nuclear peril is not mere history. Furthermore, there is the small but all-too-real possibility that Earth might be struck by an asteroid. We all hope and believe our homes won’t burn down, and yet we buy fire insurance. Does not our species as a whole need an insurance policy?

Even Carl Sagan, a long-time opponent of using manned spacecraft where robots can serve, came out in support of space colonization near the end of his life, for this reason; see his book Pale Blue Dot. And in an interview with Britain’s newspaper Daily Telegraph, eminent cosmologist Stephen Hawking said, “I don’t think that the human race will survive the next thousand years unless we spread into space. There are too many accidents that can befall life on a single planet.” Hawking is more worried about the possibility of our creating a virus that destroys us than about nuclear disaster. However, he said, “I’m an optimist. We will reach out to the stars.”

**DEVELOPMENT IN SPACE PROVIDES ANOTHER WAY TO SAVE HUMANITY, BY PREVENTING OUR OWN DESTRUCTION OF EARTH-Howerton ‘96**

[Alexander; business editor of Countdown; Why Bother About Space?; The Futurist; 01 Jan 1996; reprinted at <http://www.allbusiness.com/professional-scientific/scientific-research/536396-1.html;> retrieved 17 Jul 2011]

A second argument--and one of the most compelling--for developing space lies in the necessity of protecting our home planet. Humans are beginning to exert great pressure on the ecosystems of Mother Earth. Even conservative population estimates predict 10 billion people by 2050--nearly twice as many as we have now--with no indication of the growth rate slowing.

Industry has developed to a point where we can wield amazing power and accomplish great feats. It all occurs, however, within the earth's biosphere, so any waste products stay right here, creeping into our food chain and atmosphere.

Conservation is a noble cause, but it is ultimately a losing proposition. The best we can hope for is to slow down the rate of pollution and depletion of natural resources. We merely delay the inevitable day of our own destruction.

Science has devised possible solutions to our problems. Less-polluting energy sources, electric cars, and alternative urban designs, to name just a few, hold the promise of improving our lives and chances of survival. Yet, we have invested so much in our current way of doing things, both financially and psychically, that our present systems stringently resist change.

As we develop a space-based economy, we will have the opportunity to develop new systems and technologies, and these new discoveries and inventions will filter down to Earth, improving everyone's standard of living.

**SPACE EXPLORATION IS IMPORTANT TO SAVE THE PLANET THROUGH RESEARCH, POPULATION CONTROL AND NATURAL RESOURCE ACQUISITION- Hohler ‘09**

[Daniel, Columnist; Top 5 Reasons why Space Exploration is Important for the World; PlanetSave; 26 July 2009; <http://planetsave.com/2009/07/26/top-5-reasons-why-space-exploration-is-important-for-the-world/>; retrieved 9 August 2011]

4. NASA’s Environmental Research – You would think that the guys who burn a million pounds of rocket fuel wouldn’t be the most environmentally minded people in the world, or out of the world as it may be. However, most people don’t know that NASA does a lot of good environmental research while they are up there looking down at all of us. NASA has done a lot of work in studying air quality, climate change, alternative energy, and near earth objects; which as we all know from the movies can destroy the earth any day now without warning, unless we have a group of oil drillers, a nuke, and Bruce Willis.

3. Eliminate Earth Over Population – The current earth population is almost 6.8 BILLION people. Arguably beyond the carrying capacity of the earth already. The big dream is space colonization. We need somewhere to put all these people, or we all might end up living in skyscrapers, see all animal’s habitats destroyed, and smog up the air beyond what is breathable (see: China).

2. Natural Resources – Related to over population, we are burning through the earth’s natural resources pretty quickly. Out in space there is virtually unlimited resources. It is all just a matter of collecting it and bringing it back, which granted will not be an easy task. Still… it is virtually unlimited natural resources! There will be no more excuses for hiking up prices on barrels of oil. (Although hopefully we will have moved far beyond oil by then).

ADVANTAGE 4: HELIUM-3 IS CRITICAL FOR MEDICINE/SCIENCE

**HE-3 IS CRITICAL FOR SCIENCE, MEDICINE, AND SECURITY-Reed ‘11**

[Christina; staff writer; The Fallout of a Helium-3 Crisis; Discovery News; 19 Feb 2011; <http://news.discovery.com/earth/the-outfall-of-a-helium-3-crisis.html;> retrieved 28 Jun 2011]

The science, medical and security uses for helium-3 are so diverse that the crisis banded together a hodge-podge of universities, hospitals and government departments to try and find workable alternatives and engineer ways to recycle the gas they do have.

“This has been a bad way to do good inter-agency cooperation,” said engineer Joe Glaser of the Department of Energy. A promising alternative gas for hunting down radioactive neutrons and gamma particles for example is boron, but for medical purposes nothing beats helium-3.

For those suffering with asthma, cystic fibrosis, or other lung limitations, a simple X-ray will show the lungs as black holes in the body, a mystery box of trouble. But if a patient takes a breath of helium-3, the resulting MRI is so bright it looks as though the patient inhaled a light bulb.

**FOR SOME APPLICATIONS, THERE ARE NO KNOWN ALTERNATIVES TO HE-3-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

Outside the realm of national security, workshop participants said, helium-3 is seemingly indispensable in a variety of industries such as oil well drilling, road construction, basic science research that requires absolute zero temperatures, and medical imaging.

For some applications—like ultracold physics, missile research, and medical imaging of lungs—there are no known alternatives, said Ronald Cooper, detector team leader at the Oak Ridge National Laboratory in Tennessee. In this role, he has installed more than 3000 security systems for detecting neutrons; 75% of those systems have used helium-3. But Cooper said that helium-3 needs in some fields, including national security, oil well logging and road construction, could be met by developing alternatives.

**HE-3 IS CRITICAL FOR DOMESTIC OIL PRODUCTION-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

The U.S. oil and gas industry, for instance, uses about 2% of U.S. supplies of helium-3. The gas is used in neutron detectors lowered into oil and gas wells to help determine the hydrocarbon content, which indicates the presence of oil and gas. Brad Roscoe, scientific advisor and nuclear program manager at Schlumberger-Doll Research Center in Cambridge, Massachusetts, said that a replacement for helium-3 must be reliable in the high-temperature, high-vibration, and small-size environment of oil well logging.

The industry is looking for alternatives, Roscoe said. But he’s “pretty sure there’s nothing off the shelf that we can use.” Alternative technologies could be several years away and the commercial roll-out and acceptance of these new technologies would take over 10 years, he added.

OTHER NATIONS ARE RAPIDLY EXPANDING RACE FOR HELIUM-3

**THERE IS A SPACE RACE ON FOR HE-3-Bloomfield ‘07**

[Adrian; staff writer; Russia Sees Moon Plot in NASA Plans; 01 May 2007; The Telegraph; [http://www.telegraph.co.uk/news/worldnews/1550246/Russia-sees-moon-plot-in-Nasa-plans.html;](http://www.google.com/url?q=http%3A%2F%2Fwww.telegraph.co.uk%2Fnews%2Fworldnews%2F1550246%2FRussia-sees-moon-plot-in-Nasa-plans.html%3B&sa=D&sntz=1&usg=AFQjCNEeMyBqGFnQaoX-Rq0WmVlnz50qAQ) retrieved 20 Jun 2011]

Dismissed by critics as a 21st-century equivalent of the medieval alchemist's fruitless quest to turn lead into gold, some scientists say helium-3 could be the answer to the world's energy woes.

A non-radioactive isotope of helium, helium-3 is a proven and potent fuel for nuclear fusion - so potent that just six metric tons would supply Britain with enough energy for a year.

As helium-3 is non-polluting and is so effective in such tiny quantities, many countries are taking it very seriously. Germany, India and China, which will launch a lunar probe to research extraction techniques in September, are all studying ways to mine the isotope.

"Whoever conquers the moon first will be the first to benefit," said Ouyang Ziyuan, the chief scientist of China's lunar programme.

**RUSSIA PLANS TO BE DELIVERING INDUSTRIAL-SCALE HE-3 BY 2025-Irvine ‘06**

[Dean; Mining the Moon for a Nuclear Future; CNN; 18 Dec 2006; [http://articles.cnn.com/2006-12-18/tech/fs.moonmining\_1\_helium-3-moon-base-nuclear-fusion?\_s=PM:TECH;](http://www.google.com/url?q=http%3A%2F%2Farticles.cnn.com%2F2006-12-18%2Ftech%2Ffs.moonmining_1_helium-3-moon-base-nuclear-fusion%3F_s%3DPM%3ATECH%3B&sa=D&sntz=1&usg=AFQjCNH8Nj6g6MqwJmGADn-evKhByeqxcg) retrieved 20 Jun 2011]

While NASA aim to have a moon base by 2025 other space agencies and companies have expressed an interest in the moon and its potential energy reserves.

"We are planning to build a permanent base on the moon by 2015 and by 2020 we can begin the industrial-scale delivery... of the rare isotope helium-3," said Nikolai Sevastianov, head of Russian space vehicle manufacturer Energia, at a seminar in Moscow in January.

**THE MAIN PURPOSE OF RUSSIAN MOON EXPLORATION IS HE-3-Bloomfield ‘07**

[Adrian; staff writer; Russia Sees Moon Plot in NASA Plans; 01 May 2007; The Telegraph; [http://www.telegraph.co.uk/news/worldnews/1550246/Russia-sees-moon-plot-in-Nasa-plans.html;](http://www.google.com/url?q=http%3A%2F%2Fwww.telegraph.co.uk%2Fnews%2Fworldnews%2F1550246%2FRussia-sees-moon-plot-in-Nasa-plans.html%3B&sa=D&sntz=1&usg=AFQjCNEeMyBqGFnQaoX-Rq0WmVlnz50qAQ) retrieved 20 Jun 2011]

Yesterday Anatoly Perminov, the head of Russia's Federal Space Agency Roscosmos, said: "We are ready to co-operate but for some reason the United States has announced that it will carry out the programme itself. Strange as it is, the United States is short of experts to implement the programme."

Nasa announced in December that it was planning to build an international base camp on one of the Moon's poles, permanently staffing it by 2024. Russia's space rocket manufacturer Energia revealed an even more ambitious programme last August, saying it would build a permanent Moon base by 2015.

While the Americans have either been coy or dismissive on the subject, Russia openly says the main purpose of its lunar programme is the industrial extraction of helium-3.

**CHINA, INDIA, RUSSIA, AND THE US ARE ALL COMPETING FOR LUNAR HE-3-Technology Review ‘07**

[Mining the Moon; Technology Review; 23 Aug 2007; <http://www.technologyreview.com/Energy/19296/;> retrieved 20 Jun 2011]

At the 21st century's start, few would have predicted that by 2007, a second race for the moon would be under way. Yet the signs are that this is now the case. Furthermore, in today's moon race, unlike the one that took place between the United States and the U.S.S.R. in the 1960s, a full roster of 21st-century global powers, including China and India, are competing.

Even more surprising is that one reason for much of the interest appears to be plans to mine helium-3--purportedly an ideal fuel for fusion reactors but almost unavailable on Earth--from the moon's surface. NASA's Vision for Space Exploration has U.S. astronauts scheduled to be back on the moon in 2020 and permanently staffing a base there by 2024. While the U.S. space agency has neither announced nor denied any desire to mine helium-3, it has nevertheless placed advocates of mining He3 in influential positions. For its part, Russia claims that the aim of any lunar program of its own--for what it's worth, the rocket corporation Energia recently started blustering, Soviet-style, that it will build a permanent moon base by 2015-2020--will be extracting He3.

**THERE IS WIDESPREAD INTEREST IN MINING THE MOON FOR HE-3-Lasker ‘06**

[John; Race to the Moon for Nuclear Fuel; Wired; 15 Dec 2006; [http://www.wired.com/science/space/news/2006/12/72276;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fscience%2Fspace%2Fnews%2F2006%2F12%2F72276%3B&sa=D&sntz=1&usg=AFQjCNFERWiSVAOTIPn_rE1oOxEG4BvDAg) retrieved 20 Jun 2011]

NASA plans to have a permanent moon base by 2024, but America is not the only nation with plans for a moon base. China, India, the European Space Agency, and at least one Russian corporation, Energia, have visions of building manned lunar bases post-2020.

Mining the moon for helium-3 has been discussed widely in space circles and international space conferences. Both China and Russia have stated their nations' interest in helium-3.

"We will provide the most reliable report on helium-3 to mankind," Ouyang Ziyuan, the chief scientist of China's lunar program, told a Chinese newspaper. "Whoever first conquers the moon will benefit first."

**CHINA IS PLANNING TO EXPLORE THE MOON FOR HE-3 TO CREATE NUCLEAR POWER AND WEAPONS-Chan ‘08**

[Minnie; Do more to win space energy and arms races, lunar scientist says; South China Morning Post; 10 Sep 2008]

China should develop probes to explore the moon and the planets to help alleviate its energy crisis and advance its strategic military interests, the "father of the Chang'e lunar probe" said yesterday.

The chief scientist of the lunar probe project, Ouyang Ziyuan , said in a lecture in Hong Kong that setting up an observation station on the moon was an important objective because it could help China find sustainable energy resources.

He said scientists had so far found two important resources on the moon: solar energy and helium-3, both of which were sustainable and clean energies.

"We could set up a solar energy collection centre on the moon because half of it is constantly in the sun," Professor Ouyang said. "[And] scientists estimate that there are 10 million to 50 million tonnes of helium-3 on the moon but just 500kg on Earth."

Professor Ouyang said helium-3 would be an important energy source for nuclear weapons and power generation and that 10 tonnes would been enough to meet China's estimated total energy needs for 50 years.

**CHINA PLANS TO USE THE MOON AND HE-3 TO ESTABLISH MILITARY INDEPENDENCE-Chan ‘08**

[Minnie; Do more to win space energy and arms races, lunar scientist says; South China Morning Post; 10 Sep 2008]

"There is enough helium-3 on the moon for people on the Earth to use for tens of thousands of years," he said. "However, if the US or other countries explored the moon first, would they share the energy with China?"

He said the moon's energy resources were not owned by anyone and whoever explored it first would have the priority in exploiting it.

"Meanwhile, on today's battlefields, whoever has air supremacy will win the war. That's why the US won the first Gulf war," Professor Ouyang said.

"But in China, we are still using the global positioning system invented by the US forces ... How can we defeat our enemies if wars happen in the future?"

He said it would be possible to create an independent and innovative military monitoring system only when China set up an observation station on the moon.

**A NEW SPACE RACE IS ABOUT TO BEGIN TO ACQUIRE THE MOON’S RESOURCES-Hatch ‘10**

[Benjamin; Notes and Comments Editor; DIVIDING THE PIE IN THE SKY:THE NEED FOR A NEW LUNAR RESOURCES REGIME; Emory International Law Review; 2010]

While the notion of traveling to the Moon to secure a rare isotope, which may help an experimental,

untested, and dangerous energy source, may sound not only impractical but insane, states are currently discussing and planning for exploratory trips to the Moon to investigate mining Helium-3. The status of these programs will be briefly sketched below. n58 Suffice it to say that the pursuit of Helium-3 is no pipe dream. While going to the Moon to power the Earth may seem like a desperate measure, we certainly live in increasingly desperate times.

Regardless of whether the Moon is able to aid humanity in solving the impending energy crisis, the satellite will have further importance as states begin evaluating the feasibility of space colonization. While space colonization may seem like the stuff of pulp science fiction, states are actually considering attempting to build Moon bases and, in turn, populating Mars. n59 The International Space Station is a preliminary venture to determine the long-term effects of living outside the confines of the Earth. n60 Additionally, the Moon may be able to furnish valuable mineral ores not commonly found on the Earth. n61 As a result, a number of states are in the initial stages of planning on [\*237] visiting the Moon to reap its potential benefits. n62 For these reasons, a new space race is about to commence, which will lead not only to competition on the Earth but to a jockeying for power in space and on the Moon itself. As a result, the law of outer space, and particularly of the Moon, is more relevant now than at any time since the end of the Cold War.

COST DETAILS

**THE TOTAL ESTIMATED COST TO GET HE-3 MINING UNDERWAY IS $15 BILLION-Schmitt ‘04**

[Harrison; staff writer; Mining the Moon; Popular Mechanics; October 2004;<http://www.popularmechanics.com/science/air_space/1283056.html>; retrieved 27 Jun 2011]

The total estimated cost for fusion development, rocket development and starting lunar operations would be about $15 billion. The International Thermonuclear Reactor Project, with a current estimated cost of $10 billion for a proof-of-concept reactor, is just a small part of the necessary development of tritium-based fusion and does not include the problems of commercialization and waste disposal.

The second-generation approach to controlled fusion power involves combining deuterium and helium-3. This reaction produces a high-energy proton (positively charged hydrogen ion) and a helium-4 ion (alpha particle). The most important potential advantage of this fusion reaction for power production as well as other applications lies in its compatibility with the use of electrostatic fields to control fuel ions and the fusion protons. Protons, as positively charged particles, can be converted directly into electricity, through use of solid-state conversion materials as well as other techniques. Potential conversion efficiencies of 70 percent may be possible, as there is no need to convert proton energy to heat in order to drive turbine-powered generators. Fusion power plants operating on deuterium and helium-3 would offer lower capital and operating costs than their competitors due to less technical complexity, higher conversion efficiency, smaller size, the absence of radioactive fuel, no air or water pollution, and only low-level radioactive waste disposal requirements. Recent estimates suggest that about $6 billion in investment capital will be required to develop and construct the first helium-3 fusion power plant. Financial breakeven at today's wholesale electricity prices (5 cents per kilowatt-hour) would occur after five 1000-megawatt plants were on line, replacing old conventional plants or meeting new demand.

**HE-3 MINING PROJECT WOULD COST ABOUT $15 BILLION-Dillow ‘11**

[Clay; Former Apollo Astronaut and Senator Says Mining Helium on the Moon Could Solve The Global Energy Crisis; PopSci; 5 May 2011; <http://www.popsci.com/science/article/2011-05/former-apollo-astronaut-says-moon-mining-could-solve-global-energy-crisis>; retrieved 9 August 2011]

So how does Schmitt’s plan break down? We’ll need $5 billion for a helium-3 fusion demonstration plant, because as of right now no such thing exists. We’ll also need to invest $5 billion more in a heavy-lift rocket capable of launching regular moon missions, something akin to the Apollo-era Saturn V.

A moon base for mining the stuff would cost another $2.5 billion, and though Schmitt didn’t really specify in his recent presentation to a petroleum conference, the other $2.5 billion could easily be chalked up to operating costs in an endeavor of this magnitude.

But it could pay for itself while developing critical spaceflight technologies and enabling a mission to Mars. Schmitt says a two-square-kilometer swath of lunar surface mined to a depth of roughly 10 feet would yield about 220 pounds of helium-3. That’s enough to run a 1,000-megawatt reactor for a year, or $140 million in energy based on today’s coal prices. Scale that up to several reactors, and you’ve got a moneymaking operation.

SOLVENCY: US SHOULD LEAD INTERNATIONAL FRAMEWORK

**A US-LED INTERNATIONAL FRAMEWORK FOR MINING LUNAR HE-3 WILL LEAD TO SECURITY NECESSARY FOR PRIVATE INVESTMENT AND DEVELOPMENT-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

As indicated, there does not at present appear to be any legal barrier to the United States engaging in lunar mining, save for the very general limitations imposed by the Outer Space Treaty and broader international law. 113 Moreover, as a practical matter, no other nation is likely in the near future to be in a position to prevent the United States from establishing a lunar base and conducting activities on the Moon as it wishes. 114 Consequently, the United States could presumably proceed with an He-3-based fusion energy program on the assumption that it could mine and bring to Earth lunar He-3 without any need for seeking further international approval. Under this approach, the United States could develop an appropriate legal regime of its own, consistent with its own needs and principles, rather than having to reach compromises with other countries. There is precedent for unilateral U.S. action of this kind-the 1980 United States Deep Seabed Hard Mineral Resources Act,115 which, following U.S. rejection of the 1982 LOSC, continues to govern the commercial recovery of deep seabed minerals by U.S. companies. 116 Subsequent to its enactment, the United States concluded international agreements with several other states in 1982 and 1984 (Belgium, France, Germany, Italy, Japan, the Netherlands, and the United Kingdom) to resolve overlapping claims with respect to mining areas for polymetallic nodules of the deep seabed.

However, even if the United States could "go it alone" in this way, there are reasons why it may not wish to do so. First, neither the U.S. government nor U.S. private enterprise is likely to be willing to risk the very substantial investment and long-term effort necessarily involved in seeking to develop He-3-based fusion energy without some assurance that-assuming the very difficult technical and engineering obstacles to developing efficient fusion reactors and establishing permanent moon bases can be overcome-the requisite supply of lunar He-3 can continue to be obtained without encountering significant legal or political difficulties. Whatever may be the most legally persuasive interpretation of existing international law, other nations or people on Earth may challenge the unilateral appropriation of lunar resources by the United States, especially of a potentially uniquely valuable resource such as He-3. This, certainly, was the international experience in the 1960's when developing nations vigorously protested the prospect that a few technologically advanced countries and their private enterprises might alone appropriate what was at the time assumed to be the mineral riches of the deep seabed. That perception ultimately led to the enunciation of the "common heritage" doctrine, the convening of UNCLOS-3, and the adoption of part XI of the 1982 LOSC." Only a broadly accepted international agreement is likely to offer the continued legal and political predictability that is essential if a long-term He-3-based fusion energy program is to be undertaken and sustained.

**FAILURE TO NEGOTIATE INTERNATIONAL AGREEMENT AND STANDARDS ON HE-3 WILL PREVENT PUBLIC AND PRIVATE INVESTMENT IN HE-3 MINING-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

The need for affordable, safe, and non-polluting energy to serve the Earth's growing population is increasingly evident and urgent. The development of lunar He-3-based fusion energy,

while still uncertain of achievement, offers humanity a credible prospect of meeting that need for centuries to come. Thus, it is not surprising that the United States and other nations

proposing the eventual establishment of lunar bases have expressed interest in the possible mining and exploitation of lunar He-3.

However, neither nations nor private commercial enterprises are likely to be willing to commit resources to an He-3-based fusion energy program absent a stable and predictable legal regime governing lunar resources that provides reasonable assurance that any such effort and investment will be rewarded and can be carried on without controversy or disruption. Yet, at

present, international space law fails to establish any detailed rules governing the mining, ownership, and exploitation of He-3 and other lunar resources or to provide such assurance.

Consequently, if the United States seriously contemplates the possible development of He-3-based fusion energy, it is in its national interest to take steps to establish what it would consider as an acceptable and agreed-upon international lunar resource regime-and to do so relatively soon.

**IF THE US IS SERIOUS ABOUT LUNAR HE-3 MINING, IT MUST PURSUE INTERNATIONAL AGREEMENT-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

Finally, if countries other than the United States also engage in activities on the Moon, as now appears highly likely, it will be in the interest of each of them to have at least some

understandings to provide for cooperation on common problems and keep them from interfering with each other's activities. As the Moon Agreement anticipates,12 4 if some kind of lunar

agreement is in their common interests, it will be difficult for such an agreement to not address the salient and thus far unresolved issue of lunar resources exploitation. Consequently, if the United States determines that it is serious about seeking to develop an He-3-based fusion energy program, it would seem sensible for it to also seek international agreement on a lunar resource regime designed to provide the long-term legal and political stability that such a program will most likely require.

**THE US SHOULD BEGIN THE PROCESS OF DEVELOPING AN INTERNATIONAL FRAMEWORK ON HE-3 IMMEDIATELY-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

There are, however, several reasons suggesting that the U.S. should seek to reach international agreement on such a regime quite soon and even before the possibility and practicality of a

permanent moon base and an He-3-based fusion power program are clearly established. First, as discussed, states and enterprises are unlikely to be willing to undertake the substantial effort and investment involved in developing lunar He-3 mining and He-3-based fusion power without the assurance of political and legal stability that only a broadly accepted international agreement can provide. 127 Given the long lead time which will be required if the United States wishes to achieve a viable He-3-based fusion power program in the relatively near future-perhaps within the next half-century or so-it seems sensible for it to begin to take steps to put the necessary legal infrastructure in place fairly soon.

**NOW IS THE TIME FOR THE US TO DEVELOP AN INTERNATIONAL AGREEMENT ON HE-3-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

Third, for a variety of reasons, the current influence and "bargaining power" of the United States both as a leader in space and nuclear technology, and more generally as an actor on the

world stage, is arguably declining relative to that of China, the European Union, India, Russia, and other countries.13 5 If this is so, the ability of the United States to negotiate the kind of lunar

resource regime it wants may well be greater now than later.

**THE LACK OF INTERNATIONAL CONSENSUS ON LUNAR MINING COULD LEAD TO CONFLICT AND SLOW DEVELOPMENT-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

However, the growing interest in lunar He-3 poses its own problems. As yet, there is no international consensus on whether, or how, any nation or private entity can exploit or acquire title to lunar resources. The U.N.-developed 1967 Outer Space Treaty7 does not specifically address this question. The related U.N.- sponsored 1979 Moon Agreement8 purports to lay the

groundwork for the eventual establishment of a regime for the exploitation of lunar resources, but that agreement has thus far been ratified by only a very few countries-not including the

United States and none of which are currently leading space powers.9 Absent an agreed international legal framework, attempts by the United States or any other nation or private entity to acquire and bring to Earth significant quantities of He-3 could give rise to controversy and conflict. Indeed, without the security of an established legal regime, nations or private entities might well be reluctant to commit the very substantial money, effort, and resources necessary to mine, process, and transport back to Earth the amounts of lunar He-3 sufficient to support the broad-scale terrestrial use of He-3-based fusion energy.

SOLVENCY: FUSION WILL WORK

**ACCESSING HE-3 WILL INCREASE FUSION RESEARCH-Hedman ‘06**

[Eric; A Fascinating Hour with Gerald Kulcinski; The Space Review; 16 Jan 2006; <http://www.thespacereview.com/article/536/1;> retrieved 20 Jun 2011]

Professor Kulcinski said that at the current state of funding, the university fusion reactor is only able to prove the theoretical concepts behind the reactor. At current levels of funding it would never reach commercial viability in his lifetime. He said the Department of Energy (DOE) views the payback as too far out to fund it now. His current funding comes from two individuals that are only interested in the research and no personal payback. Part of the problem, he believes, is a lack of trust between NASA and the DOE. DOE doesn’t trust NASA to get access to helium-3 in a reasonable amount of time. NASA doesn’t trust DOE to fund and get a helium-3 reactor working if they commit the resources to get the helium-3. Hopefully access to the helium-3 will come as a byproduct of returning to the Moon, and as the DOE sees the return to the Moon advancing, they will be willing to put more money into helium-3 fusion research.

**HE-3 FUSION WILL BE CHALLENGING, BUT CAN LEAD TO DIRECT ELECTRICITY GENERATION-Williams ‘07**

[Mark; staff writer; Mining the Moon; Technology Review; 23 Aug 2007;<http://www.technologyreview.com/Energy/19296/?a=f>; retrieved 27 Jun 2011]

"He3-He3 is not an easy reaction to promote," Kulcinski says. "But He3-He3 fusion has the greatest potential." That's because helium-3, unlike tritium, is nonradioactive, which, first, means that Kulcinski's reactor doesn't need the massive containment vessel that deuterium-tritium fusion requires. Second, the protons it produces--unlike the neutrons produced by deuterium-tritium reactions--possess charges and can be contained using electric and magnetic fields, which in turn results in direct electricity generation. Kulcinski says that one of his graduate assistants at the Fusion Technology Institute is working on a solid-state device to capture the protons and convert their energy directly into electricity.

**HE-3 IS MUCH CLEANER THAN OTHER NUCLEAR FUELS-Schriber ‘08**

[Michael; How moon rocks could power the future; MSNBC; 13 Aug 2008;<http://www.msnbc.msn.com/id/26179944/>; retrieved 27 Jun 2011]

The moon is once again a popular destination, as several space-faring nations are talking about setting up bases there. One reason would be to mine fuel for future fusion reactors.

The fuel in this case is helium-3, a lighter isotope of the helium used in balloons. In high energy collisions, helium-3 fuses with other nuclei to release more energy and less waste than the reactions in traditional nuclear reactors.

"If we can show that we can burn helium-3, it is a much cleaner and safer energy source than other nuclear fuels," said Gerald Kulcinski, director of the Fusion Technology Institute at the University of Wisconsin at Madison.

**HE-3 IS MORE EFFICIENT AND CLEANER THAN OTHER FUELS FOR FUSION-Schriber ‘08**

[Michael; How moon rocks could power the future; MSNBC; 13 Aug 2008;<http://www.msnbc.msn.com/id/26179944/>; retrieved 27 Jun 2011]

Another problem is the highly energetic neutrons emitted from the deuterium-tritium reaction. These neutrons slam into the reactor walls and cause structural damage. It is expected that the walls in ITER will have to be replaced every one to two years, Kulcinski said.

This is why Kulcinski and others advocate trading the tritium with non-radioactive helium-3.

"The advantage is that it makes very few neutrons," said Rich Nebel of Emc2 Fusion, a company based in Santa Fe, N.M. "This reduces radiation issues and also greatly simplifies the engineering."

Furthermore, the reaction products of helium-3 fusion are charged, so their energy can be directly converted into electricity without having to go through the inefficient step of boiling water to make steam.

**FUSION REACTORS WILL BE READY TO USE HE-3 IN A DECADE-Economic Times ‘08**

[With He-3 on mind, India gets ready for lunar mission, Economic Times of India; 19 Sep 2008; <http://articles.economictimes.indiatimes.com/2008-09-19/news/27717546_1_chandrayaan-ii-lunar-surface-moon-impact-probe;> retrieved 28 Jun 2011]

"Probably 10 years from now fusion reactors which can use He-3 will be available. Our second mission to the moon, Chandrayaan-II, will also have a lunar lander and help us collect samples of the mineral. The government has given clearance for Chandrayaan-II and we will start the mission as soon as Chandrayaan-I is completed," Chandrayaan project chief Mylswamy Annadurai said. Programme director (satellite navigation)Surendra Pal said a couple of tonnes of He-3 would be enough to meet the energy needs of the world.

"In the next 40 years, it will be possible to transport it to the earth," he said. Besides He-3, India's first moon mission will also search for important minerals like titanium, uranium- 238 and possibility water. "Chandrayaan will look for large craters which have never been exposed to sun light. They are potential sites for frozen water, which is great subject of interest for humans," the head of ISRO's astronomy and instrumentation division Sree Kumar said.

**WE MUST ACCELERATE THE DEVELOPMENT OF ALTERNATIVE TECH TO GET HE-3-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; AAAS; 23 April 2010; [http://www.aaas.org/news/releases/2010/0423helium3.shtml;](http://www.google.com/url?q=http%3A%2F%2Fwww.aaas.org%2Fnews%2Freleases%2F2010%2F0423helium3.shtml%3B&sa=D&sntz=1&usg=AFQjCNG0_C3Fp_-P1itTXZsht1yz9bJVuQ) retrieved 20 Jun 2011]

Helium-3 users have tried some obvious approaches to managing the supply, he said. The users have been notified of the diminished supply and asked to limit their use of the isotope. They’re considering a more random approach to positioning neutron detectors and trying to make the existing detectors more efficient. And some are working to recycle the gas.

“But the main response is to accelerate the development and deployment of alternative technologies, especially for portal detectors which are the largest users to helium-3,” Fetter said.

SOLVENCY: THERE IS A HUGE ADVANTAGE TO BEING FIRST

**CONFLICT OVER HE-3 ON THE MOON IS INEVITABLE; THERE WILL BE A TREMENDOUS ECONOMIC ADVANTAGE FOR THE STATE THAT FIRST ACQUIRES IT-Hatch ‘10**

[Benjamin; Notes and Comments Editor; DIVIDING THE PIE IN THE SKY:THE NEED FOR A NEW LUNAR RESOURCES REGIME; Emory International Law Review; 2010]

The historical conflicts over imperialist regimes and colonialism tend to suggest that when powerful states have an interest in amassing something that exists in large, previously unowned quantities in one location, they will inevitably come into conflict with one another. States have a limited economic interest in the Antarctic, and so they are unlikely to invest military assets and the necessary financing to vindicate or broaden their claim to something that is not generating them any wealth. In contrast, states seem to believe that they have potentially great economic interests in the Moon and, accordingly may have a correspondingly large motivation to have conflicts over it.^" Exploration of the Moon will benefit humanity—on Earth, new technologies will be have to be developed to aid states in the new space race— and on the Moon, providing new opportunities for human growth and expansion.Whatever name a regime wants to give to the Moon—*res nullius*  or *res communes*—the Moon represents an unparalleled opportunity. Imagine a situation where one state was able to not only find large quantities of Helium-3 or some other valuable resource on the Moon but also succeeded in denying access to other states. That state would enjoy a tremendous economic advantage by cornering the market in some ultra-rare, useful commodity. Resources by their nature breed conflict. As demonstrated above, states will soon be converging on the Moon to reap the benefits that it may provide. Given the recent actions by the United States and China, and the spirit of conquest and competition that seems to be informing the current Moon rush, the vague and generic OST will not be able to sufficiently stop state conflict over the greatest economic opportunity in history.

**OTHER NATIONS ARE PRIORITIZING BEING FIRST TO THE MOON TO MINE HE-3-Nguyen ‘11**

[Tuan C.; China to launch lunar rover, mine moon for nuclear fuel; SmartPlanet; 10 May 2011; <http://www.smartplanet.com/blog/thinking-tech/china-to-launch-lunar-rover-mine-moon-for-nuclear-fuel/7158>; retrieved 9 August 2011]

A top Chinese official has confirmed that the world’s most populous nation plans to send robots to the moon.

Ziyuan Ouyang, chief scientist of the Chinese lunar exploration program, made the announcement at the IEEE International Conference on Robotics and Automation (ICRA), held in Shanghai. The missions, scheduled for launch in 2013 and 2017, will serve as a tune up for a more challenging goal: putting a man on the moon by 2025.

“But why?” you ask. Well, beyond obvious bragging rights, the China National Space Administration’s ambitious foray into lunar exploration is part of a grander scheme to exploit the moon’s vast iron reserves and its abundance of Helium-3, a rare but heavily sought-after fuel for nuclear fusion plants.

This elaborate operation to mine the moon for these coveted natural resources was set in motion back in 2007 when the agency launched into space its first lunar orbiter Chang’e-1 (named after the moon goddess of Chinese folklore) to scan the landscape and produce a detailed 3-D map of the moon’s surface. This was followed in 2010 by the successful launch of another probe, Chang’e-2, which was equipped with a higher-resolution camera and orbited at an even closer distance of 100 kilometers. The data is being used to pinpoint an ideal landing spot for a rover.

SOLVENCY: MINING IS FEASIBLE

**RUSSIAN SCIENTISTS ARE OPTIMISTIC THAT THEY CAN EXTRACT LUNAR HE-3 BY 2020-Oberg ‘06**

[James; Moonscam: Russians try to sell the moon for foreign cash; The Space Review; 06 Feb 2006; [http://www.thespacereview.com/article/551/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F551%2F1%3B&sa=D&sntz=1&usg=AFQjCNFzN1OlUBiT7bKD8COoMUdpaJ8UQQ) retrieved 20 Jun 2011]

Sevastianov, the recently-appointed head of the Energia Rocket and Space Corporation (the firm that builds and operates all of Russia’s human space vehicles), claimed that one ton of helium-3 could produce as much energy as 14 million tons of oil. “Ten tons of helium-3 would be enough to meet the yearly energy needs of Russia,” he added. “There are practically no reserves of helium on the Earth. On the Moon, there are between 1 million and 500 million tons, according to various estimates,” he said, enough for the entire planet’s energy needs for a thousand years.

“We are optimistic about a complex for transportation which can be created by 2015, and a complex for extracting helium-3 on the Moon can be built by 2020,” Sevastianov told “Russia TV” reporter Aleksandr Rogatkin in a program aired January 29.

**RUSSIA HAS ANNOUNCED PLANS TO MINE HE-3 BY 2020-Williams ‘07**

[Mark; staff writer; Mining the Moon; Technology Review; 23 Aug 2007;<http://www.technologyreview.com/Energy/19296/?a=f>; retrieved 27 Jun 2011]

Even more surprising is that one reason for much of the interest appears to be plans to mine helium-3--purportedly an ideal fuel for fusion reactors but almost unavailable on Earth--from the moon's surface. NASA's Vision for Space Exploration has U.S. astronauts scheduled to be back on the moon in 2020 and permanently staffing a base there by 2024. While the U.S. space agency has neither announced nor denied any desire to mine helium-3, it has nevertheless placed advocates of mining He3 in influential positions. For its part, Russia claims that the aim of any lunar program of its own--for what it's worth, the rocket corporation Energia recently started blustering, Soviet-style, that it will build a permanent moon base by 2015-2020--will be extracting He3.

**ROBOTIC EXCAVATIONS COULD HELP MEET EARTH ENERGY NEEDS IN 10-15 YEARS-The Hindu ‘10**

[Helium-3 from the Moon in Ten Years; The Hindu; 03 Dec 2010]

The precious nuclear fuel could solve our energy problems It may not be long before Helium-3, a much-sought after nuclear fuel, is brought to Earth from the moon, believes the former chairman of the [Indian Space Research](http://global.factiva.com.weblib.lib.umt.edu:8080/ha/default.aspx) Organisation (ISRO), G. Madhavan Nair.

In 10 to 15 years “robotic excavations” of the moon for the isotope could help meet Earth's energy requirements, said Mr. Nair in his keynote address at a conference on ‘Cosmologies' on Thursday.

While Helium-3 is rare on Earth, it is believed to be fairly abundant on the moon, trapped in the mineral Titanite. The mineral was an “indirect finding” by the Moon Mineralogy Mapper and the Hyperspectral Imager on board Chandrayaan-1, said Mr. Nair.

A/T: OTHER MATERIALS

**THERE IS NO DROP-IN TECHNOLOGY REPLACEMENT FOR HE-3-Dixon ‘10**

[Darius; Helium-3 Shortage Could Mean Nuke Detection ‘Disaster’; Wired; 29 April 2010; [http://www.wired.com/dangerroom/2010/04/helium-3-shortage-could-mean-nuke-detection-disaster/;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fdangerroom%2F2010%2F04%2Fhelium-3-shortage-could-mean-nuke-detection-disaster%2F%3B&sa=D&sntz=1&usg=AFQjCNE94a3FVct9SQMoUta_tr2vyQs4Gg) retrieved 20 Jun 2011]

So far, the alternatives to helium-3 have been hard to come by. The Domestic Nuclear Detection Office of DHS is studying boron trifluoride as a cost-effective replacement for helium-3, but the gas is classified as a hazardous material. Other projects under consideration include lithium-loaded glass fibers and complex material like, cesium-lithium-yttrium-chloride, called “click.” However, none has been commercialized or rigorously tested.

“Up to six different neutron-detection technologies may be required to replace helium-3 detectors,” for its four main uses, said Anderson. “[A] drop-in replacement technology for helium-3 does not exist today.”

**MOST INDUSTRIES USING HE-3 HAVE NO ALTERNATIVE AND MORE AND MORE APPLICATIONS ARE BEING DEVELOPED FOR THE TECHNOLOGY-McElroy ‘10**

[Molly; AAAS Workshop Explores How to Meet Demand for Helium-3 in Medicine, Industry, and Security; Advancing Science, Serving Society; 23 April 2010; <http://www.aaas.org/news/releases/2010/0423helium3.shtml>; retrieved 9 August 2010]

Are there alternatives to helium-3 use in medicine? John Pantaleo, Isotope Program Director in the Office of Nuclear Physics at the U.S. Department of Energy, described some of the alternatives. The isotope xenon-129 could be used instead of helium-3, but xenon-129 does not produce as clear images as does helium-3. And, John Pantaleo said, xenon-129 has a sedative effect on patients and may not usable in children. He also said that inhaled helium-3 might be recaptured as the patients exhale it and then recycled for other uses.

Across all helilum-3 uses, AAAS workshop participants said that they could be more efficient at recovering existing and unused systems containing helium-3. Some industries, such as neutron detection systems for national security, have already made strides in developing alternatives that could be put into use soon while other industries have some ideas for alternatives.

“While the demand for helium-3 from the post-9/11 homeland security sector is pretty large, we’ve seen dramatic growth in the uses of helium-3 in several different industries,” said Tannenbaum, the workshop organizer. “It’s unfortunate that all of these demands came online at about the same time, and all well after we stopped making the tritium that decays to helium-3.

**ALTERNATIVES ARE IN EARLY STAGES OF RESEARCH-Subcommittee on Investigations and Oversight ‘10**

[Caught by Surprise: Causes and Consequences of the Helium-3 Supply Crisis; 22 April 2010; <http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg57170/html/CHRG-111hhrg57170.htm>; retrieved 9 August 2011]

For neutron scattering facilities that require tremendous amounts of Helium-3 gas, the situation is very grim. At least 15 of these multi-billion dollar research facilities are being or have been built in at least eight countries, including the U.S., United Kingdom, France, Germany, Switzerland, Japan, South Korea and China. By 2015, these facilities will require over 100,000 liters of He-3 gas, according to estimates provided to the Subcommittee. Most of those needs are unlikely to be met. There have been several international meetings of scientists discussing possible alternatives to He-3 for spallation neutron detection, but the research is in the very early stages.

A/T: HELIUM-3 WILL BE TOO EXPENSIVE

**HE-3 WOULD HAVE SIGNIFICANT VALUE, $4 BILLION/TON-Wakefield ‘00**

[Julie; staff writer; Researchers and space enthusiasts see helium-3 as the perfect fuel source; Space.com; 30 June 2000;<http://www.space.com/scienceastronomy/helium3_000630.html>; retrieved 01 Dec 2008]

Scientists estimate there are about 1 million tons of helium 3 on the moon, enough to power the world for thousands of years. The equivalent of a single space shuttle load or roughly 25 tons could supply the entire United States' energy needs for a year, according to Apollo17 astronaut and FTI researcher Harrison Schmitt.

When the solar wind, the rapid stream of charged particles emitted by the sun, strikes the moon, helium 3 is deposited in the powdery soil. Over billions of years that adds up. Meteorite bombardment disperses the particles throughout the top several meters of the lunar surface.

"Helium 3 could be the cash crop for the moon," said Kulcinski, a longtime advocate and leading pioneer in the field, who envisions the moon becoming "the Hudson Bay Store of Earth."Today helium 3 would have a cash value of $4 billion a ton in terms of its energy equivalent in oil, he estimates. "When the moon becomes an independent country, it will have something to trade."

**HE-3 MINING COULD PAY FOR ITSELF WHILE SIMULTANEOUSLY DEVELOPING CRITICAL SPACEFLIGHT TECHNOLOGIES-Dillow ‘11**

[Clay; staff writer; Former Apollo Astronaut and Senator Says Mining Helium on the Moon Could Solve The Global Energy Crisis; Popular Science; 05 May 2011; <http://www.popsci.com/science/article/2011-05/former-apollo-astronaut-says-moon-mining-could-solve-global-energy-crisis;> retrieved 28 Jun 2011]

But it could pay for itself while developing critical spaceflight technologies and enabling a mission to Mars. Schmitt says a two-square-kilometer swath of lunar surface mined to a depth of roughly 10 feet would yield about 220 pounds of helium-3. That’s enough to run a 1,000-megawatt reactor for a year, or $140 million in energy based on today’s coal prices. Scale that up to several reactors, and you’ve got a moneymaking operation.

Why go to all this trouble? Helium-3 is abundant on the moon and produces little to no radioactive waste that must be cleaned up and stored. The reaction necessary would burn at a much hotter temperature than other fusion reactions, but the chance of environmental disaster via radioactive spill is virtually nil. Plus we would establish a permanent presence on the moon.

Throw in another $5 billion, and we might even be able to populate said moon base with a clone work force and some soothing, Kevin Spacey-esque AI.

A/T: MOON TREATY/OUTER SPACE TREATY

**THE MOON TREATY SHOULD NOT BE AN OBSTACLE TO AMERICAN HE-3 DEVELOPMENT-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

What, then, is the effect of the Moon Agreement on the law applicable to the exploitation of lunar resources and, in particular, the mining and exploitation of He-3? As indicated, the

agreement is not in itself legally binding on the United States, nor indeed on other major space powers, or most other states, since they are not parties.99 Arguably, the agreement should be

given little weight as evidence of developing customary law, since, in contrast to other "space law" agreements that have achieved widespread ratification, the Moon Agreement has, over a

considerable period, gained few adherents, none of which are significant space powers.

**NEITHER THE OUTER SPACE TREATY NOR THE MOON PROHIBIT LUNAR MINING, BUT SERIOUS LEGAL CHALLENGES WILL OCCUR-Bilder ‘09**

[Richard; Law Professor @ University of Wisconsin; A Legal Regime for the Mining of Helium-3 on the Moon: U.S. Policy Options; Fordham International Law Journal; Volume 33, Issue 2; 2009]

In sum, while the Outer Space Treaty, perhaps as supplemented by the Moon Agreement, establishes a useful framework for many prospective activities on the Moon and

clearly prohibits staking exclusive national or private claims to particular areas of the lunar surface, neither the treaty nor the agreement appears to preclude the mining and acquisition of

property rights in lunar He-3 by national, international, or private enterprises, subject to certain broad "common heritage" obligations, such as the obligation to share to some unclear extent the benefits or proceeds of such activities. However, whatever the merits of this conclusion, it will clearly remain open to at least vigorous political as well as legal challenges particularly

by developing or other states currently unable to participate in lunar mining or other activities.

Moreover, the Outer Space Treaty and Moon Agreement, and international law more generally, leave many other significant questions concerning the potential exploitation of He-3 or other lunar

resources unresolved. Consequently, if the United States or other space powers that intend to establish stations on the Moon plan to proceed with mining lunar He-3 in connection with their

potential development of an He-3-based fusion power program, they will be doing so under conditions of substantial legal and political-not to mention technological and economic uncertainty. The question, then, is whether the United States should do something to remedy this situation and, if so, what?

Mars Direct Affirmative

**CONTENTION 1. THE US SPACE PROGRAM IS STUCK IN STAGNATION**

**A. NASA IS AIMLESS WITHOUT A LOFTY GOAL TO ACHIEVE-Grierson '04**

[Bruce; BEYOND NASA: DAWN OF THE NEXT SPACE AGE; Popular Science; April 2004; page 68]

The people at Tumlinson's meeting yearned for the era when NASA set lofty goals such as the Apollo missions and beat the deadline to achieve them, when PanAm was taking bookings for space-liner trips to the Moon. To the people in this room, NASA had come to stand for No Americans in Space at All. It was time for a change. And regardless of what kind of rhetoric happened to be emanating from Washington, the solution, all agreed, was to take matters into their own hands.

DISCONTENT HAS LONG CRACKLED ON THE FRINGES OF NASA. Some enthusiasts view the predicament of terrestrial life as a little like what the writer Nick Hornby has said Bruce Springsteen's songs are all about: You can stay and rot, or you can escape and burn. What you can't do is stand still. Self-destruction--by bioterrorism, nuclear holocaust, ozone depletion--looms, many believe, as an alternative to the natural event--asteroid collision, ice age--that will eventually do us in. (In his latest book, British cosmologist Martin Rees, a Cassandra with unsettlingly sterling credentials, puts our chances of making it through another century at fifty-fifty.) Bet-hedgers call for "species redundancy": creating human outposts in space so that we will survive even if Earth doesn't. "What does it cost to have an insurance policy?" asks Elon Musk, head of the orbital launch company SpaceX. "If it's percent of our annual economy, isn't that money well spent?"

**B. NASA IS STUCK IN SHUTTLE MODE, LEAVING IT STAGNANT AND INEFFECTIVE-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

Over the course of its history, NASA has employed two distinct modes of operation. The first, prevailed during the period from 1961 to 1973, and may therefore be called the Apollo Mode. The second, prevailing since 1974, may usefully be called the Shuttle Era Mode, or Shuttle Mode, for short.

In the Apollo Mode, business is conducted as follows. First, a destination for human spaceflight is chosen. Then a plan is developed to achieve this objective. Following this, technologies and designs are developed to implement that plan. These designs are then built, after which the mission is flown.

The Shuttle Mode operates entirely differently. In this mode, technologies and hardware elements are developed in accord with the wishes of various technical communities. These projects are then justified by arguments that they might prove useful at some time in the future when grand flight projects are initiated.

Contrasting these two approaches, we see that the Apollo Mode is destination driven, while the Shuttle Mode pretends to be technology driven, but is actually constituency driven. In the Apollo Mode, technology development is done for mission directed reasons. In the Shuttle Mode, projects are undertaken on behalf of various internal and external technical community pressure groups and then defended using rationales. In the Apollo Mode, the space agency's efforts are focused and directed. In the Shuttle Mode, NASA's efforts are random and entropic.

**CONTENTION II. US SPACE PROGRAM’S MINDSET PREVENTS A REALISTIC MARS PROJECT FROM COMING TO FRUITION.**

**A. LONG TERM PLANNERS AT NASA BELIEVE IN THE INCREMENTAL APPROACH FOR FAR-AWAY DESTINATIONS LIKE MARS-Morring '02**

[Frank, Jr.; Mars Is The Destination; Aviation Week & Space Technology; 16 December 2002; page 59]

Space exploration is not really O'Keefe's gig. He was hired to get spending on the International Space Station under control, and he readily admits that his main goal is getting to Feb. 19, 2004, without a major catastrophe. “That's the day that Node 2 is going to be launched and deployed to the International Space Station,” he says. “If we don't reach Node 2, core configuration, you can forget about any excursion after that.”

BUT THE MEN AND WOMEN who put together the NEXT strategy are in the space business for the long haul. They'll be around long after Sean O'Keefe has gone on to the reward he has no doubt been promised if he succeeds with the station. They want to go to Mars, and they seem to have hit on a practical way to get there. The details of their approach are certainly open to debate, but the overall strategy looks like it could work.

**B. NASA PLANS HAVE NO DIRECT MARS COMPONENT AND SEE MARS AS A GOAL AFTER SEVERAL INCREMENTAL STEPS-Morring '02**

[Frank, Jr.; Mars Is The Destination; Aviation Week & Space Technology; 16 December 2002; page 59]

Space buffs and Mars-direct boosters have been understandably dismayed at the latest exploration scheme to emanate from the ninth floor of NASA headquarters—understandably but unnecessarily.

The NASA Exploration Team (NEXT, in the inevitable acronym) has come up with a plan to buy exploration “by the yard,” starting at the libration point between the Earth and the Moon and gradually moving outward. No bold excursions to Mars or a return to the moon for the NEXT bunch. NASA management wants a step-by-step approach that will allow humankind to expand its reach incrementally, unlimited by a single destination.

**C. CURRENT NASA-DEVELOPED SOLUTIONS TO MARS ARE HEAVY AND REQUIRE SUBSTANTIAL THRUST THAT IS NOT POSSIBLE WITH CURRENT TECHNOLOGIES-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

Apollo-style landings entirely on thrusters are problematic, too. Decelerating from Mars orbit and landing using rockets would require a huge amount of propellent. Also, firing rockets in the martian atmosphere at hypersonic speed can create aerodynamic drag and instability that are hard to predict.

EDL experts at NASA and in the aerospace research community have brainstormed new options for the descent stage of a human landing on Mars. A leading contender is called the supersonic inflatable aerodynamic decelerator, or SIAD. Imagine a giant airbag in the shape of a badminton shuttlecock, and you get the general idea.

Aerospace engineer Robert Braun and his students at the Georgia Institute of Technology in Atlanta have worked out scenarios for landing heavy payloads with SIAD technology. They have developed detailed plans for how to land 20 metric tons of cargo mass -- about 8.3 tons of weight in martian gravity -- with an inflatable decelerator and thrusters.

The decelerators are still pretty big -- up to 160 feet (50m) across -- but the basic engineering is plausible. The inflatable slows the craft to about 450 mph (720 km/h), a speed at which it's possible to use rocket thrusters to maneuver the payload to the final landing site and decelerate to a soft landing.

The landed payload masses cited in the original NASA DRM were as much as 65 metric tons. Braun remains skeptical that such a landing is possible with any method he can currently imagine. "To land 65 metric tons -- 100 times what we have accomplished with robotic landers -- is a very large stretch," he says.

Braun would reduce each payload. "You'd be better off landing payloads of 15 metric tons," he says. That would reduce the size of the SIAD and make other EDL options more feasible.

**D. CURRENT NASA PLANS FOR MARS WOULD REQUIRE DECADES OF PREP AND FUNDING-Petit '03**

[Charles; DREAMING OF MARS; US News and World Report; 1 September 2003; page 40]

Right now, NASA is focused on getting its remaining three shuttles back flying and finishing the international space station, originally intended to be a steppingstone to interplanetary exploration. Even before the shuttle crisis, budget overruns limited the station to a crew of three, half the planned number; now the half-finished station hosts a skeleton crew of two. The crunch, says Sandra Graham of the National Research Council's Space Studies Board, "is ominous for the utility of the station for science," including space medicine studies needed to plan trips to Mars.

"We have a lot of work to do," says John Mankins, NASA's assistant associate administrator for advanced systems. He estimates that it will take until 2020 to do the basic medical and engineering studies. Another decade to design and build the ships for a Mars trip pushes launch dates toward 2030--assuming the political will materializes, along with tens if not hundreds of billions of dollars in funding.

**CONTENTION III. DUE TO THE PERVASIVE MINDSET AT NASA, A MARS MISSION HAS NO CHANCE IN THE CURRENT FRAMEWORK**

**A. NASA'S STOCK MARS PLANS ARE EXPENSIVE AND HUGE-Wilson '98**

[Jim; Bringing Life To Mars; Popular Mechanics; November 1998; page 30]

NASA, of course, has its own plans for a manned mission to the red planet. Developed nearly 10 years ago, it is detailed in a document known as the "90-Day Report." It estimates the Earth-to-Mars round-trip ticket will cost $450 billion. Building the necessary foot ball-field-long, nuclear-powered spacecraft will take 30 years. Zubrin drew a round of laughter and applause from his audience when he derided NASA's Mars ship as the "Death Star."

**B. TRADITIONAL MARS PROGRAMS ARE EXPENSIVE AND TIME CONSUMING FOR LITTLE REWARD-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

Travel to Mars will include three steps. First, lift yourself and your ship from the bottom of Earth's gravity well. Second, accelerate on a trajectory to Mars. Third, descend into Mars' gravity well and land safely on the surface. It's not as easy as it sounds.

Rocket propellant is the problem. You must have enough to get you off Earth, to Mars, and back. The propellant always significantly outweighs the payload. In fact, it's best to visualize any interplanetary spacecraft as a massive gas tank with a tiny payload stuck to the front of it. A journey to Mars traversing hundreds of millions of miles requires a tremendous fuel supply.

One way around this dilemma is adopting a "split-mission strategy." It divides the plan into multiple stages to make the whole enterprise more manageable. The strategy has its roots in a speech President George H. W. Bush delivered in 1989 on the steps of the National Air and Space Museum in Washington, D.C.

On July 20 of that year, the 20th anniversary of the Apollo 11 Moon landing, Bush announced his Space Exploration Initiative. It called for construction of the space station, returning to the Moon, and, someday, going to Mars.

NASA launched the "90-Day Study" to flesh out Bush's vision. The Mars portion emerged as an elaborate "all-up" mission architecture. Astronauts would assemble a single massive ship at the space station. Upon arrival at Mars, the ship would split into a return vehicle to eventually take the crew home and an "excursion vehicle" to land the crew on the surface and return to orbit at the end of the expedition. This first mission would entail only 30 days on the surface.

**C. COMPARATIVE SPENDING ARGUMENTS FOR MISSIONS TO MARS ARE FLAWED AS SPACE WILL NEVER MEET THE “LITTLE-GIRL-IN-A-WHEELCHAIR” TEST-Scoblic '04**

[Peter J.; Earth Diarist: Rational Exuberance; The New Republic; 2 February 2004; page 34]

It's impossible to know just how much a manned mission to Mars would cost, but it is certain to run into the hundreds of billions of dollars. And, since ours is a world of competing priorities, we must ask, even of a concept as lofty as transcendence, is it worth it? The biggest obstacle here is less finding the money--in just the last few years, such sums have been "found" for two wars, prescription drugs for seniors, and repeated upper-bracket tax cuts--than it is combating the idea that such sums would be better spent on Earth. Powerful as it is, that argument is flawed. There will always be domestic priorities that could take precedence. A recent Tom Toles cartoon in the Post, for instance, showed a little girl in a wheelchair asking, "They're spending how much so a man can walk on Mars?" But, even though few government programs can truly stand up to the little-girl-in-a- wheelchair test, that hardly means they're irresponsible. We spend $137 million per year for the National Endowment for the Humanities, $604 million on the Smithsonian Institution, and $1.6 billion for National Park operations. We spend this money on things other than health care, anti-poverty efforts, and education not because those are unimportant, but because the extension of life cannot be all that life is, the eradication of economic poverty must not impoverish us intellectually, and education must extend well outside the classroom. Why go to Mars now? Is there really a pressing need? That all depends on whether you think the purpose of government--indeed, of civilization--is simply to make sure we get through the day for as many days as possible, or whether it is time to reach for something a bit more ambitious.

**THUS, THE PLAN: The United States Federal Government will substantially increase its exploration of space beyond the Earth’s mesosphere by adopting the “Mars Direct” exploration framework for a mission to Mars.**

**CONTENTION IV. MARS DIRECT IS A COMPREHENSIVE PLAN FOR A REALISTIC MARS MISSION THAT DRAMATICALLY CHANGES THE WEIGHT AND TECHNOLOGY REQUIREMENTS. IT IS BEST DESCRIBED BY ITS CREATOR, DR. ROBERT ZUBRIN, AN AEROSPACE ENGINEER AND PRESIDENT OF THE MARS SOCIETY IN ‘09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

At an early launch opportunity, for example 2014, a single heavy lift booster with a capability equal to that of the Saturn V used during the Apollo program is launched off Cape Canaveral and uses its upper stage to throw a 40-tonne unmanned payload onto a trajectory to Mars. (Such a booster could be readily created by converting the Shuttle launch stack, deleting the Orbiter and replacing it with a payload fairing containing a hydrogen/oxygen rocket stage.) Arriving at Mars 8 months later, the spacecraft uses friction between its aeroshield and Mars’ atmosphere to brake itself into orbit around the planet, and then lands with the help of a parachute. This payload is the Earth Return Vehicle (ERV). It flies out to Mars with its two methane/oxygen driven rocket propulsion stages unfueled. It also carries six tonnes of liquid hydrogen cargo, a 100 kW nuclear reactor mounted in the back of a methane/oxygen driven light truck, a small set of compressors and automated chemical processing unit, and a few small scientific rovers.

As soon as the craft lands successfully, the truck is telerobotically driven a few hundred meters away from the site, and the reactor deployed to provide power to the compressors and chemical processing unit. The hydrogen brought from Earth can be quickly reacted with the Martian atmosphere, which is 95% carbon dioxide gas (CO2), to produce methane and water, thus eliminating the need for long-term storage of cryogenic hydrogen on the planet's surface. The methane so produced is liquefied and stored, while the water is electrolyzed to produce oxygen, which is stored, and hydrogen, which is recycled through the methanator. Ultimately, these two reactions (methanation and water electrolysis) produce 24 tonnes of methane and 48 tonnes of oxygen. Since this is not enough oxygen to burn the methane at its optimal mixture ratio, an additional 36 tonnes of oxygen is produced via direct dissociation of Martian CO2. The entire process takes 10 months, at the conclusion of which a total of 108 tonnes of methane/oxygen bipropellant will have been generated. This represents a leverage of 18:1 of Martian propellant produced compared to the hydrogen brought from Earth needed to create it. Ninety-six tonnes of the bipropellant will be used to fuel the ERV, while 12 tonnes are available to support the use of high powered, chemically fueled long range ground vehicles. Large additional stockpiles of oxygen can also be produced, both for breathing and for turning into water by combination with hydrogen brought from Earth. Since water is 89% oxygen (by weight), and since the larger part of most foodstuffs is water, this greatly reduces the amount of life support consumables that need to be hauled from Earth.

The propellant production having been successfully completed, in 2016 two more boosters lift off the Cape and throw their 40-tonne payloads towards Mars. One of the payloads is an unmanned fuel-factory/ERV just like the one launched in 2014, the other is a habitation module carrying a crew of four, a mixture of whole food and dehydrated provisions sufficient for 3 years, and a pressurized methane/oxygen powered ground rover. On the way out to Mars, artificial gravity can be provided to the crew by extending a tether between the habitat and the burnt out booster upper stage, and spinning the assembly.

Upon arrival, the manned craft drops the tether, aerobrakes, and lands at the 2014 landing site where a fully fueled ERV and fully characterized and beaconed landing site await it. With the help of such navigational aids, the crew should be able to land right on the spot; but if the landing is off course by tens or even hundreds of kilometers, the crew can still achieve the surface rendezvous by driving over in their rover. If they are off by thousands of kilometers, the second ERV provides a backup.

However, assuming the crew lands and rendezvous as planned at site number one, the second ERV will land several hundred kilometers away to start making propellant for the 2018 mission, which in turn will fly out with an additional ERV to open up Mars landing site number three. Thus, every other year two heavy lift boosters are launched, one to land a crew, and the other to prepare a site for the next mission, for an average launch rate of just one booster per year to pursue a continuing program of Mars exploration. Since in a normal year we can launch about six Shuttle stacks, this would only represent about 16% of the U.S. launch capability, and would clearly be affordable. In effect, this “live off the land” approach removes the manned Mars mission from the realm of mega-spacecraft fantasy and reduces it in practice as a task of comparable difficulty to that faced in launching the Apollo missions to the Moon (Fig. 1).

The crew will stay on the surface for 1.5 years, taking advantage of the mobility afforded by the high powered chemically driven ground vehicles to accomplish a great deal of surface exploration. With a 12 tonne surface fuel stockpile, they have the capability for over 24,000 km worth of traverse before they leave, giving them the kind of mobility necessary to conduct a serious search for evidence of past or present life on Mars—an investigation key to revealing whether life is a phenomenon unique to Earth or general throughout the universe. Since no-one has been left in orbit, the entire crew will have available to them the natural gravity and protection against cosmic rays and solar radiation afforded by the Martian environment, and thus there will not be the strong driver for a quick return to Earth that plagues alternative Mars mission plans based upon orbiting mother-ships with small landing parties. At the conclusion of their stay, the crew returns to Earth in a direct flight from the Martian surface in the ERV. As the series of missions progresses, a string of small bases is left behind on the Martian surface, opening up broad stretches of territory to human cognizance.

**CONTENTION V. MARS DIRECT IS THE BEST CHANCE THE UNITED STATES HAS TO EXPAND EXPLORATION AND MAKE MARS A REALITY**

**A. MARS SHOULD BE THE GOAL OF THE UNITED STATES SPACE PROGRAM-San Francisco Chronicle '08**

[Bull's-eye on Mars; San Francisco Chronicle; 30 May 2008; page B10]

A new set of cosmic goals is required for practical reasons, but also for the spirit of endeavour itself. Mr Bush is correct in saying ``the desire to explore and understand is part of our character.'' Mars should be the target, as the quest for life beyond Earth remains one of the great scientific grails. While other countries have had varying success with space missions, it is only the vibrant economic power of the US that will get us to another world. Without a Cold War race against the Russians, American presidents today face a greater challenge in winning public support for space than did Kennedy. George Bush Sr's $400 billion moon-Mars proposal died in Congress. Opinion polls show Americans ambivalent on the Bush proposal. One must hope that will change because sooner or later, as Mr Bush put it, ``human beings are headed into the cosmos''.

**B. MARS DIRECT RADICALLY SIMPLIFIES THE PLANNED MISSION TO MARS BY USING RESOURCES ON THE RED PLANET-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 152]

This is the spirit of “Mars Direct,” a new approach to Mars exploration that I introduced in 1990 while a senior engineer for the Martin Marietta Astronautics company, working as one of its leaders in development of advanced concepts for interplanetary missions. This plan employs no immense interplanetary spaceships, and thus requires neither orbiting space bases nor storage facilities. Instead, a crew and their habitat are sent directly to Mars by the upper stage of the same booster rocket that lifts them to Earth orbit, in just the same way as the Apollo missions and all unmanned interplanetary probes launched to date have flown. Flying the mission this way radically simplifies and scales down the required hardware, and eliminates the need for decades of development and hundreds of billions of dollars of expenditure on orbital assembly infrastructure. The key to this plan is the mission’s ability to use Mars-native resources to make its return propellant and much of its consumables on the surface of the planet itself.

**C. MARS DIRECT BATTLES THE STICKER SHOCK THAT WOULD OTHERWISE DOOM MARS TRAVEL-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

The price of Bush's initiative was estimated at $500 billion, and by 1990 his administration had all but abandoned it. But the episode did stimulate important progress. It spurred Zubrin, then working at Martin Marietta Astronautics, to develop the Mars Direct plan.

Zubrin was concerned that national "sticker shock" over Bush's proposed initiative would doom future human Mars exploration. He developed the Mars Direct concept with a colleague at Martin Marietta, David Baker. "It was apparent we needed a much quicker, cheaper plan, or there would be no program at all," Zubrin recalls.

**D. SIMPLIFIED MARS MISSIONS WOULD COST ONLY 40 BILLION DOLLARS-Salotti '11**

[Jean Marc; Professor of Computer Science, Ecole Nationale Supérieure de Cognitique, Institut Polytechnique de Bordeaux; Simplified scenario for manned Mars missions; Acta Astronautica; September-October 2011; page 266]

We propose a simplified but efficient scenario for a manned Mars mission. The idea is to select a crew of only 2 astronauts and to bring in situ resource utilization systems in the same vehicle. For security reasons, we suggest duplicating the mission as it was proposed by Von Braun. At very moment of the journey, the two vehicles would stay close so that each crew could provide help to the other. We show that this scenario is much simpler than the last design reference architecture proposed by NASA. The initial mass in low Earth orbit is minimized and the risks are also reduced. The total cost could be in the order of 40 billion dollars.

**ADVANTAGE: MARS EXPLORATION ALLOWS HUMANS TO UNLOCK THE SECRETS OF THE COSMOS**

**A. HUMAN EXPLORATION OF MARS WILL HAVE A PROFOUND IMPACT OF OUR UNDERSTANDING OF THE COSMOS-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

When NASA announced its discovery of possible microbe fossils last August, the agency termed the evidence compelling but not conclusive. Further investigations by the first human explorers could have a profound impact on our understanding of our place in the cosmos. Conclusive evidence of Martian life, present or fossilized, would strongly suggest that life abounds in the universe. On the other hand, if we find that Mars, despite its once clement climate, never produced any life, we would have to accept the possibility that life on earth is a fluke. We could be virtually alone in the universe.

The search for life will be intensive, and there are many different places to look. The planet's dry riverbeds and lake beds may have been the last redoubts of a retreating Martian biosphere, and thus might contain fossils. Water ice sheets covering the planet's north pole could hold well-preserved remains of actual organisms. Geologically heated ground water beneath the surface--if it exists--may yet harbor life. By studying the differences from, and similarities to, species that evolved on our own planet, we could begin to discern what is incidental to earth life and what is fundamental to the very nature of life itself. The results could lead to breakthroughs in medicine, genetic engineering, and all the biological and biochemical sciences.

**B. MARS IS THE BEST GOAL FOR THE SPACE PROGRAM BECAUSE IT OFFERS THE MOST PAYBACK FOR HUMANKIND-Zubrin '03**

[Robert; President of the Mars Society; Mission to Mars: The Red Planet beckons, says The Mars Society's ROBERT ZUBRIN. Now is no time for Canada to drop out of a project that may be humanity's greatest challenge; Globe & Mail; 23 August 2003; Page A19]

Calling for a humans-to-Mars program may seem strange in the wake of February's space shuttle calamity, but there is strong justification. The most tragic aspect of the Columbia accident is that seven fine people died performing a mission of no particular importance. Human spaceflight will always be dangerous. If we are to dare such perils, we should do so for goals that are worth the risk. Opening a new planet to humanity qualifies.

Why Mars? Because of all the planetary destinations currently within reach, Mars offers the most payback in terms of what it portends for the future of humankind.

Mars is the Rosetta Stone for helping us understand the position of life in the universe. Images of Mars taken from orbit show that the planet had liquid water flowing on its surface for a billion years during its early history -- a duration five times as long as it took life to appear on Earth after there was liquid water here.

**C. MARS MISSION IS CRITICAL TO UNITE HUMANITY AND PROVIDE RESOURCES THAT PREVENTS TYRANNY, WAR AND GENOCIDE- Zubrin ‘97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 5031]

The frontier drove the development of democracy in America by creating a self-reliant population that insisted on the right to self-government. It is doubtful that democracy can persist without such people. True, the trappings of democracy exist in abundance in America today, but meaningful public participation in the process is deeply wanting. Consider that no representative of a new political party has been elected president of the United States since 1860. Likewise, neighborhood political clubs and ward structures that once allowed citizen participation in party deliberations have vanished. And with a reelection rate of 95 percent, the U.S. Congress is hardly a barometer of people’s will. Furthermore, regardless of the will of Congress, the real laws, covering ever broader areas of economic and social life, are increasingly being made by a plethora of regulatory agencies whose officials do not even pretend to have been elected by anyone. Democracy in America and elsewhere in Western civilization needs a shot in the arm. That boost can only come from the example of a frontier people whose civilization incorporates the ethos that breathed the spirit into democracy in America in the first place. As Americans showed Europe in the last century, so in the next the Martians can show us the path away from oligarchy and stagnation. There are greater threats that a humanist society faces in a closed world than the return of oligarchy, and if the frontier remains closed, we are certain to face them in the twenty-first century. These threats are the spread of various sorts of anti-human ideologies and the development of political institutions that incorporate the notions that spring from them as a basis of operation. At the top of the list of such destructive ideas that tend to spread naturally in a closed society is the Malthus theory, which holds that since the world’s resources are more or less fixed, population growth and living standards must be restricted or all of us will descend into bottomless misery. Malthusianism is scientifically bankrupt—all predictions made upon it have been wrong, because human beings are not mere consumers of resources. Rather, we create resources by the development of new technologies that find use for them. The more people, the faster the rate of innovation. This is why (contrary to Malthus) as the world’s population has increased, the standard of living has increased, and at an accelerating rate. Nevertheless, in a closed society Malthusianism has the appearance of self-evident truth, and herein lies the danger. It is not enough to argue against Malthusianism in the abstract—such debates are not settled in academic journals. Unless people can see broad vistas of unused resources in front of them, the belief in limited resources tends to follow as a matter of course. And if the idea is accepted that the world’s resources are fixed, then each person is ultimately the enemy of every other person, and each race or nation is the enemy of every other race or nation. The extreme result is tyranny, war, and even genocide. Only in a universe of unlimited resources can all men be brothers.

HARMS: US SPACE PROGRAM IS IN STAGNATION

**NASA IS AIMLESS, PREVENTING A MARS MISSION-Kluger '00**

[Jeffrey; WILL WE LIVE ON MARS?; Time; 10 April 2000; page 60]

Even for a supposedly spacefaring people, dreaming of Mars is dreaming big. Back when Apollo astronauts were routinely bunny-hopping on the nearby moon, Mars seemed like an obvious next goal. But during the past 25 years, the best we've been able to muster has been a few unmanned Martian probes. After the two most recent ones famously flamed out, and after last week's scathing report blaming nasa mismanagement for the failures, even that seems beyond us.

**ALL ATTEMPTS TO MAKE NASA DESTINATION-DRIVEN ARE THWARTED BY EFFORTS FOR THE SHUTTLE AND ISS INSTEAD-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

NASA's attempt to become a destination-driven space agency is being placed on hold, and thus at severe risk, because the funds needed to get it up and running are being diverted to Shuttle and Station instead. This should not be. We need to admit that the ISS is a mistake, and that expenditures on it do not support reaching the goals that we have for the space program. Shuttle flights to ISS thus cannot be justified either. In reality, the only future Shuttle flight that can be honestly justified is that to upgrade and repair the Hubble Space Telescope, because that stands on its own merits as a program of world-historic scientific value.

**MUST ABANDON THE SHUTTLE MODE THINKING TO MAKE MARS POSSIBLE-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

The key to success come from rejecting the policy of continued stagnation represented by senile Shuttle Mode thinking, and returning to the destination-driven Apollo Mode method of planned operation that allowed the space agency to perform so brilliantly during its youth. In addition, we must take a lesson from our own pioneer past and from adopt a “travel light and live off the land” mission strategy similar to that which has well-served terrestrial explorers for centuries. The plan to explore the Red Planet in this way is known as Mars Direct. Here's how it could be accomplished.

**NASA IS AIMLESSLY SPENDING MONEY-Zubrin ‘11**

[Robert; President of the Mars Society; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

It has been a year since President Barack Obama announced his new space policy. Since that time, NASA has spent something on the order of ten billion dollars on human spaceflight in order to accomplish nothing. This is not surprising. There were no plans to accomplish anything. Nor, if the plan remains in place, will anything be accomplished by 2020, after the expenditure of a further 100 billion dollars. The plan requires zero accomplishment, it aims for zero accomplishment, and it will deliver zero accomplishment.

**SHUTTLE MODE WILL NOT PUSH OUR PROGRAM IN ANY SORT OF MEANINGFUL WAY-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

But the blame for this multi-decadal program of waste cannot be placed on NASA leaders alone, some of whom have attempted to rectify the situation. Rather, the political class must also accept major responsibility.

Consider the following. During the same week in September 2003 that House members were roasting former Administrator O’Keefe for his unfortunate advocacy of a destination-free NASA, a Senate committee issued a report saying that a top priority for the space agency was to develop a replacement Space Shuttle system. Did any of the Senators who supported this report explain why? Why do we need another Shuttle system? To keep doing what we are doing now? Is that what we actually want to do?

Is our primary aim to keep sending astronauts on joyrides in low Earth orbit? In that case, a second generation Shuttle might be worth building. But if we want to send humans to the Moon or Mars, we need make that decision, and then design and build a hardware set that is appropriate to actually accomplish those goals.

Advocates of the Shuttle Mode claim that by avoiding the selection of a destination they are developing the technologies that will allow us to go anywhere, anytime. That just is not true. The Shuttle Mode will never get us anywhere at all. The Apollo Mode got us to the Moon, and it can get us back, or take us to Mars. But leadership is required.

**WITHOUT A GOAL LIKE MARS, WESTERN CIVILIZATION FACES THE RISK OF TECHNOLOGICAL STAGNATION-Wilson '98**

[Jim; Bringing Life To Mars; Popular Mechanics; November 1998; page 30]

"In the future there will be two major sources of energy," predicts would-be Martian Edward B. Kiker, "nuclear power and Robert Zubrin." Zubrin is an astronautical engineer whom Kiker and 750 other founding members of the Mars Society believe has the right stuff to lead them to the red planet. Watching Zubrin expend some of that energy as he outlines his Mars Direct plan at the society's founding meeting, it is easy to catch their enthusiasm.

Why Mars? "The rate of progress within our society has been decreasing, and at an alarming rate," says Zubrin. "The technological innovations from 1963 to the present are insignificant. Without the opening of a new frontier on Mars, continued Western Civilization faces the risk of technological stagnation."

**ONLY THING BETWEEN US AND A MARS MISSION IS THE POLITICAL DECISION TO GO-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

Until they get the nod, the Mars partisans have to find ways to keep busy. Research teams from NASA and the Mars Society (a private advocacy group) are conducting expeditions to Devon Island in the Canadian Arctic--a place about as similar to the freeze-dried Martian wasteland as you're likely to find anywhere on Earth--to practice survival skills and exploration techniques. Teams at the Johnson Space Center are refining their mission scenarios and crunching their numbers to keep the costs as low as possible. "For now," says Zubrin, "the only thing between us and Mars is a political decision to go." That kind of hurdle, of course, is often the highest of all.

**CURRENT MINDSET IS A RECIPE FOR NO EXPLORATION-Zubrin ‘11**

[Robert; President of the Mars Society; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

It is clear that a mission-driven space program should be more optimal for actually accomplishing missions, but why should it be so much better at technology development than one that allegedly purports to be technology-driven? The reason is, that in the absence of a defining plan which identifies the required technologies, the “technology-driven” plan actually becomes a constituency-driven plan, with various communities lobbying NASA HQ or Congress for funding their own pet projects. These are not necessarily relevant, don’t fit together, and thus merely constitute a random set of time and money wasters that don’t enable us to go anywhere.

HARMS: NASA MINDSET STUCK IN COMPLEX, WASTEFUL MISSIONS

**IN SHUTTLE MODE, MONEY IS SPENT IN A USELESSLY INEFFICIENT WAY-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

Comparing these two records, it is difficult to avoid the conclusion that that NASA's productivity in both missions accomplished and technology development during its Apollo Mode was at least ten times greater than under the current Shuttle Mode.

The Shuttle Mode is the expenditure of large sums of money without direction by strategic purpose. That is why it is hopelessly inefficient. It is remarkable that the leader of any technical organization would tolerate such a senile mode of operation, but in the absence of course-setting mandate, Shuttle-era NASA administrators have come to accept it. Indeed, during his first 2 years in office, Administrator Sean O’Keefe explicitly endorsed this state of affairs, repeatedly rebutting critics by proclaiming “NASA should not be destination-driven.”

**THE COMPLEXITY OF PREVIOUSLY CONSIDERED MARS PLANS HAS STOPPED NASA FROM CONSIDERING THEM-Salotti '11**

[Jean Marc; Professor of Computer Science, Ecole Nationale Supérieure de Cognitique, Institut Polytechnique de Bordeaux; Simplified scenario for manned Mars missions; Acta Astronautica; September-October 2011; page 266]

A critical point of manned missions to Mars is the total payload that has to be sent to the planet [16]. Its impact on complexity, risks and cost is very high. In the last Design Reference Architecture (DRA) for manned missions to Mars from NASA, it is suggested that at least seven launches of an Ares V class launcher are required to assemble different rockets in LEO (Low Earth Orbit) and send them to Mars [9]. While many aspects of the architecture have been clearly justified, the organization as a whole seems very complex. It probably explains why no manned mission is currently planned by NASA.

**MARS DOESN'T OFFICIAL FUND RESEARCH ON HUMAN SPACEFLIGHT TO MARS-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

Right now, NASA does not officially fund research on human spaceflight to Mars. But scientists and engineers within and outside the agency continue to explore the challenge of martian EDL. It's a terrific test case for their students, and it may have applications for coming robotic missions to the Red Planet. The basic challenge of EDL is to slow down from hypersonic speed to a standstill in less than 10 minutes. Failing in this task could end with the payload at the bottom of a new crater on the martian surface.

**NASA COMMITTED TO SPACE NUCLEAR POWER INITIATIVES TO SUPPORT INCREMENTAL MISSIONS-Morring '02**

[Frank, Jr.; Mars Is The Destination; Aviation Week & Space Technology; 16 December 2002; page 59]

Lawmakers in both houses have already voted to fund NASA's space nuclear power initiative, a direct offshoot of the four-year-old NEXT planning process. Administrator Sean O'Keefe picked up the space nuke plan as soon as he showed up at NASA almost a year ago, and plugged it right into the agency's Fiscal 2003 budget request. Final action is due in January, when lawmakers return to take up the unfinished business of the 107th Congress, but the deal is done.

O'Keefe sometimes leaves his sincerity open to question, as when he habitually starts his response to some congressional zinger with the words “thank you for that question, senator.” But he does go out of his way to insist the space nuclear power initiative is intended for civil space, and is not a backdoor way to get some more taxpayer money over to his pals at the Pentagon to use on space-based radars and directed-energy weapons.

HARMS: LOSING FOCUS ON MARS HURTS US SPACE CREDIBILITY

**ABANDONING THE CONSTELLATION PROJECT MEANS LOSING THE SPACE LEADERSHIP RACE TO OTHER NATIONS-Spotts '10**

[Pete; Obama NASA plan: Mars shot as next generation's Apollo mission; The Christian Science Monitor; 15 April 2010; http://www.csmonitor.com/USA/2010/0415/Obama-NASA-plan-Mars-shot-as-next-generation-s-Apollo-mission; retrieved 15 June 2011]

Rep. Rob Bishop (R) of Utah, where Alliant Techsystems is a prime contractor for the Ares 1 rocket NASA was building under the Constellation program, accused the administration "of relinquishing our position as the global leader in space and missile defense to Russia, China, and India."

**UNITED STATES LEADERSHIP IMPORTANT IN A MARS MISSION TO COMPETE WITH THE CHINESE SPACE PROGRAM-Coile '04**

[Zachary; Budgeteers bushwhack president's Mars plan; They say the U.S. can't afford new space ventures; San Francisco Chronicle; 14 January 2004; page A15]

Some proponents of Bush's plan said the United States must continue to push the envelope of space exploration to avoid falling behind other nations that are now developing their own space programs, particularly China.

"The Chinese have just recently put a man in space, and they have a goal to go to the surface of the moon within five years, or to go to at least an orbit of the moon within five years," Rep. Nicholas Lampson, a Houston Democrat, whose district includes the Johnson Space Center, said in a recent radio interview. "That's a fairly fast goal. And I hope that we are not a nation that gets to sit back and say, 'Ah, been there, done that.' Let's say, 'We're better than that, we can be there. And why don't you come and join us?' "

**CURRENT PLANS WILL LEAVE THE UNITED STATES WITHOUT LEADERSHIP IN SPACE EXPLORATION-Zubrin ‘11**

[Robert; President of the Mars Society; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

The American space program is a unique enterprise in the history of the human race. It is the ornament of our age, and one of the things for which our time will be most highly regarded. Future ages will remember us, because this is when we first set sail for other worlds. Up until now, America has been leading the way. The United States comprises 4 percent of the world’s population, yet has been responsible for about 90 percent of the successful probes and 100 percent of the human expeditions beyond Earth orbit. In doing so, we have made a terrific demonstration of the power of freedom and creativity to transcend all limits to human aspirations.

This is an extraordinary achievement, accomplished through the ingenuity, courage, and commitment of a broad technical community with NASA at its helm. To impose a scheme to lobotomize the helmsman and leave this great venture rudderless, adrift, and wandering towards wreck is not just a mistake, it is a crime – a crime against America, against science, and the pioneer spirit itself. Every patriot needs to reject this plan.

The American people want and deserve a space program that really is going somewhere. It is time set that goal and commit to it. Humans to Mars.

**MARS MISSION PUSHES PEACEFUL, COOPERATIVE EXPLORATION OF SPACE-Rampelotto ‘11**

[Pabulo Henrique, Department of Biology, Federal University of Santa Maria (UFSM), Brazil; Why Send Humans to Mars? Looking Beyond Science; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

Furthermore, the benefits of close cooperation among countries in space exploration have been made clear on numerous missions. International crews have been aboard the Space Shuttle many times, and the Mir Space Station has hosted space explorers from many nations. After the realization of the International Space Station, human exploratory missions to Mars are widely considered as the next step of peaceful cooperation in space on a global scale. Successful international partnerships to the human exploration of the red planet will benefit each country involved since these cooperation approaches enrich the scientific and technological character of the initiative, allow access to foreign facilities and capabilities, help share the cost and promote national scientific, technological and industrial capabilities. For these reasons, it has the unique potential to be a unifying endeavor that can provide the entire world with the opportunity for mutual achievement and security through shared commitment to a challenging enterprise.

**IF WE WAIT ON MARS, ANOTHER COUNTRY WILL GO INSTEAD AND REAP THE MASSIVE TECHNOLOGY BENEFIT-McLane ‘10**

[James C.; Associate Fellow in the American Institute of Aeronautics and Astronautics; The Space Review; 1 June 2010; <http://www.thespacereview.com/article/1635/1>; retrieved 25 July 2011]

If America discards its hard-won preeminence in human spaceflight, another nation is likely to appreciate the opportunity, take the challenge, go to Mars, and become the new world leader.

Some suggest we should wait for better technology to arrive so we can make a human trip to Mars safer. How very silly! What if Columbus had decided not to travel across the Atlantic until he could go on a steamship? Ironically, the risk of human death for a manned Mars landing is probably in the same order of magnitude as the danger Columbus faced 500 years ago. Today, the knowledge that’s needed to put a hero on Mars either exists right now, or is close at hand. Such a voyage and the founding of an outpost will be very difficult and, in fact, it is just barely possible. That’s one of the exciting attractions of the effort.

The aerospace industry must get behind this concept before it is too late. A permanent human presence on Mars would generate so much new work that the profits would seem as if the fat years of the Cold War had returned. But, this time, instead of building secret weapons that bring us closer to our own destruction, we would work together to expand humanity out into the solar system where we naturally belong.

Either we pursue this effort now and reap enormous benefits, or discouraging scenarios will develop. Our current staff of expert practitioners will disperse, thus squandering the billions of dollars the US has spent over the past 50 years becoming the world leader in human space flight. If we wait a decade or two, the ever-increasing capability of smart robots could well mean that humans will never go to live on another planet. If humanity ceases to dare to explore and move out into a new wilderness, we lose a thing that makes us special and different from all other life. If America discards its hard-won preeminence in human spaceflight, another nation is likely to appreciate the opportunity, take the challenge, go to Mars, and become the new world leader. I hope we do not have to watch that happen.

INHERENCY: CURRENT NASA MARS VISIONS ARE TOO COMPLEX AND EXPENSIVE

**NATION WON'T SUPPORT EXTRAVAGANT EXPENDITURES FOR THE MARS MISSION IN LIGHT OF DEFICIT PROBLEMS-USA Today '04**

[Astronomical venture; USA Today; 12 January 2004; page 12A]

Yet President Bush seems oblivious to the budget's woes. This week, he plans to announce a new space mission that is as extravagant as it is daring. His proposed manned mission to Mars and permanent base on the moon evoke President Kennedy's stirring -- and ultimately successful -- call 43 years ago to put a man on the moon.

In 1961, however, the nation was willing, even eager, to spend fortunes in a race with the Soviet Union that had as much to do with military security as space exploration. While the nation's space ambitions remain important today, so too are its down-to-earth needs to rein in a ballooning deficit.

**COMMITMENT POLITICALLY IS THE KEY FACTOR STOPPING A PROGRAM LIKE MARS DIRECT FROM HAPPENING-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

Now it's time to come back to earth. The greatest obstacle to gaining a foothold on Mars won't be found in the engineering details of a human Mars mission. It won't be found in the rigors of the journey or the long days exploring a new world. It won't be found on Mars. The greatest obstacle to sending humans to Mars resides here on our home planet in the guise of earthly politics. How can we raise the money needed to get the program off the ground?

**COST OF A MARS MISSION MEAN THERE IS NO POLITICAL WILL FOR IT-Venezia and Harrison '04**

[Todd and Bridget; MANNED JOURNEY FACES MISSION IMPOSSIBILITIES; THe New York Post; 3 March 2004; page 9]

And despite Bush's call for a mission, the political will is not there, he said.

"It's cost. It's resources. We have a deficit approaching a couple of trillion dollars. It takes money away from other projects . . . and there's no promise of extra money to pay for this."

Experts put the price tag on a manned Mars mission at roughly $100 billion dollars - that's more than three times the Department of Homeland Security's 2005 budget and a quarter of the defense budget.

**NASA MARS PROGRAMS ARE RIDDLED WITH COST OVERRUNS WHICH BECOME TOO BIG TO CANCEL-Vergano '08**

[Dan; Technical glitches force delay of Mars mission; USA Today; 5 December 2008; page 2A]

MSL is "a marvelous mission, it will do wonderful things. But at what cost?" said Keith Cowing, editor of the NASA Watch website. "And how often do we have to watch cost overruns on these NASA missions where projects get too big to cancel?"

**CURRENT MARS DESIGN REFERENCE MISSION IS MUCH MORE EXPENSIVE THAN MARS DIRECT-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

NASA followed Zubrin's lead with its Design Reference Mission (DRM), drawn up in the 1990s by scientists and engineers at Johnson Space Center. The DRM, like Mars Direct, is not a detailed set of spacecraft designs and procedures. NASA bills it as a general framework for developing, comparing, and improving architectures for a future Mars mission.

The DRM adopts Mars Direct's split-mission strategy and the "live off the land" philosophy that uses ISRU technology to manufacture propellent. An important difference, however, is that NASA's plan separates the return trip into two legs. The crew would blast off from the martian surface in a Mars Ascent Vehicle (MAV) and then transfer to a waiting interplanetary vehicle placed in orbit by a previous cargo flight.

In a 1998 update to the DRM, NASA planners abandoned the direct-to-Mars launch approach, opting for a strategy sometimes called Mars Semi-Direct. Doing so would eliminate the need to develop an expensive new launcher that could send NASA's heavy 200-ton-plus payloads hurtling to Mars. An 80-ton launcher would lift payload and propulsion stages into low Earth orbit, where they would dock and leave for Mars. This would require a minimum of six launches to get the first crew on Mars.

The NASA mission to Mars involves more and heavier hardware than Mars Direct, but it takes essentially the same approach. And like Mars Direct, the DRM helps make Mars exploration look a lot more feasible. NASA offered no official cost estimate for the DRM, but most likely it would be less than the $500 billion Bush initiative.

**HUMAN NEEDS WILL ALWAYS TRUMP FAR AWAY SPENDING LIKE THE MARS EXPLORATION PROGRAM-Morring '02**

[Frank, Jr.; Mars Is The Destination; Aviation Week & Space Technology; 16 December 2002; page 59]

There is no known El Dorado to drive space exploration, no Spice Islands in space or oil reserves on Mars that we know of. The Cold War is over, but peace hasn't exactly broken out to pay a dividend. Simple human needs for food, clothing and shelter on Earth will always outweigh the abstract attraction of the unknown. Still, human curiosity is a powerful need too, and the science addressed by the NEXT studies can help meet it.

**TRADITIONAL MARS MISSIONS ARE TOO COSTLY AND GIANT TO CONSIDER-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

The usual proposals for launching a human mission to Mars, be they from the 1950s or the 1990s, call for enormous spaceships hauling to Mars all the supplies and propellant required for a two- to three-year round-trip mission. The size of these spacecraft means that they must be assembled in earth orbit--they're simply too large to launch from the earth's surface in one piece. Thus a virtual "parallel universe" of gigantic orbiting dry docks, hangars, cryogenic fuel depots, checkout points, and crew quarters must also be placed in orbit to enable assembly of the spaceships and storage of the vast quantities of propellant.

Such a mission to Mars would be exceedingly costly and would have to incorporate orbital construction and other technologies that won't be available for another 30 years. One such plan, known as the "90-Day Report," developed in response to President Bush's 1989 call for a Space Exploration Initiative, produced a cost estimate of $450 billion. Sticker shock in Congress doomed Bush's program and has deterred most people from seriously considering a humans-to-Mars program ever since. Continuing this trend, President Clinton announced in September that he would postpone any such mission until its cost could be justified.

INHERENCY: OTHER PATHS TO MARS EXPLORATION STALLED

**PRIVATE SPACE COMPANIES HAVE YET TO PRODUCE A MEANINGFUL PATH TO SPACE EXPLORATION-Grierson '04**

[Bruce; BEYOND NASA: DAWN OF THE NEXT SPACE AGE; Popular Science; April 2004; page 68]

The idea that bootstrappers can open up space by themselves has always been met by skepticism. After all, not a single proven private space company has yet to emerge. And hype about private-sector space projects rings hollow to the investors who lost their shirts on quixotic ventures like MirCorp's plan for a private three-guest space hotel, or Rotary Rocket, the single-stage-to-orbit helicopter. ("You know the secret of making a small fortune in space?" Rotary CEO Gary Hudson reportedly quipped to a couple of guys from NASA as his operating budget quickly vanished: "Start with a large one.") Or to anyone who has seriously considered the logistics of even a state-funded mission to Mars.

**MARS SCIENCE LABORATORY MISSION IS OVER BUDGET AND PLAGUED WITH TECHNICAL PROBLEMS-Chang '08**

[Kenneth; Nasa Delays Mars Mission; The New York Times; 5 December 2008; page A24]

NASA announced that it would push back the launching of its next Mars mission by two years because of delays and technical issues. The Mars Science Laboratory, an S.U.V.-size rover that is to explore the Martian surface for two years, is now scheduled for launching in 2011. It had been scheduled to lift off next October and arrive at Mars in 2010. Problems with its electrical motors have not been solved, and officials said they did not think they could meet the original schedule without compromising rigorous testing. Because the Earth and Mars come closest to each other every 26 months, the next chance for launching is fall 2011. The delay comes at considerable cost. The project, approved at $1.63 billion in 2006, is now budgeted at $1.88 billion, and the delay will add $400 million.

**PRIVATE MISSIONS TO MARS ARE DOOMED TO FAIL- Atkinson ‘10**

[Nancy; Could a Human Mars Mission Be Funded Commercially?; Universe Today; 7 October 2010; <http://www.universetoday.com/75263/could-a-human-mars-mission-be-funded-commercially/>; retrieved 6 August 2011]

Some of the ideas Joseph outlined for marketing does have some validity, McLane said. “Long ago NASA should have realized that the image they cultivate of nerdy, ethically and sexually diverse astronauts does not inspire the tax payer nearly as much as the early astronauts who we expected to be risk taking, hell raising test pilots,” he said.

In respect to finances, McLane said he agrees with Joseph that there is a place for private capital, but not in regards to the venture capital proposal.

“Private money could jump start a manned Mars mission,” McLane said, “but persuading billionaires to invest based on some speculative financial return is doomed to fail. I believe rich folks might be willing to help pay to put a human on Mars, but the motivations would be philanthropy and patriotism, not financial gain. Several wealthy citizens might contribute seed money (say a quarter billion dollars or so) to finance a detailed study of the design options for a one way human mission – a concept that thus far NASA refuses to consider. Such a study would reveal the technical practicality of the one-way mission and the relative cheapness of the approach. The study would probably show that a human presence on Mars would cost little more than a human moon base assuming the same 10 year time span for accomplishing both programs.”

Dr. Joseph concludes his paper by asserting that several foreign countries “are already planning on making it to Mars in the next two decades.” McLane said this seems highly improbable since the funds spent today by these nations on manned spaceflight are a tiny fraction of what the US currently spends.

INHERENCY: MARS PROGRAMS AT NASA HAVE BEEN CUT OR DELAYED

**MARS SCIENCE LABORATORY PROGRAM HAS FORCED CUTS OF THE NASA MARS PROGRAM BY 50%-Vergano '08**

[Dan; Technical glitches force delay of Mars mission; USA Today; 5 December 2008; page 2A]

"No one wants a $2 billion hole in the ground instead of a successful mission," said planetary scientist John Mustard of Brown University in Providence, R.I., who heads NASA's Mars program advisory panel. But "this is going to have ripple effects in the science community," he added, noting that NASA had already cut Mars office funding about 50% from previous years, down to about $300 million.

The extra $400 million, spread over 2011 to 2014, will come from other Mars missions and perhaps other planetary explorations, NASA's Ed Weiler said at the briefing. NASA will consult with planetary scientists on their priorities before it shifts money from other programs, such as a 2013 "scout" mission to Mars.

**OBAMA LOW-COST SPACE POLICY LACKS DETAILS-Chang '10**

[Kenneth; For Mission to Mars, a New Road Map; The New York Times; 8 June 2010; page D4]

''Game-changing'' and ''affordable'' are perhaps the most repeated adjectives spoken by NASA officials in the last few months.

The premise underlying President Obama's proposed space policy is that development of new space technologies can speed space exploration at lower costs.

But skeptics in Congress counter that NASA has provided too few details to convince them that they should largely throw away the $10 billion that has been spent so far in NASA's Constellation moon program and spend billions more on something new.

At a workshop last month in Galveston, members of NASA study teams looking at how to put in effect the Obama policy presented their current thinking to 450 attendees from industry and academia.

**THE UNITED STATES HAS DELAYED THE MARS SCOUT MISSION-The New York Times '07**

[Mars Shot Is Put Off For 2 Years, NASA Says; The New York Times; 22 December 2007; page A16]

NASA has delayed the launching of a mission to Mars by two years, to 2013, because of an undisclosed conflict of interest involved in one of two final proposals, officials said Friday.

Postponing the Mars Scout program mission means that the National Aeronautics and Space Administration will miss an opportunity to launch a flight to Mars for the first time in more than a decade, Doug McCuistion, director of the agency's Mars Exploration Program, said at a news conference.

Mars and Earth only get close enough to efficiently launch explorations every 26 months.

**OBAMA'S GOAL OF MARS IN 2040 ESSENTIALLY MEANS THE UNITED STATES DOESN'T HAVE MARS AS A GOAL-Wolfgang '11**

[Ben; Future bright to NASA chief; Bolden: U.S. 'recommitting' itself to human space flight; The Washington Times; 4 July 2011; page A5]

Others aren't so sure. President Obama has set 2040 as the target date for humans to reach Mars orbit, but critics contend that if the Red Planet was truly a priority, the U.S. would try to get there in the next decade.

They cite President John F. Kennedy's proclamation in 1961 that America would send a man to the moon and return him safely to Earth before the end of the decade, a goal famously fulfilled July 20, 1969.

When you say you're going to Mars in 2040, you're basically saying that you're not going to go to Mars, said engineer Robert Zubrin, founder and president of the Mars Society and author of The Case for Mars.

**OBAMA'S COMMITMENT TO BUSH'S SPACE VISION IS AN OPEN POLITICAL QUESTION-Perlman '09**

[David; Science Editor; Moon crash landing is part of the mission; San Francisco Chronicle; 18 June 2009; page A1]

Because an ample supply of water could help provide unlimited fuel for any future moon base, seeking it out has been a high-priority mission for NASA leaders still bent on implementing former President George W. Bush's "vision for space exploration" that Bush said would start with "a foothold on the moon."

Whether the Obama administration pursues that goal with as high a priority remains an open political question.

**OBAMA CANCELLED BUSH'S CONSTELLATION PROGRAM-Spotts '10**

[Pete; Obama NASA plan: Mars shot as next generation's Apollo mission; The Christian Science Monitor; 15 April 2010; http://www.csmonitor.com/USA/2010/0415/Obama-NASA-plan-Mars-shot-as-next-generation-s-Apollo-mission; retrieved 15 June 2011]

In a speech delivered at the Kennedy Space Center in Florida Thursday afternoon, President Obama aimed to answer charges leveled by lawmakers, former astronauts, and former National Aeronautics and Space Administration (NASA) officials that his plans for the space agency spell doom for the country's human spaceflight program.

In February, the White House released a proposed budget that canceled former President George W. Bush's Constellation program, which set a deadline of 2020 to put US astronauts back on the moon for the first time since the final Apollo mission.

Instead, the White House opted for what a presidential commission identified last year as a more financially sustainable program - one that would allow American astronauts to leapfrog the moon and begin visiting more-distant solar-system destinations during the decade of the 2020s and beyond.

**OBAMA SPACE VISION IS MORE ABOUT A BROAD PHILOSOPHY SHIFT TOWARDS A SPACE ECONOMY RATHER THAN A DESTINATION-Spotts '10**

[Pete; Obama NASA plan: Mars shot as next generation's Apollo mission; The Christian Science Monitor; 15 April 2010; http://www.csmonitor.com/USA/2010/0415/Obama-NASA-plan-Mars-shot-as-next-generation-s-Apollo-mission; retrieved 15 June 2011]

Through a speech delineating destinations and rough timetables, however, Mr. Obama appeared to be setting out something potentially more sweeping than raw budget documents indicate - an attempt to build a foundation for the United States to become a spacefaring nation, not just a spacefaring government.

More than simply setting a goal for NASA to develop the technologies and missions needed to send humans beyond the moon, he has challenged the commercial space industry to take up the journeyman tasks that NASA would abandon - such as ferrying astronauts to and from the space station - hoping it will kindle the rise of a true space economy.

"Fifty years after the creation of NASA," he said, "our goal is no longer just a destination to reach. Our goal is the capacity for people to work and learn, operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite."

**CONGRESS HASN’T FUNDED CURRENT SPACE PLANS-Simberg ‘11**

[Rand; Aerospace Engineer and Consultant; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

Fortunately, it’s unlikely to continue, both because Congress has neither authorized nor appropriated sufficient funds with which to do it, and because there will be a growing awareness that it is unnecessary. The recent announcement of a new vehicle being developed by Space Exploration Technologies, with almost half the capability of the Saturn V, at a cost per pound previously only dreamed of (a thousand dollars), and flying out of Florida within three years, will put a stake in its heart, and none too soon.

SOLVENCY: MARS DIRECT TECHNICAL DETAILS

**MARS DIRECT WOULD USE NUCLEAR ENGINE FOR A RETURN JOURNEY HOME-Petit '03**

[Charles; DREAMING OF MARS; US News and World Report; 1 September 2003; page 40]

Other ideas include exceedingly efficient ion engines that use electric fields instead of heat to fling atoms out the back. Powered by giant solar panels or nukes, they would produce at most a few pounds of thrust. But they could run for weeks, gradually accelerating the ship for a swift journey. Not every would-be Mars admiral wants exotic rockets, though. NASA consultant Robert Zubrin, founder of the Mars Society, has for 10 years thumped for a plan called Mars Direct, featuring big, shuttle-derived chemical rockets. Zubrin, however, would take along a nuclear power plant to convert Mars minerals into fuel for the return trip.

**NUCLEAR ENGINES HAVE THE BEST CHANCE OF MAKING MARS A REALITY-Petit '03**

[Charles; DREAMING OF MARS; US News and World Report; 1 September 2003; page 40]

A Mars mission would require hard engineering and big money, and some people may not like one of NASA's candidate components for deep space missions: small nuclear reactors to provide electricity or even form the heart of rocket engines. But in NASA backrooms, engineers are cooking up nukes and other schemes to get people to Mars and beyond if and when Congress or the administration gives the green light.

A nuclear-powered Mars trip is not a new idea. In the late 1950s to mid-'60s, scientists assigned to a secretive project called Orion pursued a concept in which small hydrogen bombs ejected from the stern of a mammoth 4,000-ton spaceship would propel it, carrying scores of people to other planets. Separate projects tested nuclear rocket engines at the atom-bomb-scarred Nevada Test Site. Hydrogen gas flowing over white-hot fuel rods in reactors about the size of oil drums but seething with the power of three Hoover dams spewed out the back, generating thrusts of up to 200,000 pounds with an efficiency twice that of any chemical rocket.

Stanley Gunn, now retired from Rocketdyne, ran many of the tests and says his team was told in the mid-'60s to be ready for a manned Mars mission by 1984. "We could have done it," he says. Such audacious projects collapsed in part because the atmospheric nuclear test ban made blasting radiation-tainted rocket exhaust into the open air unthinkable.

While nukes hardly win popularity contests with the public, they remain irresistible to many space jockeys. A 1997 study estimated that without shielding, every cell nucleus in a person's body would be pierced by a cosmic ray during a yearlong round trip to Mars, away from Earth's sheltering magnetic field. Even with heavy shielding, the less time in space, the better. Powerful, compact nuclear rockets could make fast trips cheaper, minimizing radiation for the crew. To reduce risk to the folks back home, regular rockets would deliver the atomic motors to orbit; they would light up there and not build up dangerous nuclear waste until far from Earth.

Stanley Borowski, an engineer at NASA's Glenn Research Center, is pushing hard for a three-ship Mars expedition. Two would deliver cargo in advance. A third would bring a crew for a 500-day visit. His key is clusters of small, "bimodal" nuclear rocket motors that, after a hefty burst for half an hour, would throttle down to make electricity for spacecraft systems.

SOLVENCY: ZUBRIN GOOD

**ZUBRIN IS A NOTED AUTHOR AND AEROSPACE ENGINEER- Space Fellowship ‘11**

[This Week On The Space Show; Space Fellowshop; 28 June 2011; <http://spacefellowship.com/news/art26063/this-week-on-the-space-show.html>; retrieved 9 July 2011]

Dr. Robert Zubrin is a noted author and the Founder of The Mars Society. The Mars Society, an international organization dedicated to furthering the exploration and settlement of Mars by both public and private means. Dr. Zubrin is also President of Pioneer Astronautics, an aerospace R&D company located in Lakewood, Colorado. Dr. Zubrin was formerly a Staff Engineer at Lockheed Martin Astronautics in Denver, he holds a Masters degree in Aeronautics and Astronautics and a Ph.D. in Nuclear Engineering from the University of Washington.

Zubrin is the inventor of several unique concepts for space propulsion and exploration, the author of over 100 published technical and non-technical papers in the field, and was a member of Lockheed Martin’s “scenario development team” charged with developing broad new strategies for space exploration. In that capacity, he was responsible for developing the “Mars Direct” mission plan, a strategy which by using Martian resources, allows a human Mars exploration program to be conducted at a cost 1/8th that previously estimated by NASA. Zubrin is known internationally as one of the most creative engineers working in the aerospace industry today, and he and his work have been subject of much favorable press coverage in The Economist, The New York Times, The Boston Globe, the London Times, The Washington Post, Fortune Magazine, Newsweek, Air and Space Smithsonian, Popular Science, Omni, Space News, and many other publications. He is the holder of two US Patents, and has two more pending. In addition to his technical publications, Dr. Zubrin is the author of “The Case for Mars: How We Shall Settle the Red Planet and Why We Must,” published by Simon and Schuster’s Free Press Division in Oct. 1996, and “Entering Space: Creating a Spacefaring Civilization,” published by Tarcher Putnam in Aug. 1999, and “Mars on Earth” published by Tarcher Penguin in Sept. 2003. His book, “The Holy Land,” is a science fiction satire of the current situation in the Middle East. Dr. Zubrin has also written a play about Benedict Arnold. His latest book, “How To Live On Mars: A Trusty Guidebook To Surviving And Thriving On The Red Planet,” is a must read.

**ZUBRIN'S FRAMEWORK IS THE MOST COMPREHENSIVE ACCOUNT OF MARS SCIENCE AND THOUGHT-Clarke '97**

[Authur C.; Science Fiction Writer; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 46]

Robert Zubrin’s book—which is often very amusing and contains asides which will not endear him to NASA—is the most comprehensive account of the past and future of Mars that I have ever encountered. It explains why we should go there, how we may go there—and, perhaps most important of all, how we may “live on the land” when we get there.

**ZUBRIN IS A TOP-DRAWER SPACE ENGINEER-Scott ‘00**

[Jim; New Real Estate; The American Scientist; January-February 2000; <http://www.americanscientist.org/bookshelf/pub/new-real-estate>; retrieved 6 August 2011]

Robert Zubrin is big on the long view of space exploration. But his credentials—a top-drawer space engineer and author of the best-selling The Case for Mars—give him enough reign to take us on a stepladder to the stars.

Zubrin also is president of the Mars Society, a group of scientists and engineers intent on the human exploration and colonization of Mars as quickly and efficiently as possible. From Mars to the stars, Zubrin has done his homework once again, his many equations in the book may leave lay readers reeling.

SOLVENCY: MUST ACT NOW ON A MARS MISSION

**NOW IS THE TIME FOR HUMANS TO MAKE MARS THEIR GOAL-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

Humanity today stands at the brink of a liberating development which will be remembered far into future ages, when nearly all the other events of our time are long forgotten. That development is the initiation of the human career as a spacefaring species.

The Earth is not the only world. There are numerous other planetary objects in our own solar system, millions in nearby interstellar space, and hundreds of billions in the galaxy at large. The challenges involved in reaching and settling these new worlds are large, but not beyond humanity's ultimate capacity. Were we to become spacefarers, we will open up a prospect for a human future that is vast in time and space, and rich in experience and potential to an extent that exceeds the imagination of anyone alive today. When we open the space frontier, we will open the door to the creation of innumerable new branches of human civilization, replete with new languages, new cultures, new literatures, new forms of social organization, new knowledge, technological contributions, and epic histories that will add immeasurably to the human story.

We were once a small collection of tribes living in the east African rift valley. Had we stayed in our native habitat, that is all we would be today. Instead, we ventured forth, took on the challenges of the inhospitable ice age environments to the north, and then elsewhere, and in consequence, transformed ourselves into a global civilization. When we go into space, the expansion of our possibilities will be equally dramatic. As a result, the human experience a few thousand years from now will be as rich in comparison to ours, as our global society is in comparison to tribal culture of the Kenyan rift valley at the time of our species’ origin.

That is why I believe that we today are living not at the end of history, but at the beginning of history. Provided we do what we should, our nation will be remembered not so much for the great deeds our predecessors have already done, but for those it has yet to do. We should embrace our role as humanity's vanguard, as pioneers of the future. Only thus will we honor the true American tradition by continuing it, bravely taking on the untamed space frontier to open new worlds for our posterity, as our courageous predecessors did for us.

The American people want and deserve a space program that is actually going somewhere. For that to occur, it needs be given a goal, from that goal a produce a plan, and from that plan, action. It is within our power to make this happen. It is within our power to initiate a program of exploration that will lead in time to the greatest flowering of human potential, knowledge, progress, and freedom that history has ever known. We should do so.

**WITH A MORE DIRECT FOCUS, THE UNITED STATES COULD GET TO MARS RELATIVELY QUICKLY-Wolfgang '11**

[Ben; Future bright to NASA chief; Bolden: U.S. 'recommitting' itself to human space flight; The Washington Times; 4 July 2011; page A5]

Mr. Zubrin is one of the leading advocates of sending humans to Mars as soon as possible, and he argues it could be done relatively quickly if NASA dedicated itself to the task. Instead, he fears NASA will waste time and money on various scatterbrained programs in the coming years.

NASA needs a destination. .. It needs a destination that is worth going to, he said.

**MUST TAKE THE OPPORTUNITY TO SHAPE THE FUTURE OF MARS-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Mars is the New World. Someday millions of people will live there. What language will they speak? What values and traditions will they cherish as they move from there to the solar system and beyond? When they look back on our time, will any of our other actions compare in value with what we do now to bring their society into being? Today we have the opportunity to be the parents, the founders, the shapers of a new branch of the human family. By so doing, we will put our stamp on the future. It is a privilege not to be disdained lightly.

**MARS SHOULD BE THE GOAL OF EXPLORATION-Zubrin ‘11**

[Robert; President of the Mars Society; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

If we are going to have a space program that actually accomplishes great things, we need to have a great goal, and a schedule that compels action to achieve that goal in the real world of the here and now. The goal should be humans to Mars. The schedule for its achievement should be ten years. If we embrace that goal and accept that challenge we will then be driven to choose, develop, build, and operate systems and technologies that actually make sense, and which will get us to Mars before this decade is out. If we do not take such an approach, then another decade will pass, and a hundred billion more will be spent, and we will be no closer to sending humans to Mars in 2020 than we are today.

**PUBLIC EFFORTS TOWARDS MARS, EVEN IF UNREALISTIC, ARE IMPORTANT FOR PUSHING MARS EXPLORATION BACK INTO PUBLIC SIGHT-Scoblic '04**

[Peter J.; Earth Diarist: Rational Exuberance; The New Republic; 2 February 2004; page 34]

It's hard not to scoff at the president's call for a return to the moon, Mars, and "beyond" if for nothing other than its political transparency. The president's sudden dose of the vision thing immediately endeared him to the thousands of aerospace workers in Florida, while costing him almost nothing before he leaves office. But, despite its narrow opportunism, the president's plan is important, because it thrusts the prospect of a manned mission to Mars back into the public sphere.

**AN APOLLO-LIKE GOAL FOR NASA IS CRITICAL-Zubrin ‘11**

[Robert; President of the Mars Society; The Great PJ Media Space Debate; Pajamas Media; 22 May 2011; <http://pajamasmedia.com/blog/the-great-pj-media-space-debate/>; retrieved 18 July 2011]

If we want to again have a human spaceflight program that does accomplish great things, we need to look back to the time when we did, and see how NASA operated then. That was the Apollo era. The Apollo program worked because NASA had a definite goal — a real goal worthy of the space program of a nation constituting the pioneering vanguard of human progress, with a deadline attached to it requiring concrete action in the here and now.

Because it had a real goal with a real deadline, NASA was forced to come up with a real plan to accomplish it, requiring the building of real vehicles, enabled by the development of those real technologies really required to enable them. (I apologize for the repeated use of the word “real.” However it’s really important in this context.) Operating in this way — with goals defining plans defining vehicles, defining technology development — NASA reached the Moon within 8 years of program start.

SOLVENCY: MARS DIRECT WOULD TAKE LESS THAN A DECADE TO TOUCHDOWN

**MARS DIRECT WOULD TAKE ONLY 10 YEARS AND COST $20-$30 BILLION-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

Mars Direct diverged radically from the previous all-up strategy. First, a cargo-only vehicle launches into space on a booster comparable to the Apollo-era Saturn 5. It carries an Earth Return Vehicle (ERV) that will eventually bring the astronauts home. The payload goes directly to Mars with no stopover in low Earth orbit for assembly or fueling. This is the "direct" part of Mars Direct.

The Earth Return Vehicle lands on Mars unfueled for the return flight. Instead, it carries in-situ resource utilization (ISRU) hardware. This includes an automated chemical processing plant, a nuclear electric generator, and liquid hydrogen "feedstock" (raw material to kick off the manufacturing process). The ISRU plant then combines the feedstock with carbon dioxide from the martian atmosphere to produce methane and oxygen for rocket fuel.

At the next favorable Earth-Mars alignment for a launch -- 26 months after the cargo flight -- the crew will depart Earth. But they will leave only after confirming the ISRU hardware has fueled the return ship. The crew ship is the equivalent of a small cottage with rocket propulsion. It carries a methane-burning rover, a crew of four, and everything they will need to live for 3 years.

The trajectory Mars Direct uses for the outbound and return flights minimizes the propellant required, but at the cost of an extended stay on the planet. After the 6-month cruise to Mars, the astronauts must remain there for about 600 days until Earth swings around to an orbital position that requires the least amount of fuel to reach home.

As the crew ship departs for Mars, a cargo flight blasts off to deliver a second Earth Return Vehicle into Mars orbit. This provides a safety margin: If the ERV sent earlier fails, the astronauts can still get home using the second one. And if the crew ends up not using the backup ERV, it will be waiting when the next crew arrives from Earth to explore Mars.

With every mission, the number of crew habitats and other equipment left on the surface increases. This provides the basis for a permanent human presence and perhaps colonization.

The price tag for Mars Direct was a key selling point. Zubrin's original estimate claimed it would take $20 to $30 billion and 10 years to develop the hardware plus $1 to $2 billion for subsequent piloted flights to the growing Mars outpost. Today, he says, it would cost in the neighborhood of $30 to $40 billion and $2 to $3 billion per additional visit.

**IF WE STARTED TODAY, THE UNITED STATES COULD HAVE A TEAM ON MARS IN 10 YEARS-Zubrin '03**

[Robert; President of the Mars Society; Mission to Mars: The Red Planet beckons, says The Mars Society's ROBERT ZUBRIN. Now is no time for Canada to drop out of a project that may be humanity's greatest challenge; Globe & Mail; 23 August 2003; Page A19]

The American space program, which succeeded so brilliantly in the Apollo period of 1961 to 1973, has spent most of the subsequent 30 years without a central goal. We need one to drive our space program forward. And at this point in history, that goal can only be the human exploration and settlement of Mars.

We're ready for this challenge. We are much better prepared today to send humans to Mars than we were to launch humans to the moon in 1961 when U.S. president John F. Kennedy challenged Americans. Given the will, we could have our first teams on Mars within 10 years.

**FIRST MARS OUTPOST COULD BE ESTABLISHED IN A DECADE WITH MARS DIRECT-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

We can establish our first small outpost on Mars within a decade. We and not some future generation can have the eternal honor of being the first pioneers of this new world for humanity. All that's needed is present day technology, some 19th century industrial chemistry, a solid dose of common sense, and a little bit of moxie.

**MARS DIRECT IS A CONCEPTUAL BREAKTHROUGH THAT CHALLENGES EXISTING PARADIGMS FOR MARS-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

Predictably, few were happy with the plan's expense, complexity, long timeline, and the short time it provided for exploration of the martian surface. So in August 1990 Robert Zubrin and David Baker, engineers at Martin Marietta in Denver, proposed a controversial alternative: the Mars Direct mission plan.

Zubrin's Mars Direct contains conceptual breakthroughs that make a manned mission simpler, cheaper, and more effective. It uses a different trajectory to get a crew to Mars in just six months. Once there, astronauts would explore the Red Planet for 500 days while waiting for the planets to line up for a six-month return to Earth. Astronauts wouldn't linger in martian orbit--they would head down to the planet's surface, where they would dig in to escape radiation exposure.

Zubrin's plan uses two different landers. A Habitat lander transports the crew to Mars and houses them on the surface, while an Earth Return Vehicle carries them home. The landers are small, about 40 tons each, or around half the weight of the Space Shuttle orbiter.

Most important, though, is Zubrin's reliance on martian resources. The Habitat lands on Mars with empty fuel tanks. The Earth Return Vehicle, which is sent two years ahead without crew, manufactures 107 tons of methaneoxygen fuel for the trip home by combining martian air with six tons of liquid hydrogen brought from Earth. This might sound like sleight-of-hand, but it's just 19th-century industrial chemistry.

**MARS DIRECT COULD BE UP AND RUNNING IN SEVEN YEARS-Wilson '98**

[Jim; Bringing Life To Mars; Popular Mechanics; November 1998; page 30]

On the first Mars Direct mission--which could happen as early as August 2005--a single heavy-lift rocket similar to the Saturn V that carried Apollo astronauts to the moon would launch a startup cargo. It would consist of an unfueled 2-stage methane/oxygen Earth-return vehicle (ERV), about 7 tons of liquid hydrogen, a 50-kilowatt nuclear reactor mounted in the back of a methane/oxygenfueled truck, a few small scientific rovers, and--most important of all--an automated chemical factory.

After landing safely on the Martian surface in February 2006 the nuclear reactor would begin manufacturing electric power for the chemical factory. Hydrogen brought from Earth would be combined with plentiful Martian carbon dioxide in the presence of a nickel or ruthenium catalyst to produce flammable methane and virtually pure water. The methane would then be liquefied and stored for later use as rover fuel and ERV propellant. Electric current would be passed through some of the water to generate oxygen. By September 2006 the chemical factory would have manufactured enough fuel and oxidizer for the rocket's return trip to Earth, plus enough for rovers to take long exploratory drives around the Martian surface.

During fall 2007 there would be two launches. The first would carry a second ERV. About two weeks later the manned mission would formally begin. A 4-person crew would lift off in a 15-ft.-tall, 24-ft.dia. 2-story habitation module. Upper-stage rockets normally separate from their payloads in flight. On manned Mars Direct missions they would remain attached by a 1000-ft. tether. A small rocket motor aboard the habitat would set the pair into motion at 2 revolutions per minute, creating centrifugal force that would simulate Martian gravity.

When the explorers landed 180 days later, they would find that the chemical factory that had been operating for the past had made enough water and oxygen for their stay and enough fuel for their return trip. The second ERV, launched just before their takeoff, would have landed by this point and would be prepared for the next crews. Missions would leapfrog each other by distances of about 250 miles, setting up a network of habitats, and oxygen and water factories that would become a lifeline for future colonists. Early explorers would set up greenhouses so that food could be grown on the surface. Eventually, over a period of hundreds of years, it might be possible to create an Earthlike environment.

SOLVENCY: EXISTING FUNDING SOURCES ENOUGH FOR MARS DIRECT

**WE COULD TAKE EXISTING FUNDING TOWARDS THE DYING SHUTTLE PROGRAM AND ISS AND PUT IT TOWARDS PHASE ONE OF MARS DIRECT-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

If we take such a truth-based perspective, a much better policy becomes immediately apparent. We should fly one more Shuttle mission – to Hubble – and then shut the program down. We should then take the $6 billion per year we are currently wasting on Shuttle and ISS, and use it instead to immediately start developing the heavy lift vehicle and all the other flight elements necessary to implement a human exploration program along the lines of the Mars Direct mission plan described above. A modified subset of these hardware elements can be used to enable Lunar missions as well, and if desired, elements of the Mars flight hardware set could be tested in advance closer to home by using them to undertake missions to the Moon.

**MARS MISSION COULD BE IN THE SAME RANGE OF A MAJOR MILITARY PROCUREMENT FOR A NEW WEAPONS SYSTEM-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 185]

Twenty to thirty billion dollars is not cheap, but it’s roughly in the same range as a single major military procurement for a new weapons system; it’s in the same range as the money the United States government gave to Mexico in one afternoon in the summer of 1995. Spread over twenty years, with the first ten years developing hardware and the next ten years flying missions, it would represent between 8 percent and 12 percent of the existing NASA budget. For the sake of opening a new world to human civilization, it’s a sum that this country can easily afford.

**THE END OF THE SPACE SHUTTLE PROGRAM WILL FREE UP FUNDING FOR NEW INITIATIVES-Wolfgang '11**

[Ben; Future bright to NASA chief; Bolden: U.S. 'recommitting' itself to human space flight; The Washington Times; 4 July 2011; page A5]

The right time [to end the program] was 15 years ago, he said. The shuttle should have been treated as a first generation system from which we learned.

With the shuttle program consuming $4 billion of the $8 billion NASA budget for human space flight each year, he believes it's been difficult to focus on new, exciting projects.

**SHORT DURATION MARS PROGRAMS ARE CRITICAL TO GETTING TAXPAYER SUPPORT-McLane ‘10**

[James C.; Associate Fellow in the American Institute of Aeronautics and Astronautics; The Space Review; 1 June 2010; <http://www.thespacereview.com/article/1635/1>; retrieved 25 July 2011]

The only potential NASA program with a real ability to capture the enthusiastic support of the American public is a short duration, focused drive to send a human to live permanently on Mars. The targeted time horizon must be short—perhaps only a decade—so taxpayers in their own lifetime would be able to witness the event they are funding. This effort would salvage the aerospace industry and also breathe life back into the technological malaise that currently affects much of American society.

SOLVENCY: MARS IS A NECESSARY GOAL FOR NASA

**MARS IS THE NECESSARY GOAL FOR NASA-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

There is no more passionate cheerleader for human Mars exploration than aerospace engineer Robert Zubrin. He is the founder and president of the Mars Society and author of a 1996 manifesto, The Case for Mars: The Plan to Settle the Red Planet and Why We Must. He also was the chief architect of Mars Direct, a mission design he says could get humans on Mars sooner and cheaper than anything NASA has proposed.

For Zubrin and like-minded people, putting footprints on Mars is not a question of whether, why, or how. It's ultimately a must. It's how we'll find out if life once existed, or still exists, on Mars. It will significantly advance aerospace technology and inspire the next generation. And it will expand humanity to another planet. "NASA needs a goal," Zubrin says. "The goal should be sending humans to Mars. Mars is where the science is. It's where the challenge is. It's where the future is. It is the new frontier."

**MARS CAN DO FOR US TODAY WHAT THE MOON PROGRAM DID FOR THE UNITED STATES IN THE 60s-Zubrin '03**

[Robert; President of the Mars Society; Mission to Mars: The Red Planet beckons, says The Mars Society's ROBERT ZUBRIN. Now is no time for Canada to drop out of a project that may be humanity's greatest challenge; Globe & Mail; 23 August 2003; Page A19]

What the Moon program was in the 1960s, a Mars program can be today. It can mobilize not only the space program, but the research and development capabilities and educational system of every nation that participates. The discoveries that our robot probes have made so far are only the beginning compared to the wonders that will come to light when a whole new world is opened to human exploration.

In sending humans to Mars, we will be taking the first step toward opening a new frontier in which a new and dynamic branch of human civilization can be created. Future ages will recognize this as the greatest and most enduring of all our achievements.

**MARS PROVIDES THE GOAL THE UNITED STATES SPACE PROGRAM NEEDS TO EXPAND-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Space is there, and we are going to climb it." These words from President John F. Kennedy in 1962 set forth the goal of sending an American to the moon within the decade. But for most of the 30 years since the Apollo moon landing, the U.S. space program has lacked a coherent vision of what its next target should be. The answer is simple: the human exploration and settlement of Mars.

**UNITED STATES MUST USE MARS TO FOCUS ITS SPACE PROGRAM AND GIVE IT DIRECTION-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 92]

There can be no progress without a goal. The American space program, begun so brilliantly with Apollo and its associated programs, has spent most of the subsequent twenty years floundering without direction. We need a central overriding purpose to drive our space program forward. At this point in history, that focus can only be the human exploration and settlement of Mars.

SOLVENCY: MARS DIRECT IS LIGHTER

**MARS DIRECT IS BETTER BECAUSE IT REDUCES MANY OF THE REQUIREMENTS BY DECREASING MASS OF ITEMS DISTRIBUTED-Pine '93**

[Devera; Living off the (Martian) land; Omni; September 1993; page 29]

The Mars Direct plan begins with a single heavy-lift rocket launching an unmanned Earth Return Vehicle (ERV) from Earth to Mars. Once on Mars, the ERV would use a small nuclear reactor and six tons of liquid hydrogen brought from home to make both methane and oxygen from the Martian atmosphere, which is 95 percent carbon dioxide. An onboard pump would suck in Martian air and then a nickel catalyst would cause the carbon dioxide and liquid hydrogen to become methane and water. The methane would be stored, and electricity supplied by the reactor would split the water into oxygen and hydrogen. The hydrogen would be recycled to react with more carbon dioxide, while the oxygen would be stored. Two years later, astronauts would land on Mars at the same site. Excess fuel from the first ERV launch would allow the astronauts to explore Mars in a rover, and the Mars-fueled ERV would return them to Earth.

The plan, Zubrin says, saves time, money, and technological woes by reducing the amount of mass that needs to be launched from Earth.

**AVOIDING MASSIVE SPACESHIPS TAKES 20 YEARS OFF OF THE MARS APPROACH-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

Starting in the spring of 1990, I led a team of engineers and researchers at Martin Marietta Astronautics (now called Lockheed Martin Astronautics) in Denver in developing a live-off-the-land plan to pioneer Mars. Called Mars Direct, the plan discards unnecessary, expensive, and time-consuming detours: no need to assemble spaceships in low earth orbit; no need to refuel in space; no need for spaceship hangars at an enlarged space station; and no need for drawn-out development of lunar bases as a prelude to Mars exploration. Avoiding these detours saves perhaps 20 years and avoids the ballooning administrative costs that tend to afflict extended government programs.

**TECHNOLOGY NEEDED FOR MARS AVAILABLE TODAY WITH A SMALL SPACECRAFT-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

This goal is not beyond our reach. No giant spaceship built with exotic equipment is required. Indeed, all the technologies needed for sending humans to Mars are available today. We can reach the Red Planet with relatively small spacecraft launched directly to Mars by booster rockets embodying the same technology that carried astronauts to the moon more than a quarter-century ago. The key to success lies with the same strategy that served the earliest explorers of our own planet: travel light and live off the land. The first piloted mission to Mars could reach the planet within a decade. Here is how the proposed plan — what I call the Mars Direct project — would work.

SOLVENCY: “LIVING OFF THE LAND” OF MARS DIRECT SOLVES

**MARS DIRECT RELIES ON A “LIVING OFF THE LAND” PHILOSOPHY-Pine '93**

[Devera; Living off the (Martian) land; Omni; September 1993; page 29]

Can the discovery of the Northwest Passage through the Canadian Arctic in 1906 help man reach Mars by the turn of the next century? Martin Marietta engineers Robert Zubrin and David Baker think so.

Zubrin and Baker's ``Mars Direct'' plan relies on a ``live off the land'' philosophy used by some early explorers. For instance, Roald Amundsen, who discovered the Northwest Passage, was successful because he and his crew knew how to survive on local resources: When frozen in on an island for two years, they even got fat from eating too much caribou. Zubrin and Baker would have the first Mars explorers live off Martian ``caribou''--carbon dioxide in the atmosphere.

**USE OF THE “LIVE OFF THE LAND” PHILOSOPHY DRAMATICALLY DECREASES THE COSTS OF A MARS MISSION-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 227]

How can this be? Looking at almost any plan for a human mission to Mars, be it from the 1950s or the 1990s, we see enormous spaceships hauling to Mars all the supplies and propellant required for a mission. The size of the spacecraft demands that they be assembled in Earth orbit—they’re simply too large to launch from the Earth’s surface in one piece. This requires that a virtual “parallel universe” of gigantic orbiting “dry docks,” hangars, cryogenic fuel depots, power stations, checkout points, and construction crew habitation shacks be placed in orbit to enable assembly of the spaceships and storage of the vast quantities of propellant. Based upon such concepts, it has been endlessly repeated that a mission to Mars would have to cost hundreds of billions of dollars and incorporate technologies that won’t be available for another thirty years. Yet landing humans on Mars requires neither miraculous new technologies nor the expenditure of vast sums of money. We don’t need to build “Battlestar Galactica”-like futuristic spaceships to go to Mars. Rather, we simply need to use some common sense and employ technologies we have at hand now to travel light and “live off the land,” just as was done by nearly every successful program of terrestrial exploration undertaken in the past. Living off the land—intelligent use of local resources—is not just the way the West was won; it’s the way the Earth was won, and it’s also the way Mars can be won. The conventional Mars mission plans are impossibly huge and expensive because they attempt to take all the materials needed for a two- to three-year round-trip Mars mission with them from Earth. But if these consumables can be produced on Mars instead, the story changes, radically.

**LOCAL PRODUCTION STRATEGIES ARE CRITICAL FOR CUTTING THE WEIGHT OF MARS MISSIONS-Oberg '99**

[James; Missionaries to Mars; Technology Review; January/February 1999; page 54]

NASA's innovative strategy would exploit recent advances in automation and remote control to operate a propellant extractor on Mars long before the crew arrived. If this system were implemented, even before astronauts left Earth their return vehicle would be waiting for them on Mars, its tanks already filled with martian manufactured fuel. And, in addition to rocket propellant, local production plants could create fuel for surface transportation and for electricity-producing fuel cells. Studies conducted by NASA and by Bob Zubrin's team (for their "Mars Direct" plan) show that even a modest use of local production strategies cuts the required weight of the Mars-bound spacecraft by half or more.

**MARS HAS INCREDIBLE NATURAL RESOURCES THAT CAN PROVIDE RESOURCES TO PIONEERS THAT PLAN MISSIONS THERE-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 114]

The question of taking on Mars as an interplanetary goal is not simply one of aerospace accomplishment, but one of reaffirming the pioneering character of our society. Unique among the extraterrestrial bodies of our solar system, Mars is endowed with all the resources needed to support not only life but the actual development of a technological civilization. In contrast to the comparative desert of the Earth’s moon, Mars possesses veritable oceans of water frozen into its soil as permafrost, as well as vast quantities of carbon, nitrogen, hydrogen, and oxygen, all in forms readily accessible to those inventive enough to use them. These four elements are not only the basis of food and water, but of plastics, wood, paper, clothing, and—most importantly—rocket fuel. Additionally, Mars has experienced the same sorts of volcanic and hydrologic processes that produced a multitude of mineral ores on Earth. Virtually every element of significant interest to industry is known to exist on the Red Planet. While no liquid water exists on the surface, below ground is a different matter, and there is every reason to believe that geothermal heat sources could be maintaining hot liquid reservoirs beneath the Martian surface today. Such hydrothermal reservoirs may be refuges in which microbial survivors of ancient Martian life continue to persist; they would also represent oases providing abundant water supplies and geothermal power to future human pioneers. With its twenty-four-hour day-night cycle and an atmosphere thick enough to shield its surface against solar flares, Mars is the only extraterrestrial planet that will accommodate large-scale greenhouses lit by natural sunlight. Even at this early date in its exploration, Mars is already known to possess a vital resource that could someday represent a commercial export. Deuterium, the heavy isotope of hydrogen currently valued at $10,000 per kilogram, is five times more common on Mars than it is on Earth.

**“LIVE OFF THE LAND” APPROACH WILL SAVE BILLIONS OF DOLLARS-Keck '99**

[Aries; Settling the Solar System; Astronomy; December 1999; page 60]

Zubrin began his martian crusade as a reaction to President George Bush's 1989 Space Exploration Initiative, which called for a series of missions culminating in a manned trip to Mars. Initially conceived as a call-toaction similar to President Kennedy's famous speech that led to Apollo, SEI soon became quagmired by its $400-billion-dollar price tag. As it went down in flames, Zubrin developed an alternative.

The hallmark of Zubrin's Mars Direct plan is a sustainable Mars project N one that uses existing technology and a series of small rockets that would send landers to the martian surface before the first astronauts arrive. These landers could use martian raw materials to produce the oxygen and rocket fuel needed to sustain the astronauts on the surface and get them back home cheaply. Zubrin says this "live off the land" approach could shave tens of billions of dollars off an actual manned Mars mission.

**LIVING OFF THE LAND IS CRITICAL TO MAKE THE TRIP ECONOMICALLY FEASIBLE-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 161]

A piloted Mars mission is not about building enormous interplanetary cruisers—it’s about moving a payload capable of supporting a small crew of astronauts from the surface of Earth to the surface of Mars, and then moving that or a similar payload back again to return the crew. Provided we take full advantage of the leverage afforded by the use of local resources to reduce mission logistics to a manageable level, such a task is not at all beyond our technical or fiscal means. Travel light and live off the land—that’s the ticket to Mars.

SOLVENCY: MARS DIRECT WILL BE LOW COST

**THE KEY TO MARS IS DOING IT ON THE CHEAP-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

The key to reaching Mars is doing it smart and doing it cheap. In 1989, during the 20th anniversary of the Apollo 11 lunar landing, President Bush challenged NASA to figure out how to put human beings on Mars. The space agency came back with an elephantine 30-year plan that involved construction bays and fuel depots in low-Earth orbit and carried a jaw-dropping price tag of $450 billion.

What drove up the cost of the project was the size of the spacecraft needed to reach Mars, and what drove up the size of the spacecraft was all the fuel and other consumables it would need to carry with it on so long a trip. But while Mars is indeed remote--at its farthest it's 1,000 times as distant as the moon--it has a lot of things the moon doesn't, most notably an atmosphere. And that makes all the difference.

**OVER TIME AND MISSIONS, THE COSTS OF MARS EXPLORATION AND COLONIZATION WILL DECREASE-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 173]

Over time, many new exploration bases will be added, but eventually it will have to be determined which of the base regions is the best location to build an actual Mars settlement. Ideally this will be situated above a geothermally heated subsurface reservoir, which will afford the base a copious supply of hot water and electric power. Once that happens, new landings will not go to new sites. Rather, each additional hab will land at the same site. In time, a set of structures resembling a small town will slowly take form. The high cost of transportation between Earth and Mars will create a strong financial incentive to find astronauts willing to extend their surface stay beyond the basic one and a half year tour of duty. As experience is gained in living on Mars, growing food, and producing useful materials of all sorts, astronauts will extend their stay times to four years, six years, and more. As the years go by, the transportation costs to Mars will steadily decrease, driven down by new technologies and competitive bids from contractors offering to deliver cargo to support the base. Photovoltaic panels and windmills manufactured on site and new geothermal wells will add to the power supply, and locally produced inflatable plastic structures will multiply the town’s pressurized living space. As more people steadily arrive and stay longer before they leave, the population of the town will grow. In the course of things children will be born, and families raised on Mars—the first true colonists of a new branch of human civilization.

**WORKING MORE QUICKLY TOWARDS A MARS GOAL MEANS A CHEAPER OVERALL MISSION-Wolfgang '11**

[Ben; Future bright to NASA chief; Bolden: U.S. 'recommitting' itself to human space flight; The Washington Times; 4 July 2011; page A5]

During the 1960s, as NASA was moving full steam ahead on its lunar missions, every experiment and technological breakthrough was geared toward making the moon landing a reality, Mr. Zubrin said. That approach helped save money, he argues.

The faster you do something, the cheaper it will be, he said.

**LACK OF MONEY ISN'T THE BARRIER FOR A MARS MISSION; FOCUS AND DIRECTION ARE ENOUGH-Zubrin '03**

[Robert; President of the Mars Society; Mission to Mars: The Red Planet beckons, says The Mars Society's ROBERT ZUBRIN. Now is no time for Canada to drop out of a project that may be humanity's greatest challenge; Globe & Mail; 23 August 2003; Page A19]

Nor is cost the central issue: NASA's average budget from 1961 to 1973, when it built up from near-zero space capability to storm space and reach the moon, was $17-billion (U.S.) in 2003 dollars. That's only 9-per-cent greater than NASA's current budget of $15.6-billion. The problem is not lack of money, but lack of focus and direction. As a result of operating without a central goal, the U.S. space program has floundered, and funds have been spent at a rate comparable to that of the 1960s without producing anything approaching commensurate results.

**FOCUS AND DECISION MORE IMPORTANT THAN MONEY IN A MARS MISSION-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

But we need to understand what the real goal is, and go for it. We need to understand that Mars, and not the Moon, should be our goal. We can make it to that goal, provided we directour resources in that direction. It is not a matter of money, but of willingness to focus and make decisions. The $6 billion per year currently being wasted to fund the mistakes of the past is more than enough to open the way to Mars. We just need to decide to do it.

**MARS DIRECT IS AFFORDABLE AND A LOWER LAUNCH RATE THAN THE SHUTTLE PROGRAM-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Thus, under the Mars Direct plan, the U.S. would launch two heavy-lift booster rockets every other year: one to dispatch a team of four people to inhabit Mars and the other to prepare a new site for the next mission. The average launch rate of one a year is only about 15 percent of the rate that the U.S. currently launches space shuttles and is clearly affordable. In effect, the live-off-the-land strategy used by the Mars Direct plan removes the prospect of a manned mission to Mars from the realm of megaspacecraft fantasy and renders it a task comparable in difficulty to the launching of the Apollo missions to the moon.

**MARS DIRECT WOULD COST A FRACTION OF PREVIOUS NASA ESTIMATES FOR A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

In 1990, when my colleague David A. Baker and I (we were then both at Martin-Marietta) first put forward the basic Mars Direct plan, the National Aeronautics and Space Administration viewed it as too radical to consider seriously. But over the past couple of years, with encouragement from Michael Griffin, NASA's former associate administrator for exploration, as well as from the current head of NASA, Daniel S. Goldin, the group in charge of designing human missions to Mars at the NASA Johnson Space Center decided to take another look at our idea.

In 1994 researchers there produced a cost estimate for a program based on an expanded version of the Mars Direct plan that had been scaled up by about a factor of two. Their result: $50 billion. Notably, in 1989 this same group assigned a $400-billion price tag to the traditional, cumbersome approach to a manned mission to Mars based on orbital assembly of megaspacecraft. I believe that with further discipline in the design of the mission, the cost could be brought down to the $20-billion to $30-billion range. Spent over 10 years, this amount would constitute an annual expenditure of about 20 percent of NASA's budget, or around 1 percent of the U.S. military's budget. It is a small price to pay for a new world.

**HIGH DOLLAR ESTIMATES FOR MARS INCLUDE A LOT OF UNNECESSARY TECHNOLOGY PROJECTS-Oberg '99**

[James; Missionaries to Mars; Technology Review; January/February 1999; page 54]

One credible explanation for the hideous $450 billion price tag for Bush's SEI was offered by one of the conference organizers. space engineer and Mars enthusiast Bob Zubrin. Basically, Zubrin in believes, the representatives of the different NASA centers got together, listed all of the dream projects they had always wanted to do, and all agreed to scratch one another's backs. As a result, most of the price tag was devoted to open ended developmental projects whose utility for a Mars expedition was questionable at best.

**MARS DIRECT WILL EVENTUALLY DRIVE COSTS DOWN EVEN FURTHER OVER TIME-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

Every two years, a pair of Ares boosters will blast off, one delivering a hab to a prepared site, the other an earth return vehicle to open up a new region for the next mission. Over time, a network of exploratory bases will be established, turning large areas of Mars into human territory. But eventually one base region will be chosen as the site for building an actual Mars settlement. Ideally, this will be situated above a geothermally heated reservoir to supply hot water and electric power. In time, a set of structures resembling a small town will slowly take form.

The high cost of transportation between earth and Mars will create a strong financial incentive to find astronauts willing to extend their tours to four years, six years, and more. But over time, the transportation costs to Mars will steadily fall, driven down by new technologies and competitive bids from contractors offering to deliver cargo to support the base. Photovoltaic panels and windmills manufactured on site from Martian materials will add to the power supply, and locally produced inflatable plastic structures will multiply the town's pressurized living space. With more arrivals and longer stays, the population of the town will grow. In the course of things, children will be born, and families raised, on Mars--the first true colonists of a new branch of human civilization.

**MARS DIRECT USE ACCESSIBLE SCIENCE MAKING THE TRIP MUCH MORE AFFORDABLE-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

For the past decade--ever since NASA's 1989 proposal laid its half-trillion-dollar egg--the space community has been intrigued by a mission scenario known as the Mars Direct plan. Developed by engineers at Martin Marietta Astronautics, a NASA contractor, Mars Direct calls not merely for visiting the Red Planet but also for living off the alien land.

As early as 2005, when Earth and Mars are in their once-every-26-months alignment, the plan envisions launching a four-person spacecraft to Mars--but launching it with its tanks empty of fuel and its cabin empty of crew. Landing on the surface, the craft would begin pumping Martian atmosphere--which is 95% carbon dioxide--into a reaction chamber, where it would be exposed to hydrogen and broken down into methane, water and oxygen. Methane and oxygen make a first-rate rocket fuel; water and oxygen are necessary human fuels. All these consumables could be pumped into tanks inside the ship and stored there.

Two years later, when Mars and Earth are again in conjunction, another spacecraft--this one carrying a crew--would be sent to join the robot ship on the surface. The astronauts could work on Mars for 18 months, living principally in their arrival craft, and then, at the end of their stay, abandon that ship, climb into the robot craft and blast off for home. "Fly several of these missions," says Robert Zubrin, author of the book The Case for Mars and one of the engineers who developed the plan, "and you leave the surface scattered with a series of warming huts that serve as the beginnings of a base."

What makes the Mars Direct plan remarkable is how unremarkable the science behind it is. The spacecraft in which the astronauts will live are descendants of the same pressurized vessels NASA has been building since the Mercury days. The boosters that will lift the ships off the ground are reconfigured engines cannibalized from the shuttle. The technology needed to distill the Martian atmosphere is the stuff of first-year chemistry texts. For this reason, Zubrin believes, Mars Direct could be surprisingly affordable: about $40 billion for five missions, or less than half the cost of the Apollo program in today's dollars.

**MARS DIRECT REDUCES COSTS-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

In essence, by taking advantage of the most obvious local resource available on Mars – its atmosphere – the plan allows us to accomplish a manned Mars mission with what amounts to a lunar-class transportation system. By eliminating any requirement to introduce a new order of technology and complexity of operations beyond those needed for lunar transportation to accomplish piloted Mars missions, the plan can reduce costs by an order of magnitude and advance the schedule for the human exploration of Mars by a generation. Indeed, since a lunar-class transportation system is adequate to reach Mars using this plan, it is rational to consider a milestone mission, perhaps 5 years into the program, where a subset of the Mars flight hardware is exercised to send astronauts to the Moon.

**MARS DIRECT IS A MORE LIKELY SCENARIO FOR SUCCESS AND LOW COST-Manzey '04**

[Dietrich; Institute of Psychology and Ergonomics, Technical University of Berlin; Human missions to Mars: new psychological challenges and research issues; Acta Astronautica; August-November 2004; page 781]

The distance between Earth and Mars is enormous, with Mars never getting closer than about 60 million kilometers. This makes every attempt to fly to Mars an extreme complex undertaking. A first suitability study of a human flight to Mars already was published in 1953 [1]. According to this “Marsproject” an armada of 10 spacecrafts was envisioned to transport some 50 people to the martian surface for a stay of 400 days. Since then numerous studies have been addressed, the technical possibilities for a human flight to Mars, and reference scenarios for a Mars mission have been developed in the US, Europe and Russia [2, 3 and 4]. In most of these studies, two different approaches for a flight to Mars are distinguished. The first one involves a transfer flight on a high energy trajectory that will last 160–250 days, a stay on the martian surface of a maximum of about 60 days and a flight back of again 160–250 days. Beside high costs of energy, the main disadvantage of this approach is the comparatively short-term stay on the surface which relates to constraints for a return flight due to the constellations of Earth and Mars. Thus, a second scenario seems to be more likely. This scenario involves a round-trip to Mars of about 1000 days including transfer flights on low energy trajectories lasting 200–300 days. After arrival at Mars the crew has to stay there for about 400–500 days without any possibilities for rescue or re-supply until an appropriate launch window opens for a low-energy flight back. Such an approach has been proposed in “The Mars Direct Plan” by Robert Zubrin, and has also been chosen for recent reference mission scenarios developed by NASA and ESA [2, 3 and 5]. All of these plans envision a crew of six astronauts traveling to Mars in a habitat of about 300–400 m3 which might be considerably enlarged on the martian surface by use of inflatable elements or additional elements sent by separate cargo flights, respectively.

SOLVENCY: SMALLER CREW IS PREFERRED

**LESS CREW MAKES CREW SELECTION LESS COMPLEX-Salotti '11**

[Jean Marc; Professor of Computer Science, Ecole Nationale Supérieure de Cognitique, Institut Polytechnique de Bordeaux; Simplified scenario for manned Mars missions; Acta Astronautica; September-October 2011; page 266]

Another problem is to maximize the skills of the crew. The most important skill is the ability to use and repair the numerous systems onboard the spacecraft. Since there are many sensors and many devices for the production, processing or exploitation of different elements (oxygen, water, carbon dioxide, propellant, etc.), we suggest sending two persons with primary skills in chemistry, thermodynamics, mechanics and electricity. They would have to perform a long training phase for the use of onboard systems and other relevant domains, especially medicine, biology and astronautics. Eventually, a doctor with a long training in other domains might be preferred. As it is also stated in the DRA report, we have to find efficient solutions to mitigate health problems due to long stays in microgravity [9] and [17]. Zubrin and Wagner [21] suggests spinning the spacecraft to simulate the Martian gravity. A more simple solution is to bring a centrifuge onboard [1] and [2]. Some experiments have been conducted on Earth. For instance a centrifuge is currently used at MEDES (Institut de médecine et de physiologie spatiale in Toulouse, France), but the concept has not been tested in space. We assume in this paper that a small centrifuge would be onboard and would help in minimizing the physiological effects of microgravity. Other counter measures would also help in maintaining muscular strength and crew health. Even if the skills of the astronauts enable a good exploitation of the spacecraft, we also have to consider scientific skills to perform experiments in space and on the surface of Mars. The 4 astronauts of our scenario can work together on the surface of Mars but in comparison with a crew of 6 with different specialists, there would be a lack of expertise in some domains with a possible negative impact on scientific returns. However, if that drawback enables strong simplifications of the scenario, which in turn would make manned missions less risky and affordable, is that not the most suitable option?

**A SIMPLER, MORE COST EFFECTIVE MISSION TO MARS IS POSSIBLE WITH SMALL CREWS-Salotti '11**

[Jean Marc; Professor of Computer Science, Ecole Nationale Supérieure de Cognitique, Institut Polytechnique de Bordeaux; Simplified scenario for manned Mars missions; Acta Astronautica; September-October 2011; page 266]

An efficient tradeoff between Mars Direct and Von Braun scenarios can nevertheless be made. In our scenario, we propose a single habitable module for the entire mission, the use of the same propulsion system for the landing and the return to Mars orbit and a duplication of the mission as it was suggested by Von Braun. In order to make that scenario simple and feasible, we propose a crew of 2 per vehicle. That scenario is very interesting for several reasons:

• A crew of 2 astronauts minimizes the needs in terms of mass and size of the spacecraft, which have a great impact on the mass of heat shield and propellant for landing on the surface of Mars. The entry, descent and landing stage is thus simpler and probably safer.

• If we choose a short number of astronauts per vehicle, the mass of accommodations and consumables is reduced. For the outbound stage, it might be possible to take in each vehicle a chemical unit and associated power systems for in situ propellant production. There is no need to send other spacecrafts to Mars. In addition, compared to the DRA scenario, the risk of landing too far from the ERV is eliminated.

• The preliminary automatic mission that is required in Mars Direct or in the DRA to produce propellant before the arrival of the crew can be avoided. Each vehicle would indeed carry its own system to produce propellant, which would serve as a possible backup for the second.

• The deployment and maintenance of ISRU (In Situ Resource Utilization unit) and power systems are facilitated. The use of large and flexible solar arrays might even be enabled only if astronauts are present on the surface.

• Finally, if a major incident occurs during the trip, for instance an explosion of an oxygen tank like in the Apollo 13 mission, since two vehicles are sent to Mars and return to the Earth at the same time, it is possible to undertake a rescue mission and proceed to a transshipment of the crew onto the second vehicle.

ADVANTAGE: MARS MISSION WOULD DRIVE INTEREST IN SCIENCE

**MARS HAS THE POTENTIAL OF DRIVING INTEREST IN SCIENCE-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

In terms of its social value, Mars is the bracing positive challenge that our society needs. Nations, like people, thrive on challenge and decay without it. The challenge of a humans-to Mars program would also be an invitation to adventure to every youth in the country, sending out the powerful clarion call: “Learn your science and you can become part of pioneering a new world.” There will be over 100 million kids in our nation's schools over the next 10 years. If a Mars program were to inspire just an extra 1% of them to scientific educations, the net result would be 1 million more scientists, engineers, inventors, medical researchers and doctors, making technological innovations that create new industries, finding new medical cures, strengthening national defense, and generally increasing national income to an extent that utterly dwarfs the expenditures of the Mars program.

**A MISSION TO MARS WILL CREATE EXCITEMENT FOR SCIENCE EDUCATION ACROSS THE COUNTRY-Wolfgang '11**

[Ben; Future bright to NASA chief; Bolden: U.S. 'recommitting' itself to human space flight; The Washington Times; 4 July 2011; page A5]

Aside from the scientific data that can be gained from a Mars mission, Mr. Logsdon and Mr. Zubrin agree on another purpose for an ambitious space agenda: generating excitement across the country, particularly among students who too often lack an interest in science, technology and engineering.

Having some sense of an exciting future in space is clearly important, Mr. Logsdon said.

**A MARS MISSION WOULD INCREASE INTEREST IN SCIENCE EDUCATION IN THE UNITED STATES-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Such a program would also serve as an invitation to adventure for children around the world. There will be some 100 million kids in U.S. schools over the next 10 years. If a Mars program were to inspire just an additional 1 percent of them to pursue scientific educations, the net result would be one million more scientists, engineers, inventors, medical researchers and doctors.

**JOURNEY TO MARS CRITICAL FOR HUMAN SURVIVAL-Giddings ‘11**

[S., Ph.D., To Be Human is to Explore; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

Space is the next frontier, and travel to Mars a small hop to a stepping stone in a grander quest. It would be an honor to represent humankind in its exploration, and those with an adventurous spirit will find this calling -- even with no vision of return. The first human visitors to its surface will watch in awe as they see Earth -- barely larger than a star -- rising from the martian horizon. With this distant view of home, they will begin discoveries on how to make a new life, both for themselves, and for our species.

Like with other settlers, their first challenge will be to find a way to survive and sustain life. They will begin to find resources both on the planet, and within themselves. For the first time in history, they will begin to learn whether and how humans can sustain themselves in an environment utterly different from the cradle of our species, Earth. They will begin a journey that may even be the key to humanity's survival.

**A TRIP TO MARS IS CRITICAL FOR UNDERSTANDING THE COSMOS-Giddings ‘11**

[S., Ph.D., To Be Human is to Explore; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

These pioneers will confront entirely new challenges of physics, engineering, and mobility. With their fragile toehold, they will then begin to explore the richness of a profoundly different geography and geology, possibly even a biology. They will expand the human psyche to a visceral new understanding, by witnessing the cosmos and the smallness of our planet in views never imagined by our ancestors, and never seen by the human eye. They will give the human family a bold yet terribly humbling perspective on our role in a vast cosmos.

**MAKING A MAR MISSION THE GOAL OF THE UNITED STATES WOULD HAVE EXTRAORDINARY BENEFITS TO SCIENTIFIC KNOWLEDGE-Zubrin '03**

[Robert; President of the Mars Society; Mission to Mars: The Red Planet beckons, says The Mars Society's ROBERT ZUBRIN. Now is no time for Canada to drop out of a project that may be humanity's greatest challenge; Globe & Mail; 23 August 2003; Page A19]

The challenge of a humans-to-Mars program would also be an invitation to adventure for every youth in every country participating. It would send out the clarion call: "Learn your science and you can become part of pioneering a new world." There will be more than 100 million students in North American schools over the next 10 years. If a Mars program were to inspire just an extra 1 per cent of them to pursue scientific educations, the net result would be one million more scientists, engineers, inventors, medical researchers and doctors, making technological innovations that create industries, inspire medical cures, strengthen national defence, advance the human condition, and generally increase national income to an extent that utterly dwarfs the expenditures of the Mars program.

**SPACE EXPLORATION CHALLENGES THE SCIENTIFIC COMMUNITY AND PRODUCES MANY TECHNOLOGICAL ADVANCES-The Australian '04**

[Dubya takes us to infinity and beyond; The Australian; 16 January 2004; page 10]

``We choose to explore space because doing so improves our lives and lifts our national spirit,'' said Bush, while JFK wanted moon missions ``not because they are easy, but because they are hard, because that goal will serve to organise and measure the best of our energies and skills.'' There also happen to be a lot of space votes in the big electoral states of Florida and Texas, home of rockets and mission controls. But taking out the politics, Mr Bush is still on the right track, as was Kennedy. By setting the bar high, space exploration has challenged the scientific community and produced technology used in a wide variety of applications from aerospace to communications to medicine. The space shuttle is creaking, the international space station has limitations.

**EXPLORATION OF MARS STIMULATES STUDY OF THE HUMAN BODY-Rampelotto ‘11**

[Pabulo Henrique, Department of Biology, Federal University of Santa Maria (UFSM), Brazil; Why Send Humans to Mars? Looking Beyond Science; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

The study of human physiology in the Martian environment will provide unique insights into whole-body physiology, and in areas as bone physiology, neurovestibular and cardiovascular function. These areas are important for understanding various terrestrial disease processes (e.g. osteoporosis, muscle atrophy, cardiac impairment, and balance and co-ordination defects). Moreover, medical studies in the Martian environment associated with researches in space medicine will provide a stimulus for the development of innovative medical technology, much of which will be directly applicable to terrestrial medicine. In fact, several medical products already developed are space spin-offs including surgically implantable heart pacemaker, implantable heart defibrillator, kidney dialysis machines, CAT scans, radiation therapy for the treatment of cancer, among many others. Undoubtedly, all these space spin-offs significantly improved the human`s quality of life.

ADVANTAGE: MARS MINING/EARTH RESOURCE MANAGEMENT

**MARS HAS SIGNIFICANT MINING RESOURCES MAKING IT AN IDEAL GOAL-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

But the most important reason to go to Mars is the doorway it opens for the future. Uniquely among the extraterrestrial bodies of the inner solar system, Mars is endowed with all the resources needed to support not only life but the development of a technological civilization. In contrast to the comparative desert of the Earth's Moon, Mars possesses oceans of water frozen into its soil as permafrost, as well as vast quantities of carbon, nitrogen, hydrogen, and oxygen, all in forms readily accessible to those clever enough to use them. These four elements are the basic stuff not only of food and water, but of plastics, wood, paper, clothing, and most importantly, rocket fuel.

**MARS MAY HOLD UNIMAGINED RICHES AND RESOURCES FOR FUTURE HUMANITY-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

The planet Mars is a world of spectacular mountains three times as tall as Mount Everest, canyons three times as deep and five times as long as the Grand Canyon, vast ice fields, and thousands of kilometers of mysterious dry riverbeds. The planet's unexplored surface may hold unimagined riches and resources for future humanity, as well as answers to some of the deepest philosophical questions that thinking men and women have pondered for millennia.

**MARS RESOURCE DEVELOPMENT WOULD HELP EARTH-BOUND MANAGEMENT OF RESOURCES-Rampelotto ‘11**

[Pabulo Henrique, Department of Biology, Federal University of Santa Maria (UFSM), Brazil; Why Send Humans to Mars? Looking Beyond Science; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

The permanence of humans in a hostile environment like on Mars will require careful use of local resources. This necessity might stimulate the development of novel methods and technologies in energy extraction and usage that could benefit terrestrial exploitation and thus improve the management of and prolong the existence of resources on Earth.

**MARS INCLUDES SIGNIFICANT NATURAL RESOURCES WITH EXPORT POTENTIAL-Silber ‘97**

[Kenneth; Mining the Sky: Untold Riches from the Asteroids, Comets, and Planets; Reason Magazine; April 1997; <http://findarticles.com/p/articles/mi_m1568/is_n11_v28/ai_19280035/>; retrieved 29 July 2011]

Mars will need a thriving export sector to pay for its imports of manufactured goods from Earth. (Even with a high degree of automation, Martian society's labor shortage ensures that imports will be necessary far into the future. Furthermore, such trade will be desirable, given the rule of comparative advantage.) Fortunately, Mars contains a plenitude of natural resources with export potential. Deuterium, a fuel useful for today's nuclear-power industry and essential for future nuclear-fusion reactors, is a particularly promising candidate for interplanetary commerce.

ADVANTAGE: COLONIZATION

**MARS OFFERS THE GREATEST OPPORTUNITY FOR SETTLEMENT-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

In addition, Mars has experienced the same sorts of volcanic and hydrologic processes that produced a multitude of mineral ores on Earth. Virtually every element of significant interest to industry is known to exist on the Red Planet. While no liquid water exists on the surface, below ground is a different matter, and there is every reason to believe that geothermal heat sources could be maintaining hot liquid reservoirs beneath the Martian surface today. Such hydrothermal reservoirs may be refuges in which survivors of ancient Martian life continue to persist; they would also represent oases providing abundant water supplies and geothermal power to future human settlers. With its 24-h day-night cycle and an atmosphere thick enough to shield its surface against solar flares, Mars is the only extraterrestrial planet that will readily allow large scale greenhouses lit by natural sunlight. Mars can be settled. For our generation and many that will follow, Mars is the New World. In establishing our first foothold on Mars, we will begin humanity's career as a multi-planet species.

Mars is where the science is, Mars is where the challenge is, and Mars is where the future is. That's why Mars must be our goal.

**MARS DIRECT LEADS TO AN EASY PATH OF HABITATION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Because no one will be left in orbit, the crew will benefit from the natural gravity and protection against radiation offered by the Martian environment. As a result, there is no need for a quick return to Earth, a complication that has plagued conventional mission plans that consist of an orbiting mother ship and small landing parties sent to the surface. At the conclusion of their stay, the Mars astronauts will return by direct flight in the ERV. As the series of missions progresses, a string of small bases will be left behind on the planet, opening broad stretches of Mars to continued human exploration and, eventually, habitation.

**DESIGN INNOVATIONS MAKE A MARS OUTPOST LESS EXPENSIVE THAN OUR INVESTMENT IN A LOW-ORBIT SPACE STATION-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

A permanent outpost on Mars sounds like a big-ticket item, but Joosten says that NASA is working hard to lower the costs of piloted Mars exploration. He believes that design innovations will eventually allow NASA to establish and expand a Mars outpost for about $2 billion a year--similar to what's being spent now to build a space station in low-Earth orbit.

**ONLY MARS HAS CONDITIONS IN SPACE FOR COLONIZATION-Zubrin ‘94**

[Robert; President of the Mars Society; The Economic Viability of Mars Colonization; 1994; <http://www.aleph.se/Trans/Tech/Space/mars.html>; retrieved 28 July 2011]

The primary analogy to be drawn is that Mars is to the new age of exploration as North America was to the last. The Earth's Moon, close to the metropolitan planet but impoverished in resources compares to Greenland. Other destinations, such as the Main Belt asteroids may be richer in potential future exports to Earth but lack the preconditions for the creation of a fully developed indigenous society; these compare to the West Indies. Only Mars has the full set of resources required to develop a native civilization, only Mars is a viable target for true colonization. Like America in its relationship to Britain and the West Indies, Mars has a positional advantage that will allow it to participate in a useful way to support extractive activities on behalf of Earth in the asteroid belt and elsewhere.

ADVANTAGE: ECONOMIC DEVELOPMENT

**MISSION TO MARS WILL STIMULATE THE GLOBAL INDUSTRIAL MACHINE AND TECHNOLOGICAL DEVELOPMENT-Rampelotto ‘11**

[Pabulo Henrique, Department of Biology, Federal University of Santa Maria (UFSM), Brazil; Why Send Humans to Mars? Looking Beyond Science; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

In the last decade, the human exploration of Mars has been a topic of intense debate. Much of the focus of this debate lies on scientific reasons for sending, or not sending, humans to Mars. However, the more profound questions regarding why our natural and financial resources should be spent on such endeavor have not been addressed in a significant way. To be successful, the human exploration of Mars needs reasons beyond science to convince the public. People are far more interested in the short-term outcome of exploration than any nebulous long-term benefits. Finding the right balance of science and other factors is critical to convince taxpayers to part with $100 billion or more of their money over the next couple of decades to fund such endeavor. In the following, I briefly explain why the colonization of Mars will bring benefits for humans on Earth, looking beyond scientific reasons.

The engineering challenges necessary to accomplish the human exploration of Mars will stimulate the global industrial machine and the human mind to think innovatively and continue to operate on the edge of technological possibility. Numerous technological spin-offs will be generated during such a project, and it will require the reduction or elimination of boundaries to collaboration among the scientific community. Exploration will also foster the incredible ingenuity necessary to develop technologies required to accomplish something so vast in scope and complexity. The benefits from this endeavor are by nature unknown at this time, but evidence of the benefits from space ventures undertaken thus far point to drastic improvement to daily life and potential benefits to humanity as whole.

One example could come from the development of water recycling technologies designed to sustain a closed-loop life support system of several people for months or even years at a time (necessary if a human mission to Mars is attempted). This technology could then be applied to drought sufferers across the world or remote settlements that exist far from the safety net of mainstream society.

**RETURN ON INVESTMENT ON A MARS TRIP WOULD BE TEN TO ONE-McLane ‘10**

[James C.; Associate Fellow in the American Institute of Aeronautics and Astronautics; The Space Review; 1 June 2010; <http://www.thespacereview.com/article/1635/1>; retrieved 25 July 2011]

Rather than some fanciful and inaccurate speculation on what a tiny Mars outpost might cost, we should consider just what the country ought to be willing to spend. Forty years ago, at its peak, the US dedicated close to 1% of its Gross National Product (GNP) to the Apollo Moon landing. This was deemed affordable, in spite of the need to simultaneously fund an expensive war in Vietnam and massive new government welfare programs. In recent years the percent of our GNP that is devoted to space exploration is down in the range of one-quarter of one percent. America should easily be able to devote perhaps half a percent of its GNP each year—that’s just half the cost of Apollo, in a decade-long effort that would provide a permanent human presence on Mars. Such a program would receive enthusiastic, unwavering financial support when the entire world understands that humanity is finally embarked on a dramatic new course out into the universe.

Just like the wildly successful (and profitable) Apollo moon landing effort, the human Mars landing should be an all-American project. Some experts claim that the return on investment (ROI) to the US from new and applied technology acquired during Apollo was as much as ten dollars in public benefit for each dollar our government spent. For a manned Mars program, do we really want to invite other countries to be partners and then have to share the tremendous ROI with them?

**THE ONLY PROJECT THAT COULD INSPIRE HIGH TECH INDUSTRY IN THE UNITED STATES IS A SHORT DURATION, FOCUSED MISSION TO MARS-McLane ‘10**

[James C.; Associate Fellow in the American Institute of Aeronautics and Astronautics; The Space Review; 1 June 2010; <http://www.thespacereview.com/article/1635/1>; retrieved 25 July 2011]

The American aerospace industry seems oblivious to a unique business situation that offers the greatest potential in its history for long-term profit. Since the end of the Cold War, our aerospace firms have struggled to remain viable in the face of fickle government contracts, staffing challenges, and foreign competition. America has no shortage of inventors; indeed we may offer the world’s best cradle for innovation, but our aerospace companies are straining to hold on in the global marketplace.

The only potential NASA program with a real ability to capture the enthusiastic support of the American public is a short duration, focused drive to send a human to live permanently on Mars.

**AN UNDERTAKING LIKE MARS DIRECT WOULD DRIVE MANY TIMES THE COST OF THE PROJECT INTO THE ECONOMY-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

If NASA were to undertake Mars Direct, the cost of developing the required hardware would amount to roughly $20 billion, with each individual Mars mission costing about $2 billion once the ships and equipment were in production. Spent over a period of 10 years, $20 billion would represent only about 7 percent of the combined U.S. budgets for military and civilian space exploration. This money could also drive our economy forward, much as spending $70 billion (in today's dollars) on science and technology in the Apollo program contributed to rapid U.S. economic growth during the 1960s.

**A MARS MISSION WOULD INCREASE THE RETURN ON INVESTMENT INTO NASA-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

There are additional reasons to send humans to Mars. Nations, like people, thrive on challenge; they languish without it. The space program needs a challenge. Consider these statistics: Between 1961 and 1973, with the impetus of the moon race, NASA produced technological innovations at a rate several orders of magnitude greater than that it has shown since. Even so, NASA's average budget in real dollars then was only about 20 percent more than today ($16 billion 1998 dollars compared with $13 billion). Why the enhanced productivity? Because NASA had a goal that forced its reach to exceed its grasp. Far from being a waste of money, having NASA take on the challenge of a manned mission to Mars is the key to giving the nation a real return for its space dollars.

**MARS DIRECT WOULD PUT SUBSTANTIAL INVESTMENT INTO THE ECONOMY, JUST LIKE APOLLO DID-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 246]

A rough cost estimate for Mars Direct would be about $20 billion to develop all the required hardware, with each individual Mars mission costing about $2 billion once the ships and equipment were in production. While certainly a great sum, spent over a period of ten years it would only represent about 7 percent of the existing combined military and civilian space budgets. Furthermore, this money could drive our economy forward in just the same way as the spending of $70 billion (in today’s terms) on science and technology in the Apollo program contributed to the high rates of economic growth of America during the 1960s.

A/T: MARS IS TECHNICALLY IMPOSSIBLE

**RELATIVE TO OUR TECHNOLOGY TODAY, A MISSION TO MARS IS LESS CHALLENGING THAN A MISSION TO THE MOON IN 1961-Pendick '09**

[Daniel; Next step MARS?; Astronomy; August 2009; page 30]

Zubrin has heard all this before. But he remains immune to naysayers and unrepentant in his belief in the importance of going to Mars. For him, the dream dates to the Kennedy-era rhetoric that inspired him to join the aerospace industry in the first place. Cue sound byte: We go to Mars not because it's easy, but because it is hard.

"Relative to our technology today, a mission to Mars is much less challenging than a mission to the Moon was in 1961," Zubrin says. "For us to throw up our hands at these problems and say we just can't do it is really saying we've become less of a people than we used to be."

**MARS IS CURRENTLY WITHIN OUR REACH-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

In order to accomplish anything in space we need to set a goal. What should that goal be? In my view, the answer is straightforward: Humans to Mars within a decade [3], [4] and [5].

Why Mars? Because of all the planetary destinations currently within reach, Mars offers the most, both scientifically, socially, and in terms of what it portends for the human future.

**CAN’T LET PERCEPTIONS OF TECHNOLOGY GAPS STOP EXPLORATION-McLane ‘10**

[James C.; Associate Fellow in the American Institute of Aeronautics and Astronautics; The Space Review; 1 June 2010; <http://www.thespacereview.com/article/1635/1>; retrieved 25 July 2011]

Some suggest we should wait for better technology to arrive so we can make a human trip to Mars safer. What if Columbus had decided not to travel across the Atlantic until he could go on a steamship?

**AFTER A COMMITMENT BY THE UNITED STATES, THE TECHNOLOGY COULD BE READY FOR A MARS MISSION IN JUST 8 YEARS-Khadaroo '08**

[Stacy; A mission to Mars, in Utah; The Christian Science Monitor; 26 March 2008; page 13]

He was part of an eight-person international crew including engineers, a biologist, and a GPS expert all doing their own research. For two weeks, they traded earthly conveniences for scientific progress. They imposed a delay of roughly 20 minutes on e-mails. When they ventured outside their cylindrical two-level habitat, they had to wait in an airlock and don bulky simulated spacesuits - complete with boots, ski gloves, and bulbous helmets.

The Mars Society has been running mock missions since 2002 to promote - and prepare for - sending humans to a frontier that only telescopes and rovers have explored so far. "It's kind of a dress rehearsal," says Robert Zubrin, president and founder of the nonprofit society based in Lakewood, Colo. "We're looking to see what would work on Mars and what wouldn't - what skill mix, what character mix, what set of tools...." The society also operates a research station in Canada's Devon Island in the Arctic.

Mr. Zubrin believes a Mars program could inspire this generation of youths the way the 1960s moon program inspired him. The technology would be ready if the new American president would commit next year, he says: "We could be on Mars before the end of their second term."

**UNLIKE APOLLO, WE HAVE THE KNOW-HOW RIGHT NOW TO BUILD MARS MACHINES-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

Whichever approach is chosen, what all of them have in common is the speed with which they could be pulled off. Unlike the early Apollo planners, who weren't even sure they could get astronauts into near-Earth space, much less fling them out to the moon, Mars-mission directors have the basic space-travel technology down cold. All they need is the go-ahead to design and build their machines.

**PICKING THE GOAL OF MARS WILL DO A LOT TO START THE PROCESS OF DEVELOPING THE INFRASTRUCTURE TO MAKE IT WORK-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

Exploring Mars requires no miraculous new technologies, no orbiting spaceports, and no gigantic interplanetary space cruisers We do not need to spend the next 30 years with a space program mired in impotence, spending large sums of money and taking occasional casualties while the same missions to nowhere are flown over and over again and professional technologists dawdle endlessly in their sand boxes without producing any new flight hardware. We simply need to choose our destination, and with the same combination of vision, practical thinking, and passionate resolve that served us so well during Apollo, do what is required to get there.

**EARTH-BASED MISSIONS AND EXPERIMENTS HAVE CREATED KNOWLEDGE THAT COULD BE USED FOR ANY EXPLORATION MISSION-Khadaroo '08**

[Stacy; A mission to Mars, in Utah; The Christian Science Monitor; 26 March 2008; page 13]

During Cunio's mission in February, he tracked supplies in the MIT research team's Smart Small Logistics Container - garbage bags, batteries, latex gloves. Using RFID (radio-frequency identification), the small hexagonal container can communicate via a Web-based server when items have been removed and replaced.

Fellow MIT graduate student Arthur Guest did his two-week stint at the research station first, to set up and test the container, while Cunio and engineers from Aurora Flight Sciences provided remote support in Cambridge. Then the two switched places.

"This technology can be used for any exploration mission," Mr. Guest says. The Utah station "gives you a chance to take your idea, which you've designed in the laboratory setting, and then actually see how it works in a simulated environment," he adds. Cunio and a crewmate took the logistics container outside, walked 100 meters out and back, and strapped it to an ATV to test its transportability.

**WE HAVE THE TECHNOLOGY FOR MARS RIGHT NOW-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

The last word on risk comes from someone who might face the danger first hand. Tom Jones is a veteran Shuttle astronaut who works closely with the JSC Mars team. Members of his 1990 astronaut class wore a cloth patch that showed the moon and Mars because they hoped to visit both places. Jones, a geologist whose life would be on the line during a Mars mission, says "we can do a Mars mission with what we know now. If the goal is to send people to Mars to look for life," he says, "then let's send people to Mars."

A/T: COMMON RISK-BASED OBJECTIONS TO MARS

**OF COURSE THERE IS RISK TO A MARS MISSION BECAUSE IT IS SPACE EXPLORATION-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 421]

The Martian environment itself may hold some surprises, yet the 1970s vintage Viking landers, which were designed for ninety days of operation, functioned without hindrance on the Martian surface for four years, unaffected by cold, wind, or dust. The biggest mission risk arises from possible failures in critical mechanical or electrical systems. Multiple backups for all important systems can minimize the risk, as can the presence of two ace mechanics during the mission. Anyway you slice it, though, going to Mars the first time will involve a certain level of risk. This will be true whether we make the attempt with Mars Direct in 2007 or leave it for another generation to try. Nothing great has ever been accomplished without risk. Nothing great has ever been accomplished without courage.

**HUMANS ARE READY NOW FOR HUMANS TO MARS-Zubrin '09**

[Robert; President of the Mars Society; The moon–mars initiative: Making the vision real; Futures; October 2009; page 541]

Humans to Mars may seem like a wildly bold goal to proclaim in the wake of disaster, yet such a program is entirely achievable. From the technological point of view, we’re ready. Despite the greater distance to Mars, we are much better prepared today to send humans to Mars than we were to launch humans to the Moon in 1961 when John F. Kennedy challenged the nation to achieve that goal – and we were there 8 years later. Given the will, we could have our first teams on Mars within a decade.

**NO BIOMEDICAL ROADBLOCKS EXIST FOR A MARS MISSION-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

After working with astronauts for 10 years, Charles sees no biomedical roadblocks to Mars travel. But astronaut bodies will undergo changes. For example, in weightlessness travelers will lose bone density at the rate of about one percent per month. Earth's gravity restores bone mass, but structural changes persist after astronauts return to the ground. Biomedical studies slated for the space station, which is set for completion by 2003, should provide more data on the effects of long-duration weightlessness and let physicians perfect countermeasures. Charles already prescribes countermeasures which have proven effective for astronauts during long stays on the Mir space station--rigorous daily exercise, plenty of fluids, and salt tablets.

**RISKS OF RADIATION FROM A MARS MISSION ARE NOT SUBSTANTIAL-Zubrin '97**

[Robert; President of the Mars Society; The Case for Mars The Plan to Settle the Red Planet and Why We Must; 1997; Kindle Edition; Location 416]

Mars Direct is not without risk. The consequences of extended exposure to Mars’ gravity—38 percent that of Earth—are unknown. However, experience with the more severe deconditioning of astronauts in orbiting zero-gravity facilities indicates that most of the ill effects are temporary. Then there is space radiation, which on the six-month transit trajectories necessitated by current or near-term propulsion technology will give the astronauts doses sufficient to cause an additional 0.5 to 1 percent probability of a fatal cancer at some point later in life. This is nothing to scoff at, but those of us who stay home all face a 20 percent risk of fatal cancer anyway.

**RADIATION IS NOT AN ISSUE FOR A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Nevertheless, there are plenty of opponents to the idea of sending people to Mars; these critics frequently cite several issues, which they claim make such missions too dangerous to be considered at this time. Like the dragons that once marred the maps of medieval cartographers, these fears have deterred many who otherwise might be willing to support this mission. It is therefore fitting to address these considerations here.

One of the most common concerns is the allegation that the radiation doses involved in a Mars mission present insuperable risks or are not well understood. This is untrue. Solar flare radiation, consisting of protons with energies of about one million electron volts, can be shielded by 12 centimeters (five inches) of water or provisions, and there will be enough materials on board the ship to build an adequate pantry storm shelter for use in such an event. The residual cosmic-ray dose, about 50 rem for the 2.5 year mission, represents a statistical cancer risk of about 1 percent, roughly the same as the risk from smoking for the same amount of time.

**RADIATION IS NOT A TOP CONCERN FOR HUMAN HEALTH ON MARS MISSIONS-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

Beyond that, Joosten says no standards exist for governing safe levels of radiation exposure during interplanetary flight. Shuttle astronauts in Earth orbit are statistically lumped into a category that includes nuclear power plant workers. So-called radiation workers might see a 3% increase in mortality. By necessity, the level of acceptable radiation exposure might have to be set higher because interplanetary explorers are outside of Earth's protective magnetic cocoon. Even then, radiation is unlikely to be ranked above other risks. Charles notes that, "with radiation, at least, we can devise engineering solutions." He suggests arranging an expedition's cache of food and water to act as radiation shielding.

**ZERO GRAVITY IS NOT A CONCERN FOR A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

The hazards of zero gravity have caused concern among other critics. Cosmonauts have experienced marked physiological deterioration after extended stays in zero gravity on the Russian space station. Yet in 1996 American astronaut Shannon W. Lucid spent six months in zero gravity [see "Six Months on Mir," by Shannon W. Lucid; SCIENTIFIC AMERICAN, May 1998]. Because she actually implemented the rigorous exercise program designed by NASA flight surgeons, she returned to Earth in acceptable physical condition, able to walk off the shuttle despite the pull of Earth's gravity. And, as I mentioned earlier, the manned ships going to Mars could be flown employing artificial gravity generated by rotating the spacecraft. The engineering challenges associated with designing such systems are modest and make the issue of zero-gravity health effects during interplanetary missions moot.

**BACK-CONTAMINATION OF EARTH IS NOT AN ISSUE WITH A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Recently some people have raised the possibility of back-contamination of our planet as a reason to shun human missions to Mars (or even sample-return trips carried out by robots). Such fears have no basis in science. The surface of Mars is too cold for liquid water, it is exposed to a near vacuum and to ultraviolet and cosmic radiation, and it contains an antiseptic mixture of peroxides that have eliminated any trace of organic material. The surface of Mars is as sterile an environment as one could ask for. And even if there were life deep underground, it is quite impossible that these life-forms would pose a threat to terrestrial animals and plants. Pathogens are specifically adapted to their hosts, and there are no highly developed animals or plants to support a pathogenic life cycle in the Martian subsurface groundwater. In any case, Earth currently receives about 500 kilograms (1,100pounds) of Martian material each year in the form of meteorites that originated on Mars and were blown into space by meteoric impacts. The trauma that this material has experienced during ejection from Mars, the trip to Earth and entry into Earth's atmosphere is insufficient to have sterilized it. If there is the Red Death on Mars, we already have it. Members of the space community who are concerned with public health matters would do much better to offer assistance to medical relief agencies fighting infectious diseases such as HIV and tuberculosis here on Earth.

**HUMAN STRESS IS NOT AN ISSUE WITH A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Another issue mentioned frequently by the popular media is the concern that the isolation and stress of a 2.5-year round-trip mission to Mars present forbidding difficulties. On consideration, there is little reason to believe that this is true. Compared with the stresses dealt with by previous generations of explorers, mariners, prisoners, soldiers in combat and refugees in hiding, the adversities that will be faced by the hand-picked crew of a Mars mission seem extremely modest. In fact, history indicates that the human psyche, far from being the weak link in the chain of the piloted Mars mission, is very likely to be the strongest.

**DUST STORMS ARE NOT AN ISSUE WITH A MARS MISSION-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

Mars does have intermittent local, and occasionally global, dust storms with wind speeds up to 200 kilometers per hour (125 miles per hour). Attempting to land during such an event would certainly be a bad idea (in 1971 the Soviets lost two unmanned Mars probes this way). Once a ship is on the ground, however, the storms present little danger. The atmosphere on Mars has only about 1 percent the density of Earth's atmosphere at sea level. Thus, a wind with a speed of 200 kph on Mars exerts the same force as a 20-kph wind on Earth — really just a moderate breeze. The Viking landers endured many such storms with no damage.

A/T: SHOULD GO ROBOTIC MISSIONS INSTEAD

**HUMANS MUST EXPLORE MARS-Haque ‘11**

[Shirin, Ph.D., Astronomer, University of the West Indies, The Beckoning Red Dot in the Sky, The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

The human spirit of adventure and exploration of the unknown is likely encoded into our genetic makeup to ensure our survival as a species despite the risk and possible death to the soldiers of exploration at the frontier for the sake of the many that follow and the future.

Going to Mars is nothing more than the next logical step in our advancement of discovery and exploration. It must be done. Until we can do it -- we remain restless caged spirits. Sometimes, like in the case of the lunar landings, there was the dynamics of political agendas. Had there not been political agendas, I believe with certainty that humans would have landed on the moon nonetheless. It was the logical step at the time.

The opportunity to make history, to be the early charters risking it all is a small price for the satisfaction of doing it. It is an elixir of life only to experienced. It is a part of us in the deepest sense and what makes us human.

**THE POINT OF ALL OF THE UNSTAFFED MISSIONS IS TO EVENTUALLY ACHIEVE A STAFFED MISSION-Vergano '07**

[Dan; Prepare for landing; USA Today; 5 September 2007; page 7D]

The next big mission comes in 2009, when NASA hopes to land its nuclear-powered Mars Science Laboratory Rover, designed to answer Hartmann's question on whether Mars could have supported microbes.

"We need to connect the mission to future landings," says Friedman, whose society sponsored a DVD aboard the Phoenix lander that was packed with a story collection and the names of more than a quarter-million Mars mission supporters, intended as a library for future astronauts.

The real question in Mars exploration, he adds, is whether the success of the robotic missions can translate into astronaut landings.

"Mars is the eventual goal of any human space flight program," Friedman says. "For all the success we're having now, we have to remember it's not an ordinary thing to explore another planet."

**UNSTAFFED EXPLORATION DOESN'T COUNT AS TRUE EXPLORATION; HUMANS ARE REQUIRED-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Yet for some in the space community, "robots don't really count" as true exploration, he says.

Exploration of Mars will require "very subtle forms of perception and on-the-spot intuition," argues Robert Zubrin, founder and president of the Mars Society, in another article in the Journal of Cosmology. "All of these skills are far beyond the abilities of robotic rovers.... Drilling to reach subsurface hydrothermal environments where extant Martian life may yet thrive will clearly require human explorers as well.

"Put simply," he says, "as far as the question of Martian life is concerned, if we don't go, we won't know."

**HUMAN PRESENCE IN SPACE IS A CRITICAL PART OF AMERICA'S SPACE PROGRAM-Coile '04**

[Zachary; Budgeteers bushwhack president's Mars plan; They say the U.S. can't afford new space ventures; San Francisco Chronicle; 14 January 2004; page A15]

Many space enthusiasts, however, argue against an over-reliance on robotic probes, saying a human presence in space is an essential part of America's long history of flight and space exploration -- whether or not it pays off in future commercial benefits or scientific breakthroughs.

"It's part of our national identity to pioneer new frontiers. It is a uniquely American thing, to boldly go where no one has gone before," said John Pike, a longtime space analyst and director of GlobalSecurity.org. "To ask about the commercial or scientific benefits of human space flight is like asking about the scientific benefits of the Fourth of July."

**MOST OF MARS' MYSTERIES WILL STAY UNKNOWN UNTIL HUMANS ARE ABLE TO TRAVEL THERE-Zubrin '96**

[Robert; President of the Mars Society; Mars on a shoestring; November/December 1996; page 20]

Mars became an even more tantalizing destination in August 1996 when NASA scientists announced that an Antarctic meteorite--apparently from Mars--contained organic molecules and formations suggestive of microbes. If these are the remains of life, they may well be evidence of only the most modest representatives of an ancient Martian biosphere whose more interesting and complex manifestations are still preserved in fossil beds on the planet. To find them, though, will take more than robotic eyes and remote control. In fact, all that Mars holds will remain beyond our grasp until men and women--agile, autonomous, intuitive beings--walk upon its surface.

**MARS IS AN IMPORTANT HUMAN ASPIRATION-Geller ‘11**

[Harold, Ph.D., From the Pale Blue Dot to the Red Planet: Why Choose to go to Mars?; The Journal of Cosmology, 2011, <http://journalofcosmology.com/Mars151.html>; retrieved 29 July 2011]

Even after all this banter about the supposed waste of taxpayer money to go to Mars, while I know not what others may feel, but for me, if given the opportunity I would be willing to go to Mars, even if it meant never returning to Earth. Since Neil Armstrong took those first steps on the Moon, I had dreamed of someone, perhaps even me, stepping on the sands of Valles Marineris, collecting rock samples along the way. I realize that I am too old for even this one-way mission, but there are others who are not. To give one's final days in service to the pursuit of knowledge, to many, is a fine end to a life lived as well as one could. It reminds me of Wolfgang Vishniac, who died on the hills of Antarctica. Sagan wrote of Vishniac in his seminal book Cosmos. Regarding Vishniac's last moments alive, Sagan pondered "perhaps something had caught his eye, a likely habitat for microbes, say, or a patch of green where none should be. We will never know. In the small brown notebook he was carrying that day, the last entry reads, 'Station 202 retrieved. 10 December 1973. 2230 hours. Soil temperature, -10 degrees. Air temperature -16 degrees.' It had been a typical summer temperature for Mars" (Sagan, 1980).

It was Sagan who noted that we stand on "the shores of the cosmic ocean." He continued by saying: "The ocean calls. Some part of our being knows that this is from where we came. We long to return. These aspirations are not, I think, irreverent" (Sagan, 1980). I agree.

**UNSTAFFED MISSIONS AREN'T THE SAME AS EXPERIENCING IT WITH HUMAN EXPLORERS-Scoblic '04**

[Peter J.; Earth Diarist: Rational Exuberance; The New Republic; 2 February 2004; page 34]

It is true that humans "explore" in many ways, and plenty of scientists examine the cosmos and the very nature of reality itself without taking their feet off the ground. But it is also true that information is not the same thing as experience. The very tactility of discovery, as opposed to simple knowledge, is part of what makes it vital. Last September, I drove to rural Virginia, where a group of amateur astronomers had gathered their telescopes to glimpse Mars during its closest approach to Earth in 60,000 years. With the naked eye, the planet was only a dot in the sky, vaguely orange but scarcely different from your average star. But, viewed through a telescope, the planet assumed character. A blurry white covered one tip--the southern polar cap--and a dark splotch marred its upper left: a dust storm. Watching the weather on another planet live and in color, I was--there is no other word--awed. In a society where "searching" now all too often refers to a trip to Google.com, such awe is sorely lacking. If we abandon our search for it, we condemn ourselves to a future of seeing things we have already seen, touching things we have already touched, going places we have already been. A manned mission to the Red Planet, then, is nothing less than a mission to rescue our appreciation for novelty and all that it inspires. After all, whoever said there's nothing new under the sun had obviously never been to Mars.

**LOOKING FOR PRACTICAL REASONS FOR STAFFED MISSIONS TO MARS MAY MISS THE REAL, UNDERLYING JUSTIFICATION-Scoblic '04**

[Peter J.; Earth Diarist: Rational Exuberance; The New Republic; 2 February 2004; page 34]

Applebaum mistakenly assumes that the benefits of a manned trip to Mars must be tangible if they are to be "rational." But it doesn't take a historian to know that the benefits of exploration are often impossible to forecast, nor does it take a philosopher to understand that those benefits can be affective, as well as cognitive. Exploration is valuable precisely because it is a "quest" that evokes "awe," precious not only for its visceral thrill but for the perspective it proffers. It forces us to question the future of our race, the maturation of civilization, and the reason for human existence. Such questions may seem indulgent, even silly, when contrasted with the immediate, practical demands of daily life, but that does not make them less important. If we do not ask them, we lose the opportunity to transcend the current and the mundane and imagine what we want the future to hold.

**HUMANS MUST GO TO MARS TO DO WHAT THE ROBOTS CAN'T-Zubrin '99**

[Robert; President of the Mars Society; Sending Humans to Mars; Scientific American Presents; 1999; page 46]

In the summer of 1996, in one of the most exciting announcements in history, NASA scientists revealed a rock ejected from Mars by meteoric impact that showed evidence of life on the Red Planet in the distant past. If this discovery could be confirmed by finding actual fossils on the Martian surface, it would, by implication, suggest that our universe is filled with life and probably intelligence as well. From the point of view of humanity learning its true place in the universe, this would be the most important scientific enlightenment since Copernicus. Although unmanned rovers can conduct a certain amount of the search for life on Mars, the best fieldwork requires the ability to travel long distances across very rough terrain, climb steep slopes, and do both heavy lifting and delicate sorting, as well as exercise on-the-spot intuition. All these skills are far beyond the abilities of robotic rovers. Field paleontology requires human explorers, live rockhounds on the scene.

**HUMAN CREWS ON MARS COULD DO IN TWO YEARS WHAT ROBOTS WOULD TAKE UP TO 200 YEARS TO ACCOMPLISH-Portree '97**

[David S.F.; The new Martian chronicles; Astronomy; August 1997; page 32]

Duke is confident, however, that astronauts will win the day. "Humans will substantially accelerate the rate at which we can learn about Mars," he says. He cites the example of a robotic sample-return mission. Such a mission needs years to plan, build, and launch, followed by a six-month flight to the Red Planet, almost two years on the surface, and then a six-month return to Earth. After flight, the samples would still have to be analyzed. More years would pass before any follow-up missions could be mounted to explore any questions the first mission raised.

A piloted expedition, on the other hand, might require more time to plan and build, but it would also perform more science on Mars before returning to Earth. If explorers dug up something interesting, they would collect follow-up samples the following day, not years later. "Humans could do the same science on Mars in one or two years as robots could do in 100 to 200 years," Duke says.

ALTERNATIVE PLAN: ONE-WAY MARS TRIPS

**ELIMINATING THE RETURN TRIP WOULD DECREASE THE COST OF MARS MISSIONS BY 80%-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Humans could be walking on Mars within the next couple decades, for only a fraction of the cost the United States has already budgeted for space exploration.

How? The answer is simple, say a pair of Mars researchers: Give the explorers a one-way ticket.

The most costly and tricky part of any manned space mission is providing life-support for its human crew: food, oxygen, and protection from radiation and other hazards of space travel. On a human mission to Mars, most of the cost - some 80 percent of it - would involve returning the crew to Earth, say Dirk Schulze-Makuch and Paul Davies in the October-November issue of the Journal of Cosmology. Rather than quintuple the cost, those funds could go toward building a permanent settlement, the two scientists argue.

**ONE-WAY TRIPS TO MARS WOULD BE THRILLING FOR SCIENTIFIC EXPLORERS-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Perhaps new options will present themselves. Robinson imagines a kind of "virtual" space exploration, where instruments send back data so complete and realistic that earthbound humans feel almost as though they've visited the Red Planet themselves.

But for some, nothing will replace making their own boot tracks in the Martian dust.

"I still have small kids I would like to see grow up, but otherwise, yes, I would go" on a one-way expedition to Mars, Schulze-Makuch says.

"I would be one of the first people on another planet and would experience seeing those canyons, those huge mountains. That would be just thrilling.... There would be so many things on the positive side for me as a scientist. It would be incredible."

**MARS PIONEER SYSTEM IS NOT A SUICIDE MISSION-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

They propose that, after several unmanned missions drop supplies at a base station on the Red Planet, two spacecraft carrying two humans each would be sent on the six- to eight-month voyage to Mars to begin the first human colony on another planet.

Further missions would continue to supply the first settlers, who would be older, beyond child-bearing age, and - of course - volunteers.

Eventually, as the colonists made more use of Mars' own resources, including water trapped as ice, they would be joined by more migrants from Earth.

"It's not a suicide mission at all," argues Dr. Schulze-Makuch, coauthor of the paper and an associate professor at the school of earth and environmental sciences at Washington State University in Pullman.

Mars, he admits, "will never be a second Earth, you know, our home planet. But it's feasible to have people staying for a long time, and people living there, actually."

**PLENTY OF VOLUNTEERS ARE AVAILABLE FOR ONE-WAY TRIPS TO MARS-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Last spring, President Obama put forth a set of new goals for US space exploration, including sending astronauts into orbit around Mars by the mid-2030s and returning them to Earth. While Mars has a much weaker gravitational field than Earth's, the pull is significant, which would mean that ferrying astronauts to and from the Martian surface would be an additional challenge requiring more resources.

As Schulze-Makuch and Dr. Davies, a professor at Arizona State University, have promoted their idea, many people have stepped forward to volunteer for such a mission, they say.

One-way trips of colonization are common to human history, the authors argue. Most of the early settlers coming by ship to America had little hope of ever returning to Europe.

"They knew that they would never be coming back," Schulze-Makuch says.

**ONE WAY SCENARIO IS AKIN TO LANDING ON THE NORMANDY BEACHES IN WORLD WAR TWO OR THE ORIGINAL PLYMOUTH COLONY EXPLORERS-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Dr. Zubrin has set out his own plan to send humans to Mars - and return them. But he has no problem with a one-way expedition. "Life is a one-way trip," Zubrin says. "If you don't go to Mars, you're going to die on Earth. You're going to die somewhere."

He sees a one-way ticket to Mars as a Plymouth Colony scenario, in which more and more 17th-century English settlers slowly joined the original colonists in Massachusetts Bay.

Or, perhaps colonizing Mars is more akin to hitting the beach at Normandy, Zubrin says, referring to the invasion of Europe in World War II. The rationale would be "no matter what it takes, we'll take the beach," he says. "We may well run into problems, but we'll send more of everything. We're prepared to send more machines, more people, more supplies until the beach is taken."

**COLONIES ON MARS WOULD BE A BONANZA FOR RESEARCH-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

Colonist-scientists living on Mars could produce a bonanza in basic research, the authors say. That would include a better understanding of the origin of Earth itself, and perhaps even the discovery of the first extraterrestrial life.

**MARS COLONY IS A FIRST STEP TO MOVING AWAY FROM EARTH-Lamb '10**

[Gregory; One-way ticket to Mars?; The Christian Science Monitor; 17 November 2010; http://www.csmonitor.com/Innovation/One-way-ticket-to-Mars; retrieved 30 June 2011]

And in the long term, a Martian colony would be a huge first step toward humans moving away from Earth. Famed theoretical physicist Stephen Hawking has been among those arguing that because of the chance of a disaster on Earth, humans must start moving out into the solar system.

Planetary Defense Affirmative

**Observation 1. Inherency**

**A. CONGRESS HAS MANDATED DISCOVERY OF ALL LARGE NEOS BUT NOT PROVIDED ADEQUATE FUNDING-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Congress has mandated that NASA discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. The administration has not requested and Congress has not appropriated new funds to meet this objective. Only limited facilities are currently involved in this survey/discovery effort, funded by NASA’s existing budget.

The current near-Earth object surveys cannot meet the goals of the 2005 George E. Brown, Jr. Near-Earth Object Survey Act directing NASA to discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020.

**B. THERE IS NO GOVT OR DOD PLAN TO DEAL WITH NEO THREAT-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

Planetary defense may seem an abstract and unreal national security risk. however, it proved quite a serious problem for the dinosaurs,who previously inhabited our planet,and it poses no less a threat today. no matter how remote some people might think the chances of having rocks fall on their heads, they should at least be concerned that no government or DOD contingency plan exists to counter an impact or mitigate its consequences.

**Observation2. Harms**

**A. NASA ESTIMATES THAT THERE ARE AS MANY AS 20,000 HAZARDOUS COMETS AND ASTEROIDS-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

In 1980, only 86 near-Earth asteroids and comets were known to exist. By 1990, the figure had risen to 170; by 2000, it was 921; as of this writing, it is 5,388. The Jet Propulsion Laboratory, part of NASA, keeps a running tally at www.neo.jpl.nasa.gov/stats. Ten years ago, 244 near-Earth space rocks one kilometer across or more—the size that would cause global calamity—were known to exist; now 741 are. Of the recently discovered nearby space objects, NASA has classified 186 as “impact risks” (details about these rocks are at www.neo.jpl.nasa.gov/risk). And because most space-rock searches to date have been low-budget affairs, conducted with equipment designed to look deep into the heavens, not at nearby space, the actual number of impact risks is undoubtedly much higher. Extrapolating from recent discoveries, NASA estimates that there are perhaps 20,000 potentially hazardous asteroids and comets in the general vicinity of Earth.

**B. EVEN A RELATIVELY SMALL IMPACT COULD SO FUNDAMENTALLY ALTER THE ECOSYSTEM SO DRASTICALLY AS TO CAUSE MASS EXTINCTION-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

From the perspective of the current impact hazard, the most revolutionary insight of the Alvarez paper was that even small impacts (on a geological or astronomical scale) could severely damage the terrestrial ecosystem (Chapman k Morrison 1994). The K-T impactor had a mass one billion times less than that of the Earth, yet the ensuing extinction fundamentally redirected the course of biological evolution. In the two decades since this discovery, considerable work has been done to understand the mechanisms of mass extinction and to evaluate the ways that environmental stress might depend on the energy of the impact.

**C. AN ASTEROID IMPACT ON LAND WOULD ALTER THE WORLD’S ECOSYSTEMS AND LEAD TO CATASTROPHIC LOSS OF LIFE-Koplow ‘05**

[Justin; JD Candidate, Georgetow Law School; Assessing The Creation Of A Duty Under International Customary Law Whereby The United States of America Would Be Obligated To Defend A Foreign State Against The Catastrophic But Localized Damage Of An Asteroid Impact; Georgetown International Environmental Law Review; Winter 2005]

The disaster of an asteroid impact on land would only partially stem from actual impact. As Alvarez theorized, the asteroid would kick up dust and debris sufficient to choke out sunlight for years. Photosynthesis could not occur and with the death of vegetation the world's food chains would break, effectively [\*278] ending the majority of life on Earth. n13 Yet, more likely, as the Earth is over seventy percent water, the asteroid would hit one of Earth's oceans. The impact would produce tsunamis of up to one hundred meters in height; n14 waves that, if from an Atlantic Ocean impact, would break against the Shenandoah Mountains. n15 The impact would generate wind and heat resulting in massive storm fronts that would flood large parts of the world and alter world ecosystems with catastrophic loss of life.

**D.** **EVEN IF THE ODDS ARE INCREDIBLY LOW, THE POTENTIAL IMPACT IS THE ENTIRE HUMAN RACE-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

A generation ago, the standard assumption was that a dangerous object would strike Earth perhaps once in a million years. By the mid-1990s, researchers began to say that the threat was greater: perhaps a strike every 300,000 years. This winter, I asked William Ailor, an asteroid specialist at The Aerospace Corporation, a think tank for the Air Force, what he thought the risk was. Ailor’s answer: a one-in-10 chance per century of a dangerous space-object strike.

Regardless of which estimate is correct, the likelihood of an event is, of course, no predictor. Even if space strikes are *likely* only once every million years, that doesn’t mean a million years will pass before the next impact—the sky could suddenly darken tomorrow. Equally important, improbable but cataclysmic dangers ought to command attention because of their scope. A tornado is far more likely than an asteroid strike, but humanity is sure to survive the former. The chances that any one person will die in an airline crash are minute, but this does not prevent us from caring about aviation safety. And as Nathan Myhrvold, the former chief technology officer of Microsoft, put it, “The odds of a space-object strike during your lifetime may be no more than the odds you will die in a plane crash—but with space rocks, it’s like the entire human race is riding on the plane.”

**E. THE IMPACT HAZARD FROM AN NEO STRIKE EXCEEDS ANY KNOWN NATURAL OR MAN-MADE THREAT-Chapman ‘07**

[Clark; Senior Scientist Southwest Research Institute, Dept. of Space Studies; *Comet/Asteroid Impacts and Human Society*, 2007; pgs. 145-161]

The unique threat from the skies, however, is the very small but finite chance that a large asteroid or comet, 2 km or more across, will slam into the Earth at 100 times the speed of a jetliner, instantly producing a global environmental crisis unprecedented in human history and threatening the future of civilization as we know it. Half-a-dozen times since the beginning of the Cambrian Period half-a-billion years ago, when large, fossilizable life forms evolved on our planet, giant asteroids or comets 10 or 20 km across have struck Earth, producing a global holocaust that killed almost everything alive and transformed the biosphere. Human civilization is one result of such a mass-extinction, which ended the Cretaceous Period (when dinosaurs reigned) 65 million years ago. Such a mass-extinction could conceivably happen again, although the chance of it happening during our lives is extraordinarily small. In this sense, the impact hazard exceeds any other known natural or man-made threat to civilization's or even our species' future. It is the ultimate low-probability high-consequence hazard.

**Plan: The USFG should fund and develop a space-based survey of NEOs.**

**Observation 3. Solvency**

**A. A SPACE-BASED SURVEY IN SOLAR ORBIT IS THE BEST WAY TO DISCOVER NEO THREAT-David ‘10**

[Leonard; columnist; Experts Push for a NASA Asteroid-Hunting Spacecraft; Space.com; 21 Dec 2010; <http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?;> retrieved 27 Jun 2011]

Named after the late congressman, the George E. Brown, Jr., Near-Earth Object Survey section of the 2005 NASA Authorization Act called upon the space agency to detect, track, catalogue and characterize the physical characteristics of at least 90 percent of potentially hazardous NEOs larger than roughly 460 feet (140 meters) in diameter by the end of the year 2020.

But blue-ribbon panels of experts looking into the matter for the National Research Council reported in back-to-back reports in 2009 and 2010 that a lack of cash and political muscle make it "infeasible" that such a NEO census can be accomplished by 2020.

"If we seriously want to find all the asteroids which could be an impact hazard to the Earth, as well as find the asteroids which would be good destinations for human spaceflight, then a space-based survey telescope in solar orbit interior to Earth's would be the most rapid way to do that," NASA's Lindley Johnson told SPACE.com. Johnson is the space agency's NEO Observations Program Executive in the planetary science division of NASA's Science Mission Directorate in Washington, D.C.

**B. THE UNITED STATES NEEDS MORE THAN HOPE, BUT A SPECIFIC AGENCY IN CHARGE OF PREVENTING A DISASTER THAT COULD THREATEN THE SURVIVAL OF OUR SPECIES-Seamone ‘02**

[Evan; Articles Editor, Iowa Law Review; Masters in Public Policy, UCLA; When Wishing on a Star Just Won't Do: The Legal Basis for International Cooperation in the Mitigation of Asteroid Impacts and Similar Transboundary Disasters; Iowa Law Review; March 2002]

Because several organizations are currently empowered to deal with environmental harm less devastating than the harm posed by asteroids, n231 nations should develop a similar organization to address all transboundary megadisasters.

In the final analysis, regardless of our efforts to combat unknown environmental threats, "just as avoiding an all-out nuclear exchange becomes a first priority of superpowers, so avoiding general environmental [\*1139] collapse becomes a first priority of all responsible states." n232 Collisions with Earth pose serious questions that perhaps only a diverse group of committed policymakers are capable of addressing successfully. n233 By realizing the general principle of cooperative preservation and the need for proactive and anticipatory action to mitigate transnational disasters, we can begin to answer the legal questions relating to asteroid or comet impacts. Perhaps, these very principles will inform our understanding of the legal obligations related to other low probability, high consequence transnational crises.

Congressman Burton's fears about the U.S. government's role during the time of the Skylab crisis illustrate the concerns expressed in this Note: "I think I know what NASA is doing. They know they cannot control this, and they are scared to death. They don't know what to do. They will just do nothing and keep their fingers crossed, and maybe it will end up in the Indian Ocean." n234 In other words, when Earth faces its next space-body collision crisis, let us hope and pray that there exists a functioning organization in which we can place our faith, rather than merely wishing on a star, for the survival of our species.

**C. HUMANS HAVE THE TECHNOLOGY TO PREVENT IMPACTS. WE JUST NEED THE READINESS AND ACTION OF THE INTERNATIONAL COMMUNITY-Schweickart et al ‘08**

[Russell; Chairman Association of Space Explorers Near-Earth Object Committee; ASTEROID THREATS: A CALL FOR GLOBAL RESPONSE; 25 Sep 2008; <http://www.space-explorers.org/committees/NEO/ASE_NEO_Final_Report_excerpt.pdf;> retrieved 05 Jul 2011]

Humankind possesses the first two of the elements necessary for impact prevention: search telescopes and a proven spaceflight technology. The missing third element is the readiness and determination of the international community to establish decision-making capacities. This commitment to trigger timely action must be embodied in the form of a coordinated, pre-established international NEO decision-making process. This process must include deflection criteria and campaign plans which the international community can implement rapidly and with little debate. In the absence of an agreement on a decision-making process, we may lose the opportunity to act against a NEO in time, leaving evacuation and disaster management as our only response to a pending impact. A single such missed opportunity will add painful fault-finding to the devastating physical effects of an impact. The international community must begin work now on forging all three impact prevention elements (warning, deflection technology, and a decision-making process) into an effective defense against a future collision. The purpose of this document is to initiate a process at the United Nations level leading to the establishment of a decision-making framework for prevention of an asteroid impact. The framework should include an agreed-upon set of criteria, policies, and responsibilities, which can be applied without delay in the case of a specific asteroid threat.

**D. FOR THE FIRST TIME IN HISTORY, WE HAVE THE TECHNOLOGY TO PREVENT COSMIC COLLISIONS. WE SIMPLY NEED TO BEGIN THE PROCESS NOW-Schweickart et al ‘08**

[Russell; Chairman Association of Space Explorers Near-Earth Object Committee; ASTEROID THREATS: A CALL FOR GLOBAL RESPONSE; 25 Sep 2008; <http://www.space-explorers.org/committees/NEO/ASE_NEO_Final_Report_excerpt.pdf;> retrieved 05 Jul 2011]

Faced with such a threat, we are far from helpless. Astronomers today can detect a high proportion of Near Earth Objects and predict potential collisions with the Earth. Evacuation and mitigation plans can be prepared to cope with an unavoidable impact. For the first time in our planet's 4.5-billion-year history, the technical capacities exist to prevent such cosmic collisions with Earth. The keys to a successful outcome in all cases are preparation, planning, and timely decision-making. Efforts to deflect a NEO will temporarily put different populations and regions at risk in the process of eliminating the risk to all. Questions arise regarding the authorization and responsibility to act, liability, and financial implications. These considerations make it inevitable that the international community, through the United Nations and its appropriate organs, will be called upon to make decisions on whether or not to deflect a NEO, and how to direct a proposed deflection campaign. Because of the substantial lead time required for a deflection, decisions will have to be taken before it is certain that an impact will occur. Such decisions may have to be made as much as ten times more often than the occurrence of actual impacts. Existing space technology makes possible the successful deflection of the vast majority of hazardous NEOs. However, once a threatening object is discovered, maximizing the time to make use of that technology will be equally important. Failure to put in place an adequate and effective decision-making mechanism increases the risk that the international community will temporize in the face of such a threat. Such a delay will reduce the time available for mounting a deflection campaign. Therefore, timely adoption of a decision-making program is essential to enabling effective action.

**Underview**

**A. THE CATASTROPHIC IMPACT OF A MAJOR NEO STRIKE MANDATES A MORAL OBLIGATION TO DEVELOP A MITIGATION STRATEGY NO MATTER THE LEGAL OR POLICY OBJECTIONS-Bostrom ‘02**

[Nick; Professor of Philosophy, Oxford University; Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards; Journal of Evolution and Technology; Volume 9, No.1; 2002; <http://www.nickbostrom.com/existential/risks.html;> retrieved 27 Jun 2011]

Our approach to existential risks cannot be one of trial-and-error. There is no opportunity to learn from errors. The reactive approach – see what happens, limit damages, and learn from experience – is unworkable. Rather, we must take a proactive approach. This requires *foresight* to anticipate new types of threats and a willingness to take decisive *preventive action* and to bear the costs (moral and economic) of such actions.

We cannot necessarily rely on the institutions, moral norms, social attitudes or national security policies that developed from our experience with managing other sorts of risks. Existential risks are a different kind of beast. We might find it hard to take them as seriously as we should simply because we have never yet witnessed such disasters.[5] Our collective fear-response is likely ill calibrated to the magnitude of threat.

Reductions in existential risks are *global public goods* [13] and may therefore be undersupplied by the market [14]. Existential risks are a menace for everybody and may require acting on the international plane. Respect for national sovereignty is not a legitimate excuse for failing to take countermeasures against a major existential risk.

If we take into account the welfare of future generations, the harm done by existential risks is multiplied by another factor, the size of which depends on whether and how much we discount future benefits [15,16].

**B. THE OBLIGATION TO PROMOTE NATIONAL AND GLOBAL PRESERVATION TRUMPS ANY INTERNATIONAL LEGAL EFFORT TO MITIGATE ASTEROID PREVENTION**-**Seamone ‘02**

[Evan; Articles Editor, Iowa Law Review; Masters in Public Policy, UCLA; When Wishing on a Star Just Won't Do: The Legal Basis for International Cooperation in the Mitigation of Asteroid Impacts and Similar Transboundary Disasters; Iowa Law Review; March 2002]

The legal approaches below rest on a principle requiring global cooperation for the preservation of individual nations within a collective disaster response effort (hereinafter cooperative preservation). At the most basic level, all nations are bound to a well-recognized duty of self-preservation. n137 Cooperative preservation extends this duty by recognizing that some threats are so significant as to require a nation to participate in a group addressing the problem before it can successfully fulfill its obligation of self-preservation. n138 By this token, if preplanning is the only way to limit harm to a nation - and, by virtue of such necessities as massive international evacuation, the nation is forced to cooperate with other nations - the duty to collaborate trumps the sovereign right to limit joint mitigation efforts.

International mitigation of an asteroid or comet impact depends on the existence of a global right to survival and the correlative international duty [\*1120] of nations to enforce that right. At the most basic level, two components serve as building blocks for this right. First, nations must recognize their active roles in intervening to protect their citizens. Early jurists, such as Vattel, codified the principle of international law underlying this duty:

The end or object of civil society is to procure for the citizens whatever they stand in need of for the necessities, the conveniences, the accommodation of life, and, in general, whatever constitutes happiness, - with the peaceful possession of property, a method of obtaining justice with security, and, finally, a mutual defense against all external violence... .

In the act of association, by virtue of which a multitude of men form together a state or nation, each individual has entered into engagements with all, to promote the general welfare; and all have entered into engagements with each individual, to facilitate for him the means of supplying his necessities, and to protect and defend him. It is manifest that these reciprocal engagements can not otherwise be fulfilled than by maintaining the political association. The entire nation is then obliged to maintain that association; and as their preservation depends on its continuance, it thence follows that every nation is obliged to perform the duty of self-preservation.

This right is not negative in nature, but positive. n140 In other words, the government is not obligated strictly by morality, but, rather, by the need to sustain itself, which guarantees the existence of its sovereignty.

INHERENCY: CONGRESS IS INADEQUATELY FUNDING

**CONGRESS IS UNWILLING TO COMMIT TO FUNDING ASTEROID DETECTION-Reich ‘10**

[Eugenie; NASA panel weighs asteroid danger; Scientific American; 08 Sep 2010; <http://www.scientificamerican.com/article.cfm?id=nasa-panel-weighs-asteroid-danger;> retrieved 21 Jun 2011]

Shapiro stresses that it is unclear whether Congress will give further funds to planetary protection, noting that if it doesn't, there is a risk of the money being taken away from space science. Yet without better detection and tracking there will inevitably be uncertainty about asteroid positions in the future--and even greater expense if the uncertainty leads to unnecessary efforts to thwart an apparent pressing threat.

**CONGRESSIONAL FUNDING AMOUNT IS INSUFFICIENT TO DETECT THE MAJORITY OF NEOS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

The United States spends about $4 million annually searching for near-Earth objects (NEOs), according to NASA.[1](http://books.nap.edu/openbook.php?record_id=12842&page=1#p2001b3638960001001) The goal is to detect those that may collide with Earth. The funding helps to operate several observatories that scan the sky searching for NEOs, but, as explained below, it is insufficient to detect the majority of NEOs that may present a tangible threat to humanity. A smaller amount of funding (significantly less than $1 million per year) supports the study of ways to protect Earth from such a potential collision (“mitigation”).

**DESPITE PUBLIC’S EXPECTATION, GOVERNMENTS AND AGENCIES HAVE BEEN UNWILLING TO ADEQUATELY FUND NEO SURVEYS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Unlike the other hazards listed in Table 2.2, the hazard statistics for NEOs are dominated by single events with potentially high fatalities separated by long time intervals. Should scientists identify a large life-threatening object on a collision course with Earth, tremendous public resources to mitigate the risk would almost certainly be brought to bear. However, options for effective mitigation become much more limited when threatening objects are identified with only months to years, rather than decades or centuries, before impact. Thus, one of the greatest elements of risk associated with NEOs is the public’s expectation that governments will provide protection against any threat from NEOs, even as governments and agencies have been unwilling so far to expend public funds in a concerted effort to identify, catalog, and characterize as many potentially dangerous NEOs as possible, as far in advance of a damaging impact event as feasible.

**NASA IS CAPABLE OF FINDING ALL THE THREATENING ASTEROIDS, BUT LACKS THE FUNDS-Capital Times ‘07**

[Finding Killer Asteroids Too Pricey; Capital Times; 08 Mar 2007]

NASA officials say the space agency is capable of finding nearly all the asteroids that might pose a devastating hit to Earth, but there isn't enough money to pay for the task, so it won't get done.

The cost to find at least 90 percent of the 20,000 potentially hazardous asteroids and comets by 2020 would be about $1 billion, according to a report NASA will release later this week. The report was previewed Monday at a Planetary Defense Conference in Washington. Congress in 2005 asked NASA to come up with a plan to track most killer asteroids and propose how to deflect the potentially catastrophic ones.

"We know what to do, we just don't have the money," said Simon "Pete" Worden, director of NASA's Ames Research Center.

**NASA IS CURRENTLY IN A BIND. LACKING THE RESOURCES TO TRACK ORBITS WILL LOCK US INTO SENDING INCREDIBLY EXPENSIVE MISSIONS TO DEFLECT A HUGE NUMBER OF POTENTIAL THREATS-Reich ‘10**

[Eugenie; NASA panel weighs asteroid danger; Scientific American; 08 Sep 2010; <http://www.scientificamerican.com/article.cfm?id=nasa-panel-weighs-asteroid-danger;> retrieved 21 Jun 2011]

The dilemma stems from a 2005 congressional mandate directing NASA to log 90 percent of the estimated 20,000 NEOs larger than 140 meters in diameter by 2020. NASA seems unlikely to meet the goal, but the agency is stepping up its detection and tracking of smaller objects.

That will create a new problem: If the pace of NEO detections grows but precision tracking of orbits lags behind, observers will start to find more rocks--perhaps a few per year--that seem, at first, to have a significant chance of hitting Earth, say panel members. "I don't think that issue has been understood outside the NEO community," says Lindley Johnson, NEO program officer at NASA and a member of the panel. Launching missions to track or deflect all potential asteroid threats will be prohibitively expensive, but even a small probability of regional or global devastation may not be politically palatable.

**DESPITE INTERNAL PRESSURE, NO NASA ADMINISTRATOR IS OBLIGATING NASA TO PLANETARY DEFENSE-David ‘10**

[Leonard; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 October 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html>; retrieved 9 August 2011]

The seven-person Ad Hoc Task Force on Planetary Defense was established in April and reported to the NASA Advisory Council. The NAC provides the NASA Administrator with counsel and advice on programs and issues of importance to the space agency.

The NASA Advisory Council has approved the task force report. However, there?s still a long way to go in the sense that there is no obligation on the part of the NASA Administrator to follow the recommendations.

Still, the seven-person team writing the report has elevated the NEO issue, helping to better identify how NASA should further address planetary defense.

The task force was chaired by Schweickart and fellow former astronaut Thomas Jones, with other members representing academia, a space research institute, and NASA itself.

In the final report, the task force found that a planetary defense program plan is likely to require an annual budget of approximately $250 million to $300 million per year during the next decade.

INHERENCY: NASA ISN’T PRIORITIZING

**NASA HAS NOT SHOWN ENOUGH INTEREST IN THE THREAT OF NEOS-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

Given the scientific findings, shouldn’t space rocks be one of NASA’s priorities? You’d think so, but Dallas Abbott says NASA has shown no interest in her group’s work: “The NASA people don’t want to believe me. They won’t even listen.”

NASA supports some astronomy to search for near-Earth objects, but the agency’s efforts have been piecemeal and underfunded, backed by less than a tenth of a percent of the NASA budget. And though altering the course of space objects approaching Earth appears technically feasible, NASA possesses no hardware specifically for this purpose, has nearly nothing in development, and has resisted calls to begin work on protection against space strikes. Instead, NASA is enthusiastically preparing to spend hundreds of billions of taxpayers’ dollars on a manned moon base that has little apparent justification. “What is in the best interest of the country is never even mentioned in current NASA planning,” says Russell Schweick­art, one of the *Apollo* astronauts who went into space in 1969, who is leading a campaign to raise awareness of the threat posed by space rocks. “Are we going to let a space strike kill millions of people before we get serious about this?” he asks.

**CONGRESS AND THE PRESIDENT HAVE NOT DIRECTED A FOCUS ON NEOS, AND NASA ISN’T PUSHING FOR IT-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

In January, I attended an internal NASA conference, held at agency headquarters, during which NASA’s core goals were presented in a PowerPoint slideshow. Nothing was said about protecting Earth from space strikes—not even researching what sorts of spacecraft might be used in an approaching-rock emergency. Goals that *were* listed included “sustained human presence on the moon for national preeminence” and “extend the human presence across the solar system and beyond.” Achieving national preeminence—isn’t the United States pretty well-known already? As for extending our presence, a manned mission to Mars is at least decades away, and human travel to the outer planets is not seriously discussed by even the most zealous advocates of space exploration. Sending people “beyond” the solar system is inconceivable with any technology that can reasonably be foreseen; an interstellar spaceship traveling at the fastest speed ever achieved in space flight would take 60,000 years to reach the next-closest star system.

After the presentation, NASA’s administrator, Michael Griffin, came into the room. I asked him why there had been no discussion of space rocks. He said, “We don’t make up our goals. Congress has not instructed us to provide Earth defense. I administer the policy set by Congress and the White House, and that policy calls for a focus on return to the moon. Congress and the White House do not ask me what I think.” I asked what NASA’s priorities would be if he did set the goals. “The same. Our priorities are correct now,” he answered. “We are on the right path. We need to go back to the moon. We don’t need a near-Earth-objects program.” In a public address about a month later, Griffin said that the moon-base plan was “the finest policy framework for United States civil space activities that I have seen in 40 years.”

**THERE IS NO US GOVT AGENCY IN CHARGE OF ASTEROID IMPACT-Schweickart ‘05**

[Russell; Chairman, B612 Foundation; A Call to Considered Action; 20 May 2005; <http://www.b612foundation.org/papers/Call_for_Action.pdf;> retrieved 05 Jul 2011]

There is, however, no agency of the US Government whose responsibility it is to address the issue of asteroid impacts with the Earth and the multitude of policy issues raised by NEA impacts and deflection operations. While the general public may assume that NASA has such responsibility this is not the case; NASA has no such responsibility and is, in fact, a somewhat reluctant agent in the current NEA discovery program.

**NASA SPENDS LESS THAN 1% OF ITS BUDGET ON NEO RESEARCH-Sommer ‘04**

[Geoffrey; PhD; public policy analysis at the Pardee RAND Graduate School; Astronomical Odds

A Policy Framework for the Cosmic Impact Hazard; 2004; [www.rand.org/pubs/rgs\_dissertations/2005/RAND\_RGSD184.pdf;](http://www.rand.org/pubs/rgs_dissertations/2005/RAND_RGSD184.pdf;) retrieved 12 Jul 2011]

NASA’s FY 2004 budget request includes $1.359 billion for the Solar System Exploration Theme. The Dawn asteroid mission and the Deep Impact comet mission account for $145.5 million of that sum, and $5.3 million is required for operational support of the Stardust cometary encounter (Table 2.10). The total NASA Budget Request is for $15.469 billion. Thus, including the comet and asteroid probes, funding for efforts related to the impact hazard represent about 11 percent of NASA’s FY2004 Solar System Exploration budget request, and one percent of the total NASA request for that year.11 NEO survey funding (that is, not including the “characterization” missions) amounts to $4.062 million, thus about 0.3 percent of the Solar System Exploration request, and 0.026 percent of the total NASA request.

**THERE HAS BEEN INSUFFICIENT RESEARCH INTO MITIGATION OF AN NEO IMPACT-Chapman ‘07**

[Clark; Senior Scientist Southwest Research Institute, Dept. of Space Studies; *Comet/Asteroid Impacts and Human Society*, 2007; pgs. 145-161]

Besides these modest telescopic efforts, little serious research has been devoted to mitigation of an NEA impact. In a series of conferences during the past dozen years, aerospace engineers and physicists have addressed approaches to modifying the path of an NEA, years or decades before a predicted impact, so that it would miss the Earth rather than hit. The latest meeting (the AIAA Planetary Defense Conference, held in Garden Grove CA in February 2004) is thoroughly documented (with video and associated PowerPoint charts for all presentations, http://www.planetarydefense.info/). The proceedings of a late-2002 mitigation conference were published in late 2004 (Belton et al. 2004). Since funding of NEA deflection research has been minimal, mission designs are immature. Even fundamental issues like how much warning is needed to mount a successful deflection, or how soon can we tell whether an NEA will surely hit and where, are only beginning to be studied. The main point is that there are a variety of scenarios -- involving relatively modest-sized NEAs with warning times of >5 years, preferably much longer -- in which it is plausible that a combination of existing technologies could be used to gently, and controllably, move a threatening NEA into a path that would miss the Earth by a comfortable margin, rather than hit it. In other cases, typically involving very large NEAs or comets in which there is inadequate warning for controlled deflection, there is the possibility of altering the object's path with a nuclear bomb or other violent means; the outcomes of such interventions are less readily predictable and even the development of some of these concepts threatens treaty obligations prohibiting use of nuclear weapons in space.

INHERENCY: NOT ENOUGH RESEARCH

**THERE IS SIMPLY NOT ENOUGH FOCUS ON RESEARCHING THIS KIND OF EXISTENTIAL THREAT-Bostrom ‘02**

[Nick; Professor of Philosophy, Oxford University; Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards; Journal of Evolution and Technology; Volume 9, No.1; 2002; <http://www.nickbostrom.com/existential/risks.html;> retrieved 27 Jun 2011]

We need more research into existential risks – detailed studies of particular aspects of specific risks as well as more general investigations of associated ethical, methodological, security and policy issues. Public awareness should also be built up so that constructive political debate about possible countermeasures becomes possible.

Now, it’s a commonplace that researchers always conclude that more research needs to be done in their field. But in this instance it is really true. There is more scholarly work on the life-habits of the dung fly than on existential risks.

**THERE HAS BEEN LITTLE DIRECT FUNDING OF NEO RESEARCH IN EUROPE OR THE US-Chapman ‘07**

[Clark; Senior Scientist Southwest Research Institute, Dept. of Space Studies; *Comet/Asteroid Impacts and Human Society*, 2007; pgs. 145-161]

Hemmed in by flat budgets, NASA's Office of Space Science (recently transformed out of existence in NASA's organization charts), took the "high road" and declared that funds would not be carved out from "real astronomy" for practical matters like planetary defense; thus NASA-funded NEA research in the 1990s addressed questions involving the origin and evolution of the solar system. NASA's only forays into the NEA hazard arena have been under pressure from Congress and only in the narrow endeavor of telescopic searches for NEAs. NASA spacecraft missions like NEAR Shoemaker and Deep Impact have some obvious relevance to NEA hazard mitigation issues, but they were funded to meet pure scientific objectives. There has been more willingness, in principle, to address the NEA hazard within the European Space Agency. But there has been little direct funding of NEA hazard research in Europe or by any other national science agency, presumably in part because the budgetary pie has already been sliced up for existing scientific constituencies. The scientific establishment is as conservative as any other human institution and, barring an actual NEA impact, it may prove difficult to shift priorities in order to accommodate the impact hazard.

**RESEARCH ON THESE ISSUES FINDS RESEARCH DOLLARS RARE- Russell ‘05**

[Kate; Webscape; BBC; 15 April 2005; <http://news.bbc.co.uk/2/hi/programmes/click_online/4447565.stm>; retrieved 9 August 2011]

I found the articles, which are all about things that have, will, or might collide with Earth, to be well written, balanced, and highly informed.

I was shocked to learn about the near misses, and even direct hits, from space rocks and asteroids that we have suffered in the past.

Once I got stuck in I actually spent far more time exploring this site than I had planned, which is always a good sign.

Apart from the first class content and links, there is another point to this website.

It seems NEO scientists find it hard to get funding, which seems strange when you consider that the odds are more in favour of you getting wiped out by an asteroid than a tornado, according to one linked article from space.com.

HARMS: NEOS CAN CAUSE EXTINCTION/MASSIVE IMPACT

**FAILURE TO DEVELOP ASTEROID INTERCEPTION TECHNOLOGY MEANS AN ALMOST CERTAIN THREAT TO LIVE ON EARTH-Malik ‘10**

[Tariq; NASA’s New Asteroid Mission Could Save the Planet; Space.com; 16 April 2010; <http://www.space.com/8240-nasa-asteroid-mission-save-planet.html;> retrieved 21 Jun 2011]

And there's another compelling reason for touching an asteroid: Saving the planet.

In a panel discussion that followed President Obama's Thursday space vision speech, astrophysicist John Grunsfeld ? a former NASA astronaut who flew on five shuttle missions ? suggested sending humans to purposely move an asteroid, to nudge the space rock to change its trajectory. Such a feat, he said, would show that humanity could deflect a space rock if one threatened to crash into the planet.

"By going to a near-Earth object, an asteroid, and perhaps even modifying its trajectory slightly, we would demonstrate a hallmark in human history," said Grunsfeld, who flew on three shuttle missions to fix the Hubble Space Telescope. "The first time humans showed that we can make better decisions than the dinosaurs made 65 million years ago."

Take the moon, Grunsfeld said. Tycho crater, a huge impact crater on the moon visible from Earth, was created when an asteroid crashed into it 95 million years ago, he said.

"The dinosaurs *saw* that," Grunsfeld told reporters. "Thirty million years later they're snuffed out when the same thing happens to the Earth."

If humanity doesn't develop a capability to meet space rocks head-on, and win, than it is almost a certainty that an asteroid will eventually threaten life on Earth, he added.

**THERE IS NO QUESTION THAT AN OBJECT WILL HIT EARTH AND THREATEN ALL HIGHER FORMS OF LIFE-Powell ‘00**

[Corey; staff writer; 20 Ways the World Could End; Discover Magazine; October 2000; <http://discovermagazine.com/2000/oct/featworld;> retrieved 27 Jun 2011]

Once a disaster scenario gets the cheesy Hollywood treatment, it's hard to take it seriously. But there is no question that a cosmic interloper will hit Earth, and we won't have to wait millions of years for it to happen. In 1908 a 200-foot-wide comet fragment slammed into the atmosphere and exploded over the Tunguska region in Siberia, Russia, with nearly 1,000 times the energy of the atomic bomb dropped on Hiroshima. Astronomers estimate similar-sized events occur every one to three centuries. Benny Peiser, an anthropologist-cum-pessimist at Liverpool John Moores University in England, claims that impacts have repeatedly disrupted human civilization. As an example, he says one killed 10,000 people in the Chinese city of Chi'ing-yang in 1490. Many scientists question his interpretations: Impacts are most likely to occur over the ocean, and small ones that happen over land are most likely to affect unpopulated areas. But with big asteroids, it doesn't matter much where they land. Objects more than a half-mile wide—which strike Earth every 250,000 years or so—would touch off firestorms followed by global cooling from dust kicked up by the impact. Humans would likely survive, but civilization might not. An asteroid five miles wide would cause major extinctions, like the one that may have marked the end of the age of dinosaurs. For a real chill, look to the Kuiper belt, a zone just beyond Neptune that contains roughly 100,000 ice-balls more than 50 miles in diameter. The Kuiper belt sends a steady rain of small comets earthward. If one of the big ones headed right for us, that would be it for pretty much all higher forms of life, even cockroaches.

**RIDICULING THE LIKELIHOOD OF AN NEO STRIKE IGNORES THE DEVASTATING IMPACT, WORSE THAN A FULL SCALE NUCLEAR WAR-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

It is true that destructive impacts of gigantic asteroids and comets are extremely rare and infrequent when compared with most other dangers humans face, with the

intervals between even the smallest of such events amounting to many human generations... No one alive today, therefore, has ever witnessed such an event, and indeed there are no credible historical records of human casualties from impacts in the past millennium. Consequently, it is easy to dismiss the hazard as negligible or to ridicule those who suggest that it be treated seriously.

On the other hand, as has been explained, when such impacts *do* occur, they are

capable of producing destruction and casualties on a scale that far exceeds any other natural disasters; the results of impact by an object the size of a small mountain exceed the imagined holocaust of a full-scale nuclear war... Even the worst storms or floods or earthquakes inflict only local damage, while a large enough impact could have global consequences and place all of society at risk... Impacts are, at once, the least likely but the most dreadful of known natural catastrophes.

**ASTEROID AND COMET IMPACTS HAVE HAD A PROFOUND IMPACT ON PLANETARY HISTORY-Jones ‘11**

[Tom; astronaut and planetary scientist; Steps for Planetary Defense; National Space Society, 28 May 2011; <http://www.nss.org/adastra/volume23/planetarydefense.html;> retrieved 21 Jun 2011]

I saw dramatic evidence for the role of cosmic bombardment in Earth's biological and geological history during my four voyages to orbit: Impact structures, either fresh craters or the dissected remains of ancient impact scars, mark each of the six continents visible from the Space Shuttle and the International Space Station (ISS). From Arizona's 50,000-year old Meteor Crater to the margins of the Yucatan Peninsula, site of the Chicxulub impact 65 million years ago, to the sprawling, eroded rings of South Africa's Vredefort Structure (300 km across and some two billion years old), it's clear that asteroid and comet impacts have not only changed the face of the planet, but also redirected the path of biological evolution.

**MASSIVE ASTEROIDS CAN DESTROY THE ENTIRE ECOSYSTEM-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

Finally, asteroids more massive than 10 km can become “planet killers,” imparting kinetic energy equivalent to 100 million megatons of tnt—hundreds of times greater than all the nuclear weapons in the world (fig. 3).11 impacts of this size would destroy the entire ecosystem and cause mass extinctions. Earth might have suffered a few of these since life began. an impact nearly 65 million years ago that created the Chicxulub crater off the Yucatan peninsula might have eliminated the dinosaurs.

**THERE HAVE BEEN SIX MASS EXTINCTIONS LINKED TO STRIKES BY COMETS AND ASTEROIDS-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

There are at least six mass extinctions that have been linked with large impacts on Earth from space. n23 But how and why did these impacts have such a profoundly devastating effect on such a vast spectrum of living things?

Some scientists maintain that the greatest natural disasters on Earth have been caused by impacts of large asteroids and comets. Although rare compared to "ordinary" floods and earthquakes, they are infinitely more dangerous to life. There are several reasons for this.

Initially, of course, a giant object hitting the Earth at spectacular, hypersonic velocity would utterly destroy the local area around the impact. An explosive release of kinetic energy as the object disintegrates in the atmosphere and then strikes the Earth generates a powerful blast wave. The local atmosphere can be literally blown away. If the impact falls on ocean territory, it may create a massive tidal wave or tsunami, with far-reaching effects. n24

When tsunamis strike land, their immense speed decreases, but their height increases. It has been suggested that tsunamis may be the most devastating form of damage produced by relatively small asteroids, i.e., those with diameters between 200 meters and 1 kilometer. "An impact anywhere in the Atlantic Ocean by an asteroid more than 400 meters in diameter would devastate the coasts on both sides of the ocean with tsunami wave runups of over 60 meters high." n25

Horrific as such phenomena are, they are dwarfed by a potentially far greater hazard. The impact of a sufficiently large object on land may cause

a blackout scenario in which dust raised by the impact prevents sunlight from reaching the surface [of the Earth] for several months. Lack of sunlight terminates photosynthesis, prevents creatures from foraging for food, and leads to precipitous temperature declines... Obviously even much [\*125] smaller impacts would have the potential to seriously damage human civilization, perhaps irreparably.

**ASTEROIDS WIPED MOST LIFE OFF THE EARTH 65 MILLION YEARS AGO-Coffey ‘09**

[Jerry; Asteroid Extinction Theory; Universe Today; 6 August 2009; <http://www.universetoday.com/36706/asteroid-extinction-theory/>; retrieved 9 August 2011]

The asteroid extinction theory is also known as the K-T asteroid theory and, occasionally, the Alvarez Asteroid Impact Theory. All of these theories vary slightly, but they all center around an impressive event that suddenly destroyed most of the life on Earth around 65 million years ago.

The asteroid extinction theory holds that many of the dinosaurs went extinct long before the catastrophic mass extinction at the end of the Cretaceous period, 65 million years ago. Background extinctions and many minor extinctions accounted for the disappearance of most of the dinosaur species. The latter part of the period saw some heavy tectonic shifting and volcanic activity. The super continents had all separated or were in the process of separating. Many mountain ranges were formed and sea levels rose during the mid-Cretaceous, covering about one-third of the land area. Toward the end of the Cretaceous, there was a drop in sea level, causing land exposure on all continents, more seasonality, and greater extremes between equatorial and polar temperatures. As the Earth aged these climate changes had caused many species to die out and others to emerge.

HARMS: THERE ARE MANY THREATENING NEOS

**INVESTIGATION OF THE KUIPER BELT HAS ALREADY DISCOVERED OVER 1,000 PLANET-KILLERS-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

These standard assumptions—that remaining space rocks are few, and that encounters with planets were mainly confined to the past—are being upended. On March 18, 2004, for instance, a 30-meter asteroid designated 2004 FH—a hunk potentially large enough to obliterate a city—shot past Earth, not far above the orbit occupied by telecommunications satellites. (Enter “2004 FH” in the search box at Wikipedia and you can watch film of that asteroid passing through the night sky.) Looking at the broader picture, in 1992 the astronomers David Jewitt, of the University of Hawaii, and Jane Luu, of the Massachusetts Institute of Technology, discovered the Kuiper Belt, a region of asteroids and comets that starts near the orbit of Neptune and extends for immense distances outward. At least 1,000 objects big enough to be seen from Earth have already been located there. These objects are 100 kilometers across or larger, much bigger than whatever dispatched the dinosaurs; space rocks this size are referred to as “planet killers” because their impact would likely end life on Earth. Investigation of the Kuiper Belt has just begun, but there appear to be substantially more asteroids in this region than in the asteroid belt, which may need a new name.

**THERE ARE MORE THAN A MILLION NEOS CAPABLE OF CAUSING SEVERE LOCAL DISASTERS-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Although much less frequent than most natural hazards, cosmic impacts represent the most extreme known threat in terms of damage and casualties (for a recent review see Morrison et al 2003). As we know from the end Cretaceous impact of 65 Ma, the global effects of such catastrophes can include mass extinction of species. Fortunately, events of this magnitude are exceedingly rare, and astronomers are confident that there are no asteroids in Earth approaching orbits today as large as the one that ended the age of the dinosaurs. However, the population of cosmic impactors spans a vast size range, with many more small objects than large ones. There are more than a million near-Earth asteroids that are capable of causing severe local disasters when they strike. For perspective, note that even the smallest projectile that can reach the surface at cosmic speed has an explosive energy hundreds of times greater than the Hiroshima atom bomb.

HARMS: EVEN SMALL OBJECTS CAN BE DEVASTATING

**GIVEN THE POTENTIALLY LARGE IMPACT OF SMALLER OBJECTS, SURVEYS SHOULD FIND AS MANY 30-50 METER OBJECTS AS POSSIBLE-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

The committee notes that objects smaller than 140 meters in diameter are also capable of causing significant damage to Earth. The best-known case from recent history is the 1908 impact of an object at Tunguska in the Siberian wilderness that devastated more than 2,000 square kilometers of forest. It has been estimated that the size of this object was on the order of approximately 70 meters in diameter, but recent research indicates that it could have been substantially smaller (30 to 50 meters in diameter), with much of the damage that it caused being due to shock waves from the explosion of the object in Earth’s atmosphere. (See, e.g., Chyba et al., 1993; Boslough and Crawford, 1997, 2008.) The committee strongly stresses that this new conclusion is preliminary and must be independently validated. Since smaller objects are more numerous than larger ones, however, this new result, if correct, implies an increase in the frequency of such events to approximately once in three centuries.

All told, the committee was struck by the many uncertainties that suffuse the subject of NEOs, including one other related example: Do airbursts from impactors in this size range over an ocean cause tsunamis that can severely damage a coastline? This uncertainty and others have led the committee to the following recommendation:

Recommendation: Because recent studies of meteor airbursts have suggested that near-Earth objects as small as 30 to 50 meters in diameter could be highly destructive, surveys should attempt to detect as many 30- to 50-meter-diameter objects as possible. This search for smaller-diameter objects should not be allowed to interfere with the survey for objects 140 meters in diameter or greater.

**SMALL NEO COLLISIONS COULD HAPPEN EVERY FEW HUNDRED YEARS, WITH DEVASTATING IMPACTS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Work by Boslough and Crawford (1997, 2008), however, indicates that a much lower yield could produce the same effects. They found that asteroid airbursts do not act like point explosions in the sky (e.g., like a nuclear bomb explosion) but instead are more analogous to explosions along the line of descent. In an airburst, kinetic energy (see Appendix E) is deposited along the entry path, with significant downward momentum transferred to the ground. Accordingly, these researchers suggest that smaller explosions, with net yields of 3 to 5 MT, may be sufficient to produce Tunguska-like impact events. If true, the average interval between Tunguska-like events using the Harris (2009) size distribution (see Figure 2.4) would be on the order of a few hundred years. These results would increase the calculated hazard from smaller objects, perhaps those as small as 30 meters or so in diameter. Further research is needed to better characterize this threat.

**IMPACTS WITH SMALLER BODIES CAN HAVE A DEVASTATING IMPACT-Ailor ‘08**

[William; Director, Center for Orbital and Reentry Debris Studies at The Aerospace Corporation; Planetary Defense: Are We Ready; Aerospace America; January 2008; pgs. 26-31]

We have come a long way during the past 15 years in our efforts to discover asteroids and comets larger than 1 km in diameter. Near Earth objects (NEOs) in this size range are significant:

If one of these should hit Earth, civilization as we know it would be wiped out, and humanity would be forced back to a much more primitive state. Thanks to a congressionally mandated NASA-led study, we now believe we know where about 80% of the objects 1 km or larger are. According to that study, which began in 1998, none of these objects poses an immediate threat.

Unfortunately, impacts of bodies smaller than 1 km in diameter also can have devastating, if not civilization-ending, effects. For example, an object estimated to be in the size range of 30-60 m in diameter exploded over Siberia in 1908, leveling and igniting over 2,000 km2 of forest—a region larger than the Washington, D.C., metropolitan area. According to scientific estimates, the energy released in this “Tunguska Event” was equivalent to 10-20 megatons of TNT.

**EVEN A 2 KILOMETER ASTEROID WOULD STRIKE WITH THE FORCE OF 20 MILLION HIROSHIMA BOMBS-Koplow ‘05**

[Justin; JD Candidate, Georgetow Law School; Assessing The Creation Of A Duty Under International Customary Law Whereby The United States of America Would Be Obligated To Defend A Foreign State Against The Catastrophic But Localized Damage Of An Asteroid Impact; Georgetown International Environmental Law Review; Winter 2005]

Of course, all of those secondary effects come after the initial concussive force of the impact itself. It has been estimated that an asteroid of two kilometers in diameter would impact the Earth at a speed of 30,000 kilometers per hour, with an explosive force of 320,000 megatons of TNT. n17 For reference, the Hiroshima atomic bomb was just 10 to 15 kilotons of TNT and it killed 60,000 people in the initial destruction alone. n18 The Hiroshima bomb created a ground zero temperature approaching 7000 degrees Fahrenheit, with blast winds of 980 miles per hour and serious damage done over 15,000 feet from ground zero. n19 Destruction inside one mile was total. A two-kilometer wide asteroid is twenty million times more powerful than the Hiroshima bomb, which is the most deadly weapon man has ever used in war.

**SOME OF THE WORST IMPACTS COULD COME FROM THE SMALLEST ASTEROIDS-Oregon State University ‘07**

[Ultraviolet Death May Follow Asteroid Devastation; InfoPlease; 2007; <http://www.infoplease.com/ipa/A0874428.html>; retrieved 9 August 2010]

According to their study, these factors would lead to ultraviolet-related DNA damage about 1,000 times higher than normal and general ultraviolet damage to plants about 500 times higher than normal. Ultraviolet radiation can cause mutations, cancer, and cataracts. It can kill plants or slow their growth, suppressing photosynthesis, which forms the base of the world's food chain.

The researchers said that smaller asteroid impacts, which have happened far more frequently in Earth's history, theoretically might cause similar or even worse problems with ultraviolet exposure. The ozone depletion would be less, but there would also be less of a protective dust cloud.

HARMS: THREATS ARE FREQUENT

**OBJECTS WITH 3 TIMES THE POWER OF HIROSHIMA THREATEN THE EARTH EVERY DECADE-Choi ‘10**

[Charles; A Week's Warning of Asteroid Strike Would Be Simple, Scientist Says; Space.com; 03 Dec 2010; <http://www.space.com/9629-week-warning-asteroid-strike-simple-scientist.html?;> retrieved 27 Jun 2011]

An asteroid the size of a bus exploded that Oct. 28 as it entered Earth's atmosphere over an isolated part of Indonesia. The burst of the 33-foot-long (10 meters) rock packed the equivalent of roughly 50,000 tons of TNT, more than three times the strength of the atomic bomb dropped on Hiroshima.

No one was reported hurt, but Tonry said objects of that size are likely to threaten Earth once per decade.

According to estimates by Tonry and other researchers, the rate of impact by asteroids at least 460 feet (140 meters) long is just once per 20,000 years or more ? but the smaller the rock, the larger the risk. A roughly 160-foot-long (50 meters) object like the one that devastated the Tunguska area in Russia in 1908 is likely to impact Earth about once every millennium, while a 65- to 100-foot-long asteroid (20 to 30 meters) should strike once every century.

The National Research Council estimated a 160-foot-long object would cause an average of 30,000 deaths.

**WE ARE LEARNING THAT NEO STRIKES ARE MUCH MORE FREQUENT AND LIKELY THAN WE THOUGHT-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

At the start of her research, which has sparked much debate among specialists, Abbott reasoned that if colossal asteroids or comets strike the sea with about the same frequency as they strike land, then given the number of known land craters, perhaps 100 large impact craters might lie beneath the oceans. In less than a decade of searching, she and a few colleagues have already found what appear to be 14 large underwater impact sites. That they’ve found so many so rapidly is hardly reassuring.

Other scientists are making equally unsettling discoveries. Only in the past few decades have astronomers begun to search the nearby skies for objects such as asteroids and comets (for convenience, let’s call them “space rocks”). What they are finding suggests that near-Earth space rocks are more numerous than was once thought, and that their orbits may not be as stable as has been assumed. There is also reason to think that space rocks may not even need to reach Earth’s surface to cause cataclysmic damage. Our solar system appears to be a far more dangerous place than was previously believed.

**BOTH PLANET AND CITY-KILLING OBJECTS CAN STRIKE WITH VERY LITTLE WARNING, AS EVIDENCED BY JUPITER-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

Zipping near Earth’s orbit, most of these potentially hazardous objects travel in predictable orbits, allowing us to spot them decades in advance. however, we have only begun to comprehend thethreat.Comets such as Shoemaker-Levy orbit too infrequently for us to characterize them and arrive with very little warning. this particular one hit Jupiter in 1994, raining down approximately 20 fragments several hundred meters in size and delivering several hundred megatons of explosive power per fragment.13 Furthermore, city killers can arrive without warning due to the spotty nature of our current surveillance. one such minimal warning occurred on 18 March 2004, when an asteroid came within 3.4 Earth diameters or 43,000 km from Earth, having been identified only 48 hours prior.14 this distance lies just outside the geostationary orbits of satellites circling our home.

**FURTHER INVESTIGATION WILL REVEAL DOZENS OF NEOS WHICH POSE DEVASTATING POTENTIAL THREAT- Schweickart et al ‘08**

[Russell; Chairman Association of Space Explorers Near-Earth Object Committee; ASTEROID THREATS: A CALL FOR GLOBAL RESPONSE; 25 Sep 2008; <http://www.space-explorers.org/committees/NEO/ASE_NEO_Final_Report_excerpt.pdf;> retrieved 05 Jul 2011]

Earth's geological and biological history is punctuated by evidence of repeated and devastating impacts from space. Sixty-five million years ago, an asteroid impact caused the extinction of the dinosaurs along with some 70% of Earth's living species. A more typical recent impact was the 1908 Tunguska Event, a 3-5 megaton explosion which destroyed 2,000 square kilometers of Siberian forest. A future asteroid collision could have disastrous effects on our interconnected human society. The blast, fires, and atmospheric dust produced could cause the collapse of regional agriculture, leading to widespread famine. Ocean impacts like the Eltanin event (2.5 million years ago) produce tsunamis which devastate continental coastlines. Asteroid 99942 Apophis, which has a 1-in-45,000 chance of striking Earth in 2036, would generate a 500-megaton (MT) blast and inflict enormous damage. Devastating impacts are clearly infrequent events compared to a human lifetime: Tunguska, thought to be caused by the impact of a 45-meter-wide asteroid, is an event that occurs on average two or three times every thousand years. However, when Near Earth Object (NEO) impacts occur they can cause terrible destruction, dwarfing that caused by more familiar natural disasters. Advances in observing technology will lead to the detection of over 500,000 NEOs over the next 15 years. Of those several dozen will pose an uncomfortably high risk of striking Earth and inflicting local or regional devastation.

HARMS: SMALL RISK, BUT ENORMOUS IMPACT

**THERE MAY BE LITTLE RISK OF AN NEO IMPACT, BUT ITS POTENTIAL FOR DEVASTATION IS NEARLY INFINITE-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Assessing risk is difficult primarily because of the lack of sufficient data. The committee’s best current estimates are given in Chapter 2, where the risk is presented, with its dependence on impactor size and associated average impact frequency, along with damage estimates in terms of lives and property. Figure 1.1 illustrates the estimated frequency of near-Earth object (NEO)[1](http://books.nap.edu/openbook.php?record_id=12842&page=7#p2001b3638960007001) impacts on Earth for a range of NEO sizes. For impactor diameters exceeding about 2 to 3 kilometers, worldwide damage is possible, thus affecting all of humanity and its entire living space (the minimum size at which impactors can cause global devastation is still uncertain). While such a collision is exceedingly rare, the consequences are enormous, almost incalculable. This presents the classic “zero times infinity” problem: nearly zero probability of occurrence but nearly infinite devastation per occurrence.

**PROBABILISTIC RISK OF NEO IMPACT SHOULD NOT PREVENT EXPENDITURES FOR RESEARCH-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Dealing with the hazards of near-Earth object (NEO) impact is complicated because it involves balancing the imprecisely known risks of this hazard against the costs, risks, and benefits of proposed responses. Since the NEO impact risk is partly probabilistic in nature, it is difficult to grasp and difficult to communicate unless and until an object is discovered that will hit Earth at some definite date not too far in the future. However, the probabilistic risk is similar to that for other types of natural disasters like earthquakes. Scientists have an idea of the likelihood that an earthquake of a given magnitude will strike a given region within a given time. The fundamental reasons why earthquakes occur are known (they are associated with plate tectonics), and it is known that the risks from earthquakes are particularly high in certain specific regions (e.g., near plate boundaries, in certain types of soil). However, no one can predict with confidence the date of the next great earthquake of magnitude 7 or larger that will strike San Francisco or Tokyo. Nevertheless, it is known from experience that such disasters *will occur*, and moreover experts can assess the likely damage. The United States and other countries around the world have responded to the risk of earthquakes by committing to various civil-defense and mitigation programs, including research programs. The U.S. federal and state governments dedicate resources to earthquake research in order to improve the understanding of the causes of the hazard, to better quantify risks and to improve the capabilities for prediction, and to increase the effectiveness of mitigation measures. Likewise, an appropriate and necessary aspect of mitigation of the NEO impact hazard is a research program.

**THOUGH UNLIKELY, AN EXTINCTION LEVEL EVENT DEMANDS SOLUTIONS-Matheny ‘07**

[Jason; Reducing the Risk of Human Extinction; Risk Analysis; 2007; Volume 27, Number 5;<http://www.upmc-biosecurity.org/website/resources/publications/2007_orig-articles/2007-10-15-reducingrisk.html>;; retrieved 27 Jun 2011]

Even if extinction events are improbable, the expected values of countermeasures could be large, as they include the value of all future lives. This introduces a discontinuity between the CEA of extinction and nonextinction risks. Even though the risk to any existing individual of dying in a car crash is much greater than the risk of dying in an asteroid impact, asteroids pose a much greater risk to the existence of future generations (we are not likely to crash all our cars at once) (Chapman, 2004). The “death-toll” of an extinction-level asteroid impact is the population of Earth, plus all the descendents of that population who would otherwise have existed if not for the impact. There is thus a discontinuity between risks that threaten 99% of humanity and those that threaten 100%.

**POLICYMAKERS ARE DISINCLINED TO SEE LOW-RISK EVENTS AS PRIORITIES-Matheny ‘07**

[Jason; Reducing the Risk of Human Extinction; Risk Analysis; 2007; Volume 27, Number 5;<http://www.upmc-biosecurity.org/website/resources/publications/2007_orig-articles/2007-10-15-reducingrisk.html>; retrieved 27 Jun 2011]

We may be poorly equipped to recognize or plan for extinction risks (Yudkowsky, 2007). We may not be good at grasping the significance of very large numbers (catastrophic outcomes) or very small numbers (probabilities) over large timeframes. We struggle with estimating the probabilities of rare or unprecedented events (Kunreuther et al., 2001). Policymakers may not plan far beyond current political administrations and rarely do risk assessments value the existence of future generations.18 We may unjustifiably discount the value of future lives. Finally, extinction risks are market failures where an individual enjoys no perceptible benefit from his or her investment in risk reduction. Human survival may thus be a good requiring deliberate policies to protect.

**ASTEROID WOULD BE DEVASTATING TO PLANTS AND ANIMALS ON EARTH-Oregon State University ‘07**

[Ultraviolet Death May Follow Asteroid Devastation; InfoPlease; 2007; <http://www.infoplease.com/ipa/A0874428.html>; retrieved 9 August 2010]

Scientists from Oregon State University and the British Antarctic Survey reported in March 2000 that if a huge asteroid were to hit Earth, the catastrophic destruction it would cause, and even the “impact winter” that would follow, might only be a prelude to a different but very deadly phase that would start later on. They're calling it “ultraviolet spring.”

Andrew Blaustein, a professor of zoology at Oregon State University, and his colleague Charles Cockell, a researcher with the British Antarctic Survey, examined secondary ecological repercussions of a major asteroid impact of a magnitude similar to the one that occurred around the Cretaceous-Tertiary, or K-T, boundary. This asteroid is believed to have hit off the Yucatán Peninsula with a force of almost one trillion megatons. At the time, there was a massive extinction of many animals, including the dinosaurs.

The immediate result of an asteroid impact would be devastating destruction and an impact winter, with widespread death of plants and the large terrestrial animals—including humans—that most directly depend on those plants for food. Such an impact would also load the atmosphere with nitric oxide, causing massive amounts of acid rain. As they became acidified, the lakes and rivers would have reduced amounts of dissolved organic carbons, thereby allowing for much greater penetration of ultraviolet light.

HARMS: FAILURE TO ADDRESS WILL UNDERMINE NATION STATE

**THE LEGITIMACY OF THE NATION-STATE WILL BE CALLED INTO QUESTION IF GOVERNMENTS FAIL TO RESPOND TO ASTEROID THREAT-Seamone ‘02**

[Evan; Articles Editor, Iowa Law Review; Masters in Public Policy, UCLA; When Wishing on a Star Just Won't Do: The Legal Basis for International Cooperation in the Mitigation of Asteroid Impacts and Similar Transboundary Disasters; Iowa Law Review; March 2002]

Certain dangers are so devastating that, upon their occurrence, governments inevitably develop plans to prevent similar harm. Chernobyl, Hiroshima and Nagasaki, and the World Trade Center attacks all marked events so horrific that nations rallied the resources to make a sustained collective effort necessary to regulate matters. n220 If an asteroid or comet of [\*1136] significant mass should strike a populated area, citizens of the world would undoubtedly expect to see implemented many of the preventive efforts I have urged. n221 After all, nations must prevent their citizens from returning to the Hobbesian state of nature described in Part V.C. n222 When nations do not adequately handle serious threats, their citizens will often lose faith in figures of power. n223 As a result, governments tend to respond immediately, and perhaps in an even more exaggerated way than necessary, to assure [\*1137] their citizens that their safety will be preserved. This Note holds nations to a higher standard of responsibility. Nations should no longer be preoccupied with the present, but should plan for the future. Governments must address serious concerns about allocating scarce resources and lay plans to cope with the horrific realities that will inevitably accompany megadisasters.

HARMS: APOPHIS

**APOPHIS ASTEROID DEMONSTRATES THE POTENTIAL THREAT OF SMALL NEOS-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

A more recent event gives further cause for concern. As buffs of the television show *The X Files* will recall, just a century ago, in 1908, a huge explosion occurred above Tunguska, Siberia. The cause was not a malfunctioning alien star-cruiser but a small asteroid or comet that detonated as it approached the ground. The blast had hundreds of times the force of the Hiroshima bomb and devastated an area of several hundred square miles. Had the explosion occurred above London or Paris, the city would no longer exist. Mark Boslough, a researcher at the Sandia National Laboratory, in New Mexico, recently concluded that the Tunguska object was surprisingly small, perhaps only 30 meters across. Right now, astronomers are nervously tracking 99942 Apophis, an asteroid with a slight chance of striking Earth in April 2036. Apophis is also small by asteroid standards, perhaps 300 meters across, but it could hit with about 60,000 times the force of the Hiroshima bomb—enough to destroy an area the size of France. In other words, small asteroids may be more dangerous than we used to think—and may do considerable damage even if they don’t reach Earth’s surface.

**AN ASTEROID LIKE APOPHIS WOULD INFLICT HORRIFIC HUMAN AND ECONOMIC LOSSES-Bucknam and Gold ‘08**

[Mark, Deputy Director for Plans, Secretary of Defense, and Robert, Chief Technologist for the Space Department at the Applied Physics Laboratory of Johns Hopkins University; Asteroid Threat? The Problem of Planetary Defense; Survival; Oct-Nov 2008; pg. 141-156]

An asteroid like Apophis would cause considerable damage if it collided with Earth. If it hit on land, it would make a crater about 6km across and the shock wave, ejecta and superheated air would level buildings and trees and ignite fires over a wide area.' If it hit an ocean, it would cause a devastat­ing cycle of gradually diminishing tsunamis. Scientists cannot yet predict the exact point Apophis might impact in 2036, but their current assessment predicts it would be somewhere along a long, lazy backward 'S' running from northeastern Kazakhstan through Siberia, north of Japan and across the Pacific Ocean before dipping south to converge with the west coast of North America; running eastward across Panama, Columbia and Venezuela, and finally terminating around the west coast of Africa near Senegal. The mid-point of this line lies several hundred kilometres west of Mexico's Baja Peninsula, about midway between Honolulu and Los Angeles. The tsunami from an ocean impact would likely inflict horrific human and economic losses - damage from Apophis could certainly surpass the Indian Ocean tsunami of 26 December 2004, which claimed over 200,000 lives and inflicted damages on the order of $15 billion.

SOLVENCY: THE DAVID PLAN

**FIVE STEP RECOMMENDATION FOR NASA PLAN-David ‘10**

[Leonard; Space Columnist; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 Oct 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html;> retrieved 21 Jun 2011]

The task force's five recommendations are:

1. Organize for Effective Action on Planetary Defense: NASA should establish an organizational element to focus on the issues, activities and budget necessary for effective planetary defense planning; to acquire the required capabilities, to include development of identification and mitigation processes and technologies; and to prepare for leadership of the U.S. and international responses to the impact hazard.
2. Acquire Essential Search, Track, and Warning Capabilities: NASA should significantly improve the nation?s discovery and tracking capabilities for early detection of potential NEO impactors, and for tracking them with the precision required for high confidence in potential impact assessments.
3. Investigate the Nature of the Impact Threat: To guide development of effective impact mitigation techniques, NASA must acquire a better understanding of NEO characteristics by using existing and new science and exploration research capabilities, including ground-based observations, impact experiments, computer simulations, and in situ asteroid investigation.
4. Prepare to Respond to Impact Threats: To prepare an adequate response to the range of potential impact scenarios, NASA should conduct a focused range of activities, from in-space testing of innovative NEO deflection technologies to providing assistance to those agencies responsible for civil defense and disaster response measures.
5. Lead U.S. Planetary Defense Efforts in National and International Forums: NASA should provide leadership for the U.S. government to address planetary defense issues in interagency, public education, media, and international forums, including conduct of necessary impact research, informing the public of impact threats, working toward an internationally coordinated response, and understanding the societal effects of a potential NEO impact.

SOLVENCY: EARLY DETECTION IS CRITICAL

**FINDING NEOS EARLY IS CRITICAL TO DEFENDING AGAINST THEM-David ‘10**

[Leonard; Space Columnist; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 Oct 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html;> retrieved 21 Jun 2011]

As explained in the task force report, the "driving philosophy" behind the national and international defense against NEOs should be, "find them early."

Early detection of NEOs ? especially those larger than 140 meters in size ? is key to mounting an effective and cost-effective planetary defense effort. An adequate search, detection and tracking capability could find hazardous objects several years or decades before they threaten impact.

Early detection and follow-up tracking of hazardous NEOs eliminates any need for a standing defense capability by mission-ready deflection spacecraft with their high attendant costs, the report points out.

**BEFORE DEVELOPED PLANS FOR INTERVENTION TAKE SHAPE, WE NEED AN INVENTORY OF POTENTIAL NEO THREATS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Obtaining the orbits and the physical properties of NEOs is known as characterization and is primarily needed to inform planning for any active defense of Earth. Such defense would be carried out through a suitable attack on any object predicted with near certainty to otherwise collide with Earth and cause significant damage. The apparently huge variation in the physical properties of NEOs seems to render infeasible the development of a comprehensive inventory through in situ investigations by suitably instrumented spacecraft: the costs would be truly astronomical. A spacecraft reconnaissance mission might make good sense to conduct on an object that, without human intervention, would hit Earth with near certainty. Such a mission would be feasible provided there was sufficient warning time for the results to suitably inform the development of an attack mission to cause the object to miss colliding with Earth.

**WHILE INTERNATIONAL COOPERATION WILL BE NEEDED TO ADDRESS A THREAT, THE CRITICAL FIRST STEP IS TO DETECT OBJECTS-Seamone ‘04**

[Evan; attorney and a Judge Advocate in the U.S. Army; The Precautionary Principle as the Law of Planetary Defense: Achieving the Mandate to Defend the Earth Against Asteroid and Comet Impacts While There is Still Time; Georgetown International Environmental Law Review; Fall 2004]

Based on predicted harm to earth populations, statistical analyses of the likelihood of another significant impact, and continuing discovery of large asteroid craters across the globe, international policymakers have concluded that a real threat will require international cooperation, and that decisions made in the near-term may have consequences for many generations to come. n12 Ultimately, governments can increase the chances of limiting or eliminating threats to an impact zone by detecting such threats long before the impact is due. With enough time to mount defensive measures from a space station or from earth, governments will be able to deflect or destroy the oncoming object. However, even if time is limited or affirmative defensive measures fail, agencies can secure life and property by effectively preparing local governments and their citizens to evacuate and survive under the difficult and undesirable conditions.

**SURVEYS TO DISCOVER ASTEROIDS ARE THE FIRST, ESSENTIAL STEP-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Surveys to discover threatening asteroids are the first, essential step toward protecting our planet from impacts. A several-decade warning of an impending impact, specifying magnitude, time and place, opens up a variety of mitigation and prevention options. At the minimum, the target area could be prepared or evacuated. But more importantly, such long warning times permit us to use space technology to deflect the object and avoid the collision entirely.

**EARLY DETECTION IS CRITICAL TO FORMULATING A RESPONSE-Jaroff ‘00**

[Leon; Will a Killer Asteroid Hit the Earth?; NASA Ames Research Center; 11 April 2000; <http://impact.arc.nasa.gov/news_detail.cfm?ID=39>; retrieved 9 August 2011]

Eventually, yes. But we don't have to take it lying down. Already astronomers are scanning the skies and preparing to defend the planet

What to do if an Earth-bound comet or asteroid is discovered? Early detection, preferably many years in advance, would enable us to send out exploratory spacecraft to determine the nature of the interloper, much like the spacecraft near's current investigation of the asteroid Eros. Scientists at the Los Alamos and Lawrence Livermore National Laboratories are already dreaming up a variety of ingenious defenses against an incoming asteroid. Depending on its mass and composition, they would use tailor-made nuclear explosions to pulverize small asteroids or deflect larger ones. Given enough time, and under the proper circumstances, less drastic measures would be needed. Some schemes call for conventional explosives alone, or anchoring a rocket motor or a solar sail on an asteroid to alter its orbit enough to allow it to safely bypass Earth.

**MUST HAVE EARLY WARNING SYSTEMS SIMILAR TO EARTHQUAKE EARLY WARNING-O’Neill ‘08**

[Jen; Surprise Asteroid Underlines Need for Early Detection System; Finding Dulcinea; 29 December 2008; <http://www.findingdulcinea.com/news/science/2008/December/Surprise-Asteroid-Underlines-Need-for-Early-Detection-System.html>; retrieved 9 August 2011]

In 1998, The Herald Sun reports, lawmakers directed NASA to identify “at least 90 per cent of the asteroids more than 1 km wide that orbit the sun and periodically cross Earth’s path” by 2008. Yet the search remains only three-quarters complete, and Congress stepped in last year to encourage the space agency “to come up with options for deflecting potential threats.”

A straight hit from an asteroid “could unleash more destruction than Hurricane Katrina, the 2004 Asian tsunami and the 1906 San Francisco earthquake combined,” Gareth Williams explains. Therefore, space scientists suggest that an early warning system should be implemented utilizing tools similar to those of early earthquake detection systems. According to a July findingDulcinea article, an early detections system could provide up to 10 hours of warning so people can evacuate.

SOLVENCY: DEFLECTION TECHNOLOGY

**NASA SHOULD DEVELOP AND TEST DEFLECTION TECHNOLOGY AS WELL AS DEPLOY A TELESCOPE WHICH WILL ALLOW HUMAN EXPLORATION OF ASTEROIDS-Jones ‘11**

[Tom; astronaut and planetary scientist; Steps for Planetary Defense; National Space Society, 28 May 2011; <http://www.nss.org/adastra/volume23/planetarydefense.html;> retrieved 21 Jun 2011]

NASA's Spaceguard Survey, costing about $4 million per year, has already discovered about 87 percent of the large asteroids (more than a km in size) capable of causing global impact effects and serious damage to society. In the process, more than 7,000 NEOs, most much smaller than a km, have been catalogued. About 20 percent of these NEOs are regarded as potentially hazardous objects (PHOs), following orbits that in future centuries may pose a threat to Earth. Overall, just one percent of the objects which might cause damage to Earth have been found. But what can we do, if anything, about the hazard? What should we do?

First, the executive branch should follow up on its October letter to Congress, which added deflection technology development to NASA's traditional NEO search-and-study role, by proposing a modest budget increase for NASA dedicated to planetary defense. Over the course of a decade, for about 1/60 of NASA's annual budget, the agency could conduct a thorough NEO search and demonstrate techniques and technologies that together would make deflection a practical alternative to "taking the hit" from a rogue NEO.

Second, NASA can expand the scope and pace of our search for hazardous NEOs by launching a dedicated NEO search telescope, orbiting the Sun in a Venus-like orbit to rapidly scan the cloud of asteroids presently inaccessible to Earth-based instruments. Such a telescope can find nearly all NEOs down to about 140 meters in size (the current goal directed by Congress) in less than seven years, at a total cost of about half a billion dollars. This instrument would also identify hundreds of NEO targets for potential human exploration.

Third, NASA should capitalize on its deep space operations experience to develop and demonstrate deflection technologies that might divert a NEO threatening an impact. Planetary defense experiments should be added to planned NEO science and exploration missions to obtain the critical knowledge of NEO properties we will need for a future deflection. After proving deflection techniques like the gravity tractor and kinetic impact via robotic spacecraft, NASA's ultimate goal should be an international mission demonstrating the ability to nudge a (non-threatening) NEO onto a new trajectory.

SOLVENCY: GROUND BASED TELESCOPES

**MODEST FUNDING INCREASES OF GROUND-BASED DEVICES IS ALSO NECESSARY-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

In addition to spacecraft reconnaissance missions as needed, the committee concluded that vigorous, ground-based characterization at modest cost is important for the NEO task. Modest funding could support optical observations of already-known and newly discovered asteroids and comets to obtain some types of information on this broad range of objects, such as their reflectivity as a function of color, to help infer their surface properties and mineralogy, and their rotation properties. In addition, the complementary radar systems at the Arecibo Observatory in Puerto Rico and the Goldstone Solar System Radar in California are powerful facilities for characterization within their reach in the solar system, a maximum of about one-tenth of the Earth-Sun distance. Arecibo—which has a maximum sensitivity about 20-fold higher than Goldstone’s but does not have nearly as good sky coverage as Goldstone—can, for example, model the three-dimensional shapes of (generally very odd-shaped) asteroids and estimate their surface characteristics, as well as determine whether an asteroid has a (smaller) satellite or satellites around it, all important to know for planning active defense. Also, from a few relatively closely spaced (in time) observations, radar can accurately determine the orbits of NEOs, which has the advantage of being able to calm public fears quickly (or possibly, in some cases, to show that they are warranted).

**IMMEDIATE ACTION SHOULD BE TAKEN TO CONTINUE FUNDING OF ARECIBO AND GOLDSTONE FACILITIES-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Recommendation: Immediate action is required to ensure the continued operation of the Arecibo Observatory at a level sufficient to maintain and staff the radar facility. Additionally, NASA and the National Science Foundation should support a vigorous program of radar observations of NEOs at Arecibo, and NASA should support such a program at Goldstone for orbit determination and the characterization of physical properties.

For both Arecibo and Goldstone, continued funding is far from assured, not only for the radar systems but for the entire facilities. The incremental annual funding required to maintain and operate the radar systems, even at their present relatively low levels of operation, is about $2 million at each facility (see Chapter 4). The annual funding for Arecibo is approximately $12 million. Goldstone is one of the three deep-space communications facilities of the Deep Space Network, and its overall funding includes additional equipment for space communications.

SOLVENCY: VENUSIAN TELESCOPE

**A SURVEY TELESCOPE WILL TRACK OBJECTS SMALLER THAN 140 METERS-Reich ‘10**

[Eugenie; NASA panel weighs asteroid danger; Scientific American; 08 Sep 2010; <http://www.scientificamerican.com/article.cfm?id=nasa-panel-weighs-asteroid-danger;> retrieved 21 Jun 2011]

One solution from the panel is to increase the amount that the United States invests in NEO detection and tracking from the current $5.5 million a year. The panel may also recommend the launch of a survey telescope into a solar orbit similar to that of Venus. It would orbit faster than Earth and, looking outwards, would see asteroids in Earth-crossing orbits more often than would ground-based instruments. This could improve follow-up observations, narrow estimated trajectories and remove as many asteroids as possible from the threat list. It could also spot and track asteroids on the sunward side of Earth, removing a worrisome blind spot in ground-based surveys. "It is a wonderful rapid technique to track bodies down to 140 meters and smaller," says Tom Jones, a former astronaut and panel co-chair.

**NASA NEEDS TO DEVELOP A ASTEROID-HUNTING CRAFT-David ‘10**

[Leonard; columnist; Experts Push for a NASA Asteroid-Hunting Spacecraft; Space.com; 21 Dec 2010; <http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?;> retrieved 27 Jun 2011]

NASA needs an asteroid-hunting spacecraft to finally get serious about the potential threat of nearby space rocks that could slam into Earth, experts say. Lately, support is building to finally develop such a mission for both safety and scientific reasons.

An asteroid hunter might take the form of an infrared imaging telescope placed in a Venus-like orbit around the sun. This high-tech spotter scope could view a much larger portion of the sky for possible asteroid threats than could observatories from the Earth.

Such a mission could also provide a rapid means of compiling an inventory of viable Near-Earth Object (NEO) targets for potential human exploration ? now on NASA's to-do list as called for by President Barack Obama.

**A NEW SPACE PROBE INSIDE THE VENUSIAN ORBIT WILL OFFER THE MOST EFFECTIVE OBSERVATION-David ‘10**

[Leonard; columnist; Experts Push for a NASA Asteroid-Hunting Spacecraft; Space.com; 21 Dec 2010; <http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?;> retrieved 27 Jun 2011]

Last October, the final report of the Ad-Hoc Task Force on Planetary Defense of the NASA Advisory Council (NAC) was released.

It reported, among a number of findings, that to achieve NASA's NEO search goals in a timely manner as directed by the George E. Brown NEO Survey legislation, the nation will likely need a new space probe in addition to ground-based systems.

"A spacecraft operating with sensors in the infrared band from an orbit sunward of Earth's (such as a Venus-like orbit) offers great advantages in rapid search and repeat observation frequency," the NAC task force wrote. Essentially, the observatory would be able to monitor space rocks over time to determine their hazard potential.

SOLVENCY: WE CAN PREVENT EXTINCTION

**HUMANITY HAS THE CAPACITY TO AVERT A GLOBALLY DEVASTATING DISASTER-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Humanity has the capacity to detect and perhaps to counter such an impending natural disaster. This capacity, and interest in exercising it, have developed and sharply increased in the space age, most likely sparked by the discovery in the late 1980s of the approximately 200-kilometer-diameter Chicxulub Crater formed by an impact 65 million years ago in the Yucatan Peninsula. The asteroid or comet that caused this crater is estimated to have been about 10 kilometers in diameter; its impact wrought global devastation, likely snuffing out species, including dinosaurs, in huge numbers. Later, in the 1990s, the collision of comet Shoemaker-Levy 9 with Jupiter emphasized that impacts are currently possible.

SOLVENCY: KINETIC IMPACTORS

**KINETIC IMPACTORS COULD STOP MID-SIZED NEOS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Kinetic impactors are adequate to prevent impacts on Earth by moderate-sized NEOs (many hundreds of meters to 1 kilometer in diameter) with decades of advance warning. The concept has been demonstrated in space, but the result is sensitive to the properties of the NEO and requires further study.

**TINY ALTERATIONS IN ORBIT WILL BE ENOUGH TO DEFLECT NEOS-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

For any space object approaching a planet, there exists a “keyhole”—a patch in space where the planet’s gravity and the object’s momentum align, causing the asteroid or comet to hurtle toward the planet. Researchers have calculated the keyholes for a few space objects and found that they are tiny, only a few hundred meters across—pinpoints in the immensity of the solar system. You might think of a keyhole as the win-a-free-game opening on the 18th tee of a cheesy, incredibly elaborate miniature-golf course. All around the opening are rotating windmills, giants stomping their feet, dragons walking past, and other obstacles. If your golf ball hits the opening precisely, it will roll down a pipe for a hole in one. Miss by even a bit, and the ball caroms away.

Tiny alterations might be enough to deflect a space rock headed toward a keyhole. “The reason I am optimistic about stopping near-Earth-object impacts is that it looks like we won’t need to use fantastic levels of force,” Schweickart says. He envisions a “gravitational tractor,” a spacecraft weighing only a few tons—enough to have a slight gravitational field. If an asteroid’s movements were precisely understood, placing a gravitational tractor in exactly the right place should, ever so slowly, alter the rock’s course, because low levels of gravity from the tractor would tug at the asteroid. The rock’s course would change only by a minuscule amount, but it would miss the hole-in-one pipe to Earth.

SOLVENCY: NUCLEAR WEAPONS

**NUCLEAR EXPLOSIONS CAN PROTECT US AGAINST NEO IMPACT WITHOUT DAMAGE-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Nuclear explosives can provide considerable protection against a potential NEO impact. This may be the only current means to prevent an impact by a large hazardous object (>500 meters in diameter) with a warning time under a decade or by a larger object (>1 kilometer in diameter) object with a warning time of several decades. With decades of warning for such large objects, the preferred approach uses a standoff detonation. Neutron output has certain advantages (Dearborn, 2004), as the energy coupling is relatively insensitive to the surface composition and density of the NEO. The simulations show that speed changes (*ΔV*) on the order of 2 cm/s are gravitational binding mostly maintaining the NEO as a single body. About 2 percent of the body mass is ejected, evolving to such a low density that it would likely pose no threat to Earth. Very low yield surface explosives also showed great promise for speed changes on the order of 1 cm/s. As the NEO size decreases and the required yield of the nuclear explosive drops below the tested regime, which extends down to about 0.1 kilotons, the kinetic impact approach will have to be used.

**NUCLEAR OPTION IS THE ONLY PRACTICAL ONE FOR LARGEST NEOS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Although the nuclear option provides considerable mitigation potential, for NEOs above some size the tested limits of nuclear explosives will become inadequate. Devices in the nuclear stockpile have equivalent energy releases of megatons of TNT, but NEOs larger in diameter than about 10 kilometers are likely to require larger explosive energies, a regime for which devices have not been tested or simulated. Modeling the shock dissipation of highly porous materials appears to be the primary uncertainty for both impactors and standoff bursts. This uncertainty holds particularly true for NEOs with very low density aggregates that can exist only in low-gravity environments. At present, the simulations have not examined the effects of the range of structures, shapes, and rotational states, but with Defense Threat Reduction Agency support to extend the present studies, these simulations could be done. Currently the United States and several other nations maintain nuclear stockpiles and the infrastructure to build them for purposes of national defense. Efforts to reduce those stockpiles continue, but it seems likely that they will exist for some decades. When defense concerns no longer apply, the governments involved may either accept the longer response time for a Manhattan Project-like effort or decide whether adequate safeguards can be developed so that some entity could maintain a small number of nuclear explosive packages to allow humanity to counter an NEO that could, for example, cause mass extinctions.

Finding: Other than a large flotilla (100 or more) of massive spacecraft being sent as impactors, nuclear explosions are the only current, practical means for changing the orbit of large NEOs (diameter greater than about 1 kilometer). Nuclear explosions also remain as a backup strategy for somewhat smaller objects if other methods have failed. They may be the only method for dealing with smaller objects when warning time is short, but additional research is necessary for such cases.

**STUDY CONFIRMS THAT A NUCLEAR EXPLOSION COULD DESTROY AN NEO THREAT-Wall ‘10**

[Mike; Senior Writer; Nuke-the-Asteroid Idea Revived to Protect Earth;Space.com; 14 Dec 2010; <http://www.space.com/10489-nuke-asteroid-idea-revived-protect-earth.html?;> retrieved 27 Jun 2011]

If a big asteroid were streaking toward Earth and time were running out, a well-placed nuclear explosion could help humanity avert catastrophe ? and not just in the movies.

A new study has injected new life into the old idea of dealing with a potentially threatening space rock by nuking it. The new analysis suggests that a nuclear blast could safely destroy even a relatively large asteroid. And astronauts wouldn't need to bore deep into the space rock, ? la Bruce Willis and his crew in the movie "Armageddon," to implant the bomb. An explosion on the asteroid's surface would likely do the trick, scientists report.

"It would be blown to smithereens," said study lead author Bob Weaver of Los Alamos National Laboratory in New Mexico, who presented the findings here Dec. 13 at the fall meeting of the American Geophysical Union.

**WE HAVE THE TECHNOLOGY TO PREVENT A STRIKE. WE JUST NEED THE INTERNATIONAL WILL-Wall ‘10**

[Mike; Senior Writer; Nuke-the-Asteroid Idea Revived to Protect Earth;Space.com; 14 Dec 2010; <http://www.space.com/10489-nuke-asteroid-idea-revived-protect-earth.html?;> retrieved 27 Jun 2011]

Weaver envisions humanity using a nuke in this fashion when there's not much time before impact ? a year or less, perhaps. (With more warning, other options could be on the table ? such as using an explosion to nudge the space rock out of the way of Earth.)

Humanity probably has the technological capability to pull off an asteroid-destroying mission right now, Weaver said. The tougher obstacle might be getting the international community to cooperate enough to organize such a strike. With nukes involved, working together might be difficult, he said.

"The social and political implications of how to carry out this mission are actually much tougher than the science," Weaver said.

**CONVENTIONAL BOMBS SIMPLY DO NOT HAVE THE POWER TO DESTROY ASTEROIDS-Wall ‘10**

[Mike; Senior Writer; Nuke-the-Asteroid Idea Revived to Protect Earth;Space.com; 14 Dec 2010; <http://www.space.com/10489-nuke-asteroid-idea-revived-protect-earth.html?;> retrieved 27 Jun 2011]

While some people may find the prospect of using nuclear bombs unpalatable even to blast apart asteroids, conventional explosives just couldn't deliver, Weaver said ? at least not for a space rock as big as the one in the team's models.

"They're not even close," he said of conventional bombs. "They're orders of magnitude away from being powerful enough."

SOLVENCY: NASA SHOULD LEAD PLANETARY DEFENSE

**PLANETARY DEFENSE IS A CORE, COMMON SENSE MISSION FOR NASA. THE ALTERNATIVE IS EVACUATION AND DISASTER RESPONSE-Jones ‘11**

[Tom; astronaut and planetary scientist; Steps for Planetary Defense; National Space Society, 28 May 2011; <http://www.nss.org/adastra/volume23/planetarydefense.html;> retrieved 21 Jun 2011]

With our planned telescopes and space technology, we have two of the three elements necessary to prevent future damaging asteroid impacts. NASA currently searches for the largest NEOs and warns of any asteroid discovered that is potentially hazardous to Earth. New ground-and spacebased search systems will improve our capability to protect against smaller, more numerous asteroids. NASA should design experiments and demonstrations into its asteroid exploration missions that show that NEO deflection is possible. The missing third element for NEO impact prevention is international planning to respond in advance to a future asteroid collision. NASA is wellpositioned to lead domestic and international efforts to produce such a plan. To succeed, the agency must move beyond search, analysis, and warning to develop the practical means for actually changing a threatening NEO's orbit.

Without improved NEO search and tracking, experience in deflection, and essential international planning, the only possible U.S. response to a threatened impact would be evacuation, followed by disaster response. If a sizeable random NEO strikes Earth without warning, the damage to the U.S.'s leadership and reputation would be severe — and completely avoidable. Planetary defense is a common sense mission for NASA, one that combines its scientific and technological capacities to prevent a disaster of cosmic dimensions.

**NASA IS THE BEST CIVILIAN AGENCY TO OVERSEE NEO DETECTION-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Among the civilian agencies and departments, NASA has the broadest and deepest familiarity with solar system objects and its associated rendezvous missions. The NSF supports ground-based solar system research, but it traditionally responds to proposals rather than initiating and organizing complex programs (the International Geophysical Year being one of the exceptions). The Departments of Defense and of Energy, however, have by far the most important experience with nuclear explosives, necessary for some active-defense missions for changing NEO orbits. For such missions and their preparations, these departments, or at least the latter, would certainly become involved, with coordination being maintained through the standing committee or task force described above.

**NASA IS A NATURAL HOME FOR THE PROGRAM-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

NASA is a possible choice for the lead agency. Within NASA, under its present organization, a natural home for this hazards program would be the Science Mission Directorate (SMD), which deals with solar system science. The current, small hazards program—with an approximately $4 million annual budget—is already housed in this directorate. But the hazards program discussed here would be more effective with its own director and budgetary line item(s) to ensure its viability within the much larger SMD. It would, of course, derive benefits from and provide benefits to the science and other programs in the SMD.

**NASA MUST LEAD THE WAY ON NEO DETECTION-Hsu ‘10**

[Jeremy; U.S. Must Be Ready to Meet Asteroid Threat, White House Science Adviser Says; Space.com; 21 Oct 2010; <http://www.space.com/9370-ready-meet-asteroid-threat-white-house-science-adviser.html;> retrieved 27 Jun 2011]

National emergency plans for natural disasters can also work in the unlikely scenario of an asteroid strike on the U.S., according to a letter to Congress by the White House's top science adviser, SPACE.com has learned.

The 10-page letter by John Holdren, director of the White House Office of Science and Technology Policy, adds that the U.S. has a responsibility to the world as the country most capable of detecting space rocks that threaten Earth. The Oct. 15 letter obtained by SPACE.com is addressed to the leaders of the House Committee on Science and Technology.

Holdren states that NASA must continue leading efforts to close the gap in detecting and perhaps deflecting near-Earth objects (NEO). The U.S. space agency already has the duty of alerting the rest of the government about any threatening space objects.

**NASA SHOULD ESTABLISH AN DEFENSE COORDINATION OFFICE FOR NATIONAL AND INTERNATIONAL EFFORTS-David ‘10**

[Leonard; Space Columnist; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 Oct 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html;> retrieved 21 Jun 2011]

A new report calls on NASA to establish a Planetary Defense Coordination Office to lead national and international efforts in protecting Earth against impacts by asteroids and comets.

The final report of the Ad-Hoc Task Force on Planetary Defense of the NASA Advisory Council was delivered to the Council this month, proposing five recommendations that suggest how the space agency should organize, acquire, investigate, prepare, and lead national and international efforts in planetary defense against near-Earth objects.

"This was a very important step in the process of the United States Government defining its role in protection of life from this occasional, but devastating natural hazard,? former astronaut Russell Schweickart told SPACE.com. "Happily, in the instance of asteroid impacts, this is a natural disaster which can be prevented?only, however, if we properly prepare and work together with other nations around the world."

**NASA MUST TAKE UP PLANETARY DEFENSE-UPI ‘10**

[NASA urged to consider planet 'defense;' UPI; 19 October 2010; <http://www.upi.com/Science_News/2010/10/19/NASA-urged-to-consider-planet-defense/UPI-26431287533019/>; retrieved 9 August 2011]

NASA should establish a Planetary Defense Coordination Office to lead efforts should the Earth be threatened by asteroids and comets, a U.S. report says.

The report, by the Ad-Hoc Task Force on Planetary Defense of the NASA Advisory Council, offers suggestions on how the agency should prepare to lead national and international plans for defending Earth from collisions from near-Earth objects, SPACE.com reported Tuesday.

"This was a very important step in the process of the United States government defining its role in protection of life from this occasional, but devastating natural hazard," former astronaut Russell Schweickart, co-chairman of the task force, said.

SOLVENCY: THE US SHOULD LEAD

**THE US WILL BE IN THE POSITION TO PROTECT LIFE ON EARTH FROM NEOS-David ‘10**

[Leonard; Space Columnist; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 Oct 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html;> retrieved 21 Jun 2011]

Schweickart, who served as co-chair of the task force, said the new report and its recommendations to NASA combined new information with previous studies from the past decade.

The task force met in July to discuss the need for a planetary defense office at NASA. Their final report was submitted to the space agency on Oct. 6.

"With the support of the Administration and the Congress, the U.S. will be in the position of being able to work with and provide leadership in protecting life on Earth from these preventable cosmic disasters," he said.

**THE PRECAUTIONARY PRINCIPLE DEMANDS THAT THE US ADOPT PLANETARY DEFENSE MEASURES-Seamone ‘04**

[Evan; attorney and a Judge Advocate in the U.S. Army; The Precautionary Principle as the Law of Planetary Defense: Achieving the Mandate to Defend the Earth Against Asteroid and Comet Impacts While There is Still Time; Georgetown International Environmental Law Review; Fall 2004]

As it now stands, no agency has been explicitly designated to take the lead in planetary defense measures at the international level. In the United States, while NASA currently has responsibility for tracking Near-Earth Orbiting asteroids (NEOs), it is not authorized to deploy nuclear devices or evacuate populations. In other words, the mission of NASA is heavily dependent on research rather than operational activities. Similarly, no technical guidelines exist to coordinate the efforts of the multiple agencies that would be forced to respond to asteroid and comet impacts. At a minimum, the precautionary principle requires that governments institute very rudimentary interventions in protecting the planet. While effective planetary protection efforts will require the participation of different nations and their own respective agencies, the precautionary principle calls for a single center to coordinate activities of different organizations. One example of such an organization is the Northeastern Forest Fire Protection Commission, which coordinates activities of various firefighting organizations in parts of the United States and Canada by developing regulations and providing necessary guidance.

**THE UNITED STATES SHOULD LEAD THE WAY TO DEAL WITH NEO THREAT-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Responding effectively to hazards posed by NEOs requires the joint efforts of diverse institutions and individuals, with organization playing a key role. Because NEOs are a global threat, efforts to deal with them could involve international cooperation from the outset. (However, this is one area in which one nation, acting alone, could address such a global threat.) The report discusses possible means to organize, both nationally and internationally, responses to the hazards posed by NEOs. Arrangements at present are largely ad hoc and informal here and abroad, and they involve both government and private entities.

The committee discussed ways to organize the national community to deal with the hazards of NEOs and also recommends an approach to international cooperation:

Recommendation: The United States should take the lead in organizing and empowering a suitable international entity to participate in developing a detailed plan for dealing with the NEO hazard.

**THE US SHOULD TAKE THE LEAD IN DEVELOPING AN INTERNATIONAL ORGANIZATION FOR DEALING WITH NEOS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

The United States should establish a standing committee, with membership from each of the relevant agencies and departments, to develop a detailed plan for treating all aspects of the threat posed to Earth by near-Earth objects, and apportioning among these agencies and departments the authority and responsibility for carrying out this plan, in coordination and collaboration with other nations. The standing committee would be further charged with overseeing on a continuing basis the carrying out of each agency’s and department’s activities under this plan. The administration should designate one agency or department as the lead; the chair of the committee should be the representative from this agency or department.

Recommendation: The United States should take the lead in organizing and empowering a suitable international entity to participate in developing a detailed plan for dealing with the NEO hazard.

**THE US WILL HAVE TO PLAY THE LEAD ROLE ON NEO DETECTION-Hsu ‘10**

[Jeremy; U.S. Must Be Ready to Meet Asteroid Threat, White House Science Adviser Says; Space.com; 21 Oct 2010; <http://www.space.com/9370-ready-meet-asteroid-threat-white-house-science-adviser.html;> retrieved 27 Jun 2011]

"The United States is currently the world leader in NEO detection activities and will have a vital role to play in such communications, irrespective of whether the direct risk to the United States or its territories is considered low," Holdren said.

A NASA advisory council recently suggested that the space agency set up an official Planetary Defense Coordination Office to lead protection efforts against threatening asteroids or comets.

**EVEN THOUGH THE THREAT AFFECTS THE WHOLE WORLD, ONLY THE US HAS DEVELOPED STEPS TO DEAL WITH IT-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Although the impact hazard is clearly a matter that affects all nations (Remo 1996), to date only the US government has taken significant steps to tackle the problem directly through scientific research and astronomical observations, as previously described. In 2000, the UK government commissioned a report on the hazard, which was duly published later that year (Atkinson et al. 2000). In addition to an excellent analysis of the hazard itself, this report made 14 recommendations, including some highlighting the need for international cooperation and action, although there has been relatively little follow-up.

**THE UNITED STATES DOES NOT NEED TO BEAR THE WHOLE BURDEN; OTHER NATIONS CAN SHARE THE RESEARCH AND COSTS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

The probability of a devastating NEO impact in the United States is small compared to the likelihood of an impact in other nations, most with far fewer resources to detect, track, and defend against an incoming NEO. The NEO hazard, however, is such that a single country, acting unilaterally, could potentially solve the problem. Although the United States has a responsibility to identify and defend against threats with global consequences, this nation does not have to bear the full burden for such programs. There have been several international efforts to characterize objects in the near-Earth environment, but these studies have generally been driven by scientific curiosity and were not designed to address the risk of NEOs. As NEO survey requirements evolve to fainter objects and as mitigation strategies are refined, additional resources will be necessary, and these could be provided by other developed countries. International partnerships can be sought with other science organizations, notably but not exclusively space agencies, in the areas of surveys, characterization, and mitigation technologies. NEO discovery rates and survey completeness could be significantly enhanced through the coordinated use of telescopes owned and operated by other nations. Future NEO space missions, carried out by the United States, by other nations, or through the cooperation of various countries, could be optimized for characterization that enables the development and refinement of mitigation strategies. Space missions to test such strategies could also be developed on a cooperative basis with other nations, making use of the resulting complementary capability. While a coordinated intergovernmental program would be needed to address the full spectrum of activities associated with NEO surveys, characterization, and mitigation, an important first step in this direction would be to establish an international partnership, perhaps of space agencies, to develop a comprehensive strategy for dealing with NEO hazards.

SOLVENCY: TIME TO ACT IS NOW!

**TAKING ADVANCED ACTION WILL PROVIDE US DECADES OR EVEN CENTURIES OF RESPONSE TIME-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Impacts are also unique among natural hazards in that they can be predicted with great precision and are amenable to elimination by the application of advanced space technology. In most natural hazards, preparation, response and mitigation all suppose that the event itself takes place, and the best we can do is take advanced action to minimize casualties and be prepared to provide assistance when the disaster occurs. In contrast, astronomers today are capable of predicting the motions of known asteroids with sufficient accuracy to identify specific potential impacts with a warning time of decades or even centuries.

**WE NEED TO DEVELOP PLANS BECAUSE NO ONE CAN PREDICT THE TIME OF THE NEXT STRIKE-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

No known asteroids target Earth now or for the next several years. however, this information can change rapidly. nobody knows how long Earth will be spared. our planet has not been so fortunate in the past. With 843 Phas and counting, we must seriously consider mitigation options. rather than debate whether we need planetary defense, we must determine when we will need it. From a policy perspective, we know that at least 843 asteroids prowling our neighborhood could cause local, regional, or global destruction, so we have just begun to understand the total threat. We won’t comprehend its full extent until we overcome the “giggle factor” and stop erroneously ascribing such thinking to science fiction. We need to create contingency plans and establish guidelines as an insurance policy—a far less expensive proposition than the consequences of suffering a direct hit.

**MUST ACT ON THREAT TO HUMAN SECURITY- NATIONAL SPACE SOCIETY ‘05**

[Planetary Defense Library; National Space Society; 2005; <http://www.nss.org/resources/library/planetarydefense/index.htm>; retrieved 9 August 2010]

There exists an infrequent, but significant hazard to life and property due to impacting asteroids and comets. There is currently no specific search for long-period comets, smaller near-Earth asteroids, or smaller short-period comets. These objects represent a threat with potentially little or no warning time using conventional ground-based telescopes. These planetary bodies also represent a significant resource for commercial exploitation, long-term sustained space exploration, and scientific research. The Comet/Asteroid Protection System (CAPS) is a future space-based system concept that provides permanent, continuous asteroid and comet monitoring, and rapid, controlled modification of the orbital trajectories of selected bodies. CAPS would expand the current detection effort to include long-period comets, as well as small asteroids and short-period comets capable of regional destruction. A space-based detection system, despite being more costly and complex than Earth-based initiatives, is the most promising way of expanding the range of detectable objects, and surveying the entire celestial sky on a regular basis. CAPS would provide an orbit modification system capable of diverting kilometer class objects, and modifying the orbits of smaller asteroids for impact defense and resource utilization. This Technical Memorandum provides a compilation of key related topics and analyses performed during the CAPS study, which was performed under the Revolutionary Aerospace Systems Concepts (RASC) program, and discusses technologies that could enable the implementation of this future system.

SOLVENCY: COST

**NASA CAN ADEQUATELY FUND PLANETARY DEFENSE FOR $300 MILLION ANNUALLY-David ‘10**

[Leonard; Space Columnist; Planetary Defense Coordination Office Proposed to Fight Asteroids; Space.com; 19 Oct 2010; <http://www.space.com/9356-planetary-defense-coordination-office-proposed-fight-asteroids.html;> retrieved 21 Jun 2011]

In the final report, the task force found that a planetary defense program plan is likely to require an annual budget of approximately $250 million to $300 million per year during the next decade.

That funding would be needed to meet the Congress-mandated search goal of spotting 460-feet (140-meter) wide NEOs, as well as to execute selected NEO characterization missions; develop and demonstrate NEO deflection capabilities; and develop the analytic and simulation capacity necessary for NASA?s planetary defense role.

"Once the search for potentially hazardous objects is substantially complete, the task shifts to ongoing monitoring and catalog maintenance," the report states.

After flight demonstrations of the primary deflection concepts are completed, further experiments would be integrated into scientific or exploration missions. The planetary defense program budget could then recede to operations and maintenance levels, approximately $50 million to $75 million annually, the report explains.

The task force report "strongly recommends" that the cost of NASA planetary defense activities be explicitly budgeted by the administration and funded by the Congress as a separate agency budget line, not diverted from existing NASA science, exploration, or other mission budgets.

**A UNILATERAL US NEO PROGRAM WOULD ONLY COST $250 MILLION ANNUALLY-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

At a $250-million annual budget level, a robust NEO program could be undertaken unilaterally by the United States. For this program, in addition to the research program a more robust survey program could be undertaken that would include redundancy by means of some combination of ground-and space-based approaches. This level of funding would also enable a space mission similar to the European Space Agency’s (ESA’s) proposed Don Quijote spacecraft, either alone, or preferably as part of an international collaboration. This space mission would test in situ instrumentation for detailed characterization, as well as impact technique(s) for changing the orbit of a threatening object, albeit on only one NEO. The target could be chosen from among those fairly well characterized by ground observations so as to check these results with those determined by means of the in situ instruments.

**A COST BENEFIT ANALYSIS WOULD EASILY JUSTIFY AN INVESTMENT OF $20 BILLION OVER THE NEXT CENTURY-Matheny ‘07**

[Jason; Reducing the Risk of Human Extinction; Risk Analysis; 2007; Volume 27, Number 5;<http://www.upmc-biosecurity.org/website/resources/publications/2007_orig-articles/2007-10-15-reducingrisk.html>;retrieved 27 Jun 2011]

A system to detect all large, near-Earth asteroids would cost between $300 million and $2 billion (Chapman, 2004; NASA, 2006, pp. 251–254), while a system to deflect large asteroids would cost between $1 and 20 billion to develop (Gritzner, 1997, p. 156; NASA, 2006, pp. 251–254; Sommer, 2005, p. 121; Urias et al., 1996).13 Suppose a detect-and-deflect system costing a total of $20 billion would buy us a century of protection, reducing the probability of an extinction-level impact over the next century by 50%.14 Further suppose this cost is incurred even if the deflection system is never used, and the system offers no benefit besides mitigating extinction-level asteroid impacts.15 Then the cost effectiveness of the detect-and-deflect system is $20 billion/8 billion life-years = $2.50 per life-year.

By comparison, it is common for U.S. health programs to spend, and for U.S. policies and citizens to value, more than $100,000 per life-year (Kenkel, 2001; Neumann et al., 2000; Viscusi & Aldy, 2003).16 Even if one is less optimistic and believes humanity will certainly die out in 1,000 years, asteroid defense would be cost effective at $4,000 per life-year.

**AN ASTEROID DETECTION SYSTEM WILL PAY OFF WITH MORE LIKELY HUMAN/ROBOTIC EXPLORATION OF AN ASTEROID-David ‘10**

[Leonard; columnist; Experts Push for a NASA Asteroid-Hunting Spacecraft; Space.com; 21 Dec 2010; <http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?;> retrieved 27 Jun 2011]

Needless to say, space-based searches for NEOs come with technical challenges. But finding the funding for the concept within an already over-subscribed NASA presents another challenge altogether.

"There's also a compelling need to generate momentum and show some positive progress towards this general class of mission in the near-term," Miller said.

Scientists say there would be a significant payoff, eventually.

By the end of the proposed spacecraft's lifetime ? in the range of seven to eight years after launch ? the NEO catalog would contain somewhere between half a million and a million new objects.

Beyond feeding the scientific community a wealth of new information, the telescopic capability also supports NASA's desire to fly both robotic and human expeditions to select asteroids. Furthermore, the spacecraft would enable a planetary defense response if any Earth-threatening NEOs are found, proponents say.

**NASA COULD DEVELOP A ROBUST ASTEROID PROGRAM FOR $500 MILLION/YEAR-Bucknam and Gold ‘08**

[Mark, Deputy Director for Plans, Secretary of Defense, and Robert, Chief Technologist for the Space Department at the Applied Physics Laboratory of Johns Hopkins University; Asteroid Threat? The Problem of Planetary Defense; Survival; Oct-Nov 2008; pg. 141-156]

The overall costs of programmes to find and track asteroids, and to ren­dezvous with and study them, would amount to between $2-6bn, depending on how many rendezvous missions would be launched. The effort could be carried out over a ten-year time frame at a cost of no more than $500m per year, or less than 4% of NASA's annual budget (approximately $17bn in 2007). By comparison, in fiscal year 2006 alone, the US Congress provided approximately $4bn for avian-flu initiatives21- a thousand times more than it budgeted for NASA's Spaceguard Survey programme. In 2006, the World Bank estimated that a severe pandemic with a 1% mortality rate could kill about 70m people and cost upwards of US$1.25 trillion (3.1% of global GDP).22 An asteroid the size of Apophis, which is not particularly large as asteroids go, could cause comparable levels of death and destruction.

**COST BENEFIT ANALYSIS MAKES CLEAR THE NEED FOR ASTEROID DETECTION-Chichilnisky & Eisenberger ‘10**

[Graciela, UNESCO Professor of Mathematics and Economics and Peter, nqa; Asteroids: Assessing Catastrophic Risks; Journal of Probability and Statistics; January 2010; pgs. 1-16]

Our rational decision maker who values the future of the species and understands what probabilities really mean, could go through the following simple analysis. For any value of μ even close to one-half the expected value we have calculated makes asteroids more threatening than global warming that is attracting all the attention of policy makers and the public today. In one sense this is satisfying since we would like to believe that we would give great value to prevent our extinction. However, we used the number of US$300 trillion μ 1/2 for the expected value and argued that it is what we should spend to defend against extinction. This does not seem intuitively correct for many reasons, not the least of which is that we would have no resources left to do anything else. The answer to this dilemma is to recognize that what we are really interested in is utility loss from extinction rather than expected value for the dollars we allocate. This view can help us achieve an intuitively pleasing answer that we should spend as much money today on defenses against extinction as can be usefully transferred into improved protection. In the case of asteroids based on current estimates many experts believe this might be only about 10 times what we are now spending which is about US$30 million dollars. This is a small number and the corrected valuation of the risk is high enough that we should need no further analysis to decide to increase our efforts now and when new opportunities become available in the future.

UNDERVIEW: MORAL IMPERATIVE

**IT’S A MORAL IMPERATIVE TO DEVELOP A DEFENSE AGAINST NEOS-David ‘10**

[Leonard; columnist; Experts Push for a NASA Asteroid-Hunting Spacecraft; Space.com; 21 Dec 2010; <http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?;> retrieved 27 Jun 2011]

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Scientists say there would be a significant payoff, eventually.

By the end of the proposed spacecraft's lifetime ? in the range of seven to eight years after launch ? the NEO catalog would contain somewhere between half a million and a million new objects.

Beyond feeding the scientific community a wealth of new information, the telescopic capability also supports NASA's desire to fly both robotic and human expeditions to select asteroids. Furthermore, the spacecraft would enable a planetary defense response if any Earth-threatening NEOs are found, proponents say.

"It's a moral imperative," Arentz said, whether there's no planetary defense problem at all or our planet has a problem child headed our way.

"So it's exactly like cancer. The sooner you know, the better it is. You either know you're safe or you've got the necessary lead time to fix it," Arentz added.

**TO DO NOTHING GIVEN INEVITABILITY OF STRIKES WOULD BE TO ABDICATE OUR RESPONSIBILITY-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

What is the most prudent course of action when one is confronted with an extremely rare yet enormously destructive risk? Some may be tempted to do nothing, in essence gambling on the odds. But because the consequences of guessing wrong may be so severe as to mean the end of virtually all life on planet Earth, the wiser course of action would be to take reasonable steps to confront the problem. Ultimately, rare though these space strikes are, there is no doubt that they will happen again, sooner or later. To do nothing is to abdicate our duty to defend the United States, and indeed the entire world, and place our very survival in the uncertain hands of the false god of probabilities. Thus, the mission of planetary defense might be considered by the United States at some point in time, perhaps with a role played by the military, including the United States Air Force.

A/T: DOD SOLVES

**AIR FORCE PLAN WILL NOT DETECT ALL THREATENING NEOS; A TELESCOPE INSIDE ORBIT OF VENUS IS NECESSARY-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

Current telescopes cannot track asteroids or comets accurately enough for researchers to be sure of their courses. When 99942 Apophis was spotted, for example, some calculations suggested it would strike Earth in April 2029, but further study indicates it won’t—instead, Apophis should pass between Earth and the moon, during which time it may be visible to the naked eye. The Pan-STARRS telescope complex will greatly improve astronomers’ ability to find and track space rocks, and it may be joined by the Large Synoptic Survey Telescope, which would similarly scan the entire sky. Earlier this year, the software billionaires Bill Gates and Charles Simonyi pledged $30 million for work on the LSST, which proponents hope to erect in the mountains of Chile. If it is built, it will be the first major telescope to broadcast its data live over the Web, allowing countless professional and amateur astronomers to look for undiscovered asteroids.

Schweickart thinks, however, that even these instruments will not be able to plot the courses of space rocks with absolute precision. NASA has said that an infrared telescope launched into an orbit near Venus could provide detailed information on the exact courses of space rocks. Such a telescope would look outward from the inner solar system toward Earth, detect the slight warmth of asteroids and comets against the cold background of the cosmos, and track their movements with precision. Congress would need to fund a near-Venus telescope, though, and NASA would need to build it—neither of which is happening.

**IF NASA FAILS TO LEAD ON NEO DETECTION AND INTERCEPTION, IT WILL INCREASE MOMENTUM FOR MILITARIZED SPACE-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

Wouldn’t shifting NASA’s focus away from wasting money on the moon and toward something of clear benefit for the entire world—identifying and deflecting dangerous space objects—be a surer route to enhancing national prestige? But NASA’s institutional instinct is not to ask, “What can we do in space that makes sense?” Rather, it is to ask, “What can we do in space that requires lots of astronauts?” That finding and stopping space rocks would be an expensive mission with little role for the astronaut corps is, in all likelihood, the principal reason NASA doesn’t want to talk about the asteroid threat.

NASA’s lack of interest in defending against space objects leaves a void the Air Force seems eager to fill. The Air Force has the world’s second-largest space program, with a budget of about $11 billion—$6 billion less than NASA’s. The tension between the two entities is long-standing. Many in the Air Force believe the service could achieve U.S. space objectives faster and more effectively than NASA. And the Air Force simply wants flyboys in orbit: several times in the past, it has asked Congress to fund its own space station, its own space plane, and its own space-shuttle program. Now, with NASA all but ignoring the space-object threat, the Air Force appears to be seizing an opportunity.

**THE AIR FORCE IS USING ASTEROID DETECTION TO GET ITS FOOT IN THE DOOR FOR EXPANDED MILITARY PRESENCE IN SPACE-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

All known space rocks have been discovered using telescopes designed for traditional “soda straw” astronomy—that is, focusing on a small patch of sky. Now the Air Force is funding the first research installation designed to conduct panoramic scans of the sky, a telescope complex called Pan-STARRS, being built by the University of Hawaii. By continuously panning the entire sky, Pan-STARRS should be able to spot many near-Earth objects that so far have gone undetected. The telescope also will have substantially better resolving power and sensitivity than existing survey instruments, enabling it to find small space rocks that have gone undetected because of their faintness.

The Pan-STARRS project has no military utility, so why is the Air Force the sponsor? One speculation is that Pan-STARRS is the Air Force’s foot in the door for the Earth-defense mission. If the Air Force won funding to build high-tech devices to fire at asteroids, this would be a major milestone in its goal of an expanded space presence. But space rocks are a natural hazard, not a military threat, and an Air Force Earth-protection initiative, however gallant, would probably cause intense international opposition. Imagine how other governments would react if the Pentagon announced, “Don’t worry about those explosions in space—we’re protecting you.”

**DEFENSE DEPARTMENT SHOULD ONLY BE WORKING WITH NASA AT THE LEAD-Friedman ‘10**

[Lou; Founder of the Planetary Society; Starting on Planetary Defense; The Planetary Society; 27 October 2010; <http://www.planetary.org/programs/projects/space_information/20101027.html>; retrieved 9 August 2011]

Progress is also being made on the science and technology. The pace of observations has quickened, and more NEOs of smaller and smaller size are being discovered. Space missions are being conducted. In just two weeks the Deep Impact spacecraft, which sent an impactor into a comet back in 2005, will pass by and observe closely Comet Hartley 2. Calls to build more dedicated observatories on Earth, and in space, need to be developed into firm proposals for funding and implementation. One problem is that no federal agency, not even NASA, has the prime responsibility for planetary defense -- hence no mission proposals have yet been generated.

While NASA is far ahead in consideration of the issue, the issue has also been addressed in Europe, particularly England, and in Russia; but only addressed – no programs or plans have been made. The lack of defined policy in the U.S. is mirrored throughout the world. Observation programs are not well funded and space missions are only proposed for science investigations, not for advancing planetary defense readiness.

Dr. Holdren’s letter is very welcome. It should help advance United States government planning. He reaffirms NASA’s lead responsibility for detection of NEOs. He adds that NASA should even lead in the study of mitigation and deflection, coordinating with other federal agencies, including the Department of Defense, Federal Emergency Management Agency and Department of Homeland Security. He also recommends that the U.S. continue to coordinate with international efforts to study the problem.

A/T: NO INTERCEPTOR TECH

**EVEN IF WE LACK THE TECHNOLOGY TO DEFLECT AN ASTEROID TODAY, THE THREAT WILL LEAD TO SPENDING WHATEVER TIME AND MONEY IT TAKES TO SOLVE THE PROBLEM-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Although these first small steps are being taken by space agencies, we are a long way from the technology to deflect an asteroid, especially not one of the most dangerous class, which are larger than 1 km (see AIAA 2004 for a current review of defence options). However, it seems reasonable to expect that if such a large asteroid is discovered, one whose impact could kill more than a billion people and destabilize world civilization, the space-faring nations would find a way to deflect it and save the planet. Given such a specific threat, almost any level of expense could be justified. This effort would represent the largest and most important technological challenge ever faced, and whether it is successful or not, world civilization would be forever changed.

**EVEN IF WE CURRENTLY LACK THE TECHNOLOGY, THE THREAT WILL PROVIDE THE IMPETUS TO SOLVE ASTEROID DEFENSE-Morrison ‘06**

[David; senior scientist @ NASA Astrobiology Institute; Asteroid and Comet Impacts: The Ultimate Environmental Catastrophe; Philosophical Transactions: Mathematical, Physical and Engineering Sciences; Aug 2006; pp.2041-2054]

Such prediction is possible because asteroids pass close to the Earth many times before they hit. A survey can pick them up decades or more before their final plunge toward impact, and asteroids do not (except in Hollywood) change orbits capriciously. We have neither the desire nor the capability to find them a few hours, or even a few weeks, before impact. A long-term warning of an impact can, however, permit relocation of the population and key infrastructure from the target area. Better yet, the threatening asteroid can, in principle, be diverted so that it misses the Earth entirely. While we have not yet developed this technology, I expect that several decades of warning of an impending global tragedy would provide sufficient motivation for the space-faring nations of the Earth to solve the technical problems of asteroid defence.

**WE CAN DEAL WITH ASTEROID THREAT; WE JUST NEED AN AGENCY TO TAKE THE LEAD-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

The good news is that, unlike predicting earthquakes and hurricanes, we can actually see most asteroids and comets arriving years or decades in advance and do something about it. the technology required to avert a catastrophe lies within our reach, at a comparatively modest expenditure. however, no one is in charge, no one owns the problem, and no one has been assigned the mission— not NASA,Air Force Space Command(aFsPC), or the Department of Homeland Security(dhs). We have no on-the-shelf contingency plans, tabletop interagency scenarios, interagency memoranda of agreements, standard operating procedures, or hardware available for a mitigation mission.

**WE SHOULD NOT WAIT FOR INTERCEPTOR TECHNOLOGY TO DEVELOP-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

In no case, however, is it wise to consider the application of techniques more than a few decades into the future. The technologies available at that time would likely be both more efficient and more effective, rendering present approaches obsolete. However, it is not wise to wait for those future technologies, leaving Earth unaware and threats to Earth unmitigated in the meantime.

**EVEN IF ALL WE CAN DO IS CALL FOR EVACUATION, WE NEED RESEARCH ABOUT NEOS-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

The ability to mitigate the impact hazard, or even to define appropriate strategies for mitigating the hazard, likewise depends on the acquisition of the new knowledge and understanding that could be gained through a research program. Even if the only viable mitigation approach to an impending impact is to warn the population and to evacuate, better information is needed for making sound decisions. Under what conditions should warning be provided and when, and who should evacuate? If, however, there are available active mitigation options, like changing the orbit of an impactor, again better information is needed: One must be able to predict with confidence the response of an impactor to specific forms of applied forces, impacts of various types and speeds, or various types of radiant energy, such as x rays. The required information goes beyond the basic physical characterization that determines the size and mass of the impactor and includes surface and subsurface compositions, internal structures, and the nature of their reactions to various inputs.

**THE US MUST PLAN FOR THE NECESSARY STRATEGY TO DEAL WITH AN NEO IN ADVANCE-Chapman ‘07**

[Clark; Senior Scientist Southwest Research Institute, Dept. of Space Studies; *Comet/Asteroid Impacts and Human Society*, 2007; pgs. 145-161]

One hazard posed by smaller NEA impacts mentioned above is the possible misinterpretation of the upper atmospheric explosion of an NEA as an offensive military action. This possibility has been recognized for decades, and we must hope and assume that there has been adequate promulgation of information about bolides to preclude inappropriate military responses to bolides in areas of conflict in the world.

All of these minor involvements of military institutions with the impact hazard could sharply crystallize if a specific impact threat were to develop. We would quickly focus on such questions as civilian-versus-military responsibilities for mitigation and national-versus-international approaches to deflection and disaster management. I think it would be prudent to think about these issues in advance.

A/T: LEGAL QUESTIONS/INTERNATIONAL LAW

**THE RIGHT TO SURVIVAL IS THE FOUNDATION OF ALL OTHER LEGAL RIGHTS AND REPRESENTS THE MOST FUNDAMENTAL COMMON INTEREST OF HUMANITY-Seamone ‘02**

[Evan; Articles Editor, Iowa Law Review; Masters in Public Policy, UCLA; When Wishing on a Star Just Won't Do: The Legal Basis for International Cooperation in the Mitigation of Asteroid Impacts and Similar Transboundary Disasters; Iowa Law Review; March 2002]

To understand how the duty of cooperative preservation unfolds, [\*1122] lawmakers must distinguish the historical right to survive from the subset of more abstract environmental rights. Here, nations' historical compliance upholding certain survival-based duties reveals their binding nature, as opposed to impotent rights, which have only recently been recognized. n146 Scholars often refer to this less virile strand of entitlements with the all-encompassing term "right to environment." n147 They concede the importance of basic needs for survival, n148 but fail to recognize the codification of such principles before the 1960s, n149 or more "recent years." n150 In effect, they deny ancient rights to survival by saying that the right to environment emerged in the last few decades. The right to survival described here does not refer to modern holistic notions that seek to maximize all aspects of an individual's physical, psychological, and spiritual well being. n151 Instead, I limit the concept to the bare essentials required for human subsistence. Most recognize these entitlements as the right to "have air to breathe, water to drink, food to eat, and a place in which to live and sleep." n152 In essence, these rights pertain only to the natural resources necessary for human survival. Consequently, they constitute the foundation upon which other rights are built. n153 Or, stated differently, "Survival, the most fundamental [\*1123] "common interest' of humanity, underlies all legal and social systems."

**INTERNATIONAL LAW IS ON THE SIDE OF PLANETARY DEFENSE-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

For any non-lawyer blessed with even a modicum of common sense, it might seem ludicrous even to suggest that it could be illegal to defend the Earth from space-borne destruction. The prospect of averting potential global annihilation is so manifestly good and noble that there would seem to be no question that we should do all we can to develop, maintain, and if necessary use every means available in its support. As lawyers (with or without common sense) know, however, the law sometimes does operate counter-intuitively, and sometimes does cause unjust results in a given case.

Fortunately, in the case of planetary defense, the law is on the side of common sense. As has been demonstrated herein, all likely components of a planetary defense system, whether in the surveillance or the mitigation phase, can be supported under existing international and space law. Some tools are more clearly within the bounds of legality than others, but in every instance a strong argument can be made in support of legality.

**THE UNITED STATES SHOULD NOT WAIT FOR INTERNATIONAL PLAN OR COOPERATION-Garretson & Kaupa ‘08**

[Lt. Colonel Peter and Major Douglas; Potential Mitigation Roles of the Department of Defense; Air and Space Power Journal; September 2008; <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/fal08/garretson.html;> retrieved 05 Jul 2011]

Some detractors have stated that a planetary defense program is too expensive for the united states to bear alone and that it belongs in the international arena.although they make a reasonable point, several considerations remain. First, for such a critical survival issue, the United States should not find itself at the mercy of an internationally delayed or incomplete plan. Second, international cooperation would still imply using US resources but with less US control. Third, significant national security reasons exist for having the united states pursue this capability for the defense of others. America has an interest in preserving its democratic civilization and maintaining international security.

**IF NECESSARY, THE US COULD WITHDRAW FROM TREATY OBLIGATIONS TO DEFEND THE EARTH-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

In many, if not all cases in which Earth is threatened by a major collision, there should be sufficient warning to permit the United States to serve the requisite notice of withdrawal from the Treaty. Certainly the type of gigantic meteor or asteroid strike envisioned would constitute an "extraordinary event" that jeopardizes not only the United States' "supreme interests," i.e., survival, but those of every other nation on Earth as well. Assuming the [\*150] evidence of the impending Earth strike were clear and unequivocal, it is unlikely that any notification of intent to withdraw from this Treaty would meet with much international opposition. Indeed, it may be that other nations would actively attempt to persuade the United States to take action to prevent the threatened cataclysm.

**UNITED STATES MUST LEAD THESE EFFORTS, IF EVEN BY COMMITTEE INTERNATIONALLY-Friedman ‘10**

[Lou; Founder of the Planetary Society; Starting on Planetary Defense; The Planetary Society; 27 October 2010; <http://www.planetary.org/programs/projects/space_information/20101027.html>; retrieved 9 August 2011]

It’s my view that spacefaring nations should organize an ad-hoc task force, which someday might evolve to a treaty organization (analogous to NATO) to address policies, protocols and plans for dealing with the threat of a potentially hazardous object hitting Earth. The United States could, and should, lead by proposing such a task force. We need consideration soon, not because an impact is likely soon, but, because the threat of an impact is likely soon. The Administration’s letter to Congress should have also called for an international task force, clearly stating that NEO detection, observation, investigation, analysis, mitigation and potential deflection are global issues.

A/T: EXISTING SURVEYS SOLVE

**WE CANNOT STOP SIMPLY BECAUSE A SURVEY IS COMPLETED-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Despite progress toward or completion of any survey of near-Earth objects, it is impossible to identify all of these objects because objects’ orbits can change, for example due to collisions.

Recommendation: Once a near-Earth object survey has reached its mandated goal, the search for NEOs should not stop. Searching should continue to identify as many of the remaining objects and objects newly injected into the NEO population as possible, especially imminent impactors.

**WE NEED MORE THAN EARLY WARNING SYSTEMS, WHICH WILL ONLY GIVE TIME TO EVACUATE-Choi ‘10**

[Charles; A Week's Warning of Asteroid Strike Would Be Simple, Scientist Says; Space.com; 03 Dec 2010; <http://www.space.com/9629-week-warning-asteroid-strike-simple-scientist.html?;> retrieved 27 Jun 2011]

An early warning system that could give Earth a week's notice or more before a space rock destroyed a city would cost only $1 million per observatory, its leading proponent suggests.

Given current technologies, this lead time would not be enough to mount a mission to deflect the incoming object, but it could be enough to evacuate the area under threat.

Astronomer John Tonry at the University of Hawaii mentioned a near-miss in 2009 as he stressed the need for an early warning system against cosmic impacts.

**NASA IS CLOSE TO CONGRESS’S GOAL BUT THERE ARE THOUSANDS MORE NEOS TO FIND-Hsu ‘10**

[Jeremy; U.S. Must Be Ready to Meet Asteroid Threat, White House Science Adviser Says; Space.com; 21 Oct 2010; <http://www.space.com/9370-ready-meet-asteroid-threat-white-house-science-adviser.html;> retrieved 27 Jun 2011]

NASA has begun closing in on its congressionally directed goal of finding at least 90 percent of all NEOs with a diameter of 1 kilometer or greater. Search teams had discovered about 903 of an estimated 1,050 NEOs in that size category as of Oct. 1, and the space agency plans to reach its 90 percent detection goal by the end of this year.

Just 149 of the discovered objects have orbits that could possibly bring them into collision with Earth, and none present an impact threat within the next 100 years. Another 993 objects less than one kilometer in diameter also have orbits that could someday pose a threat to our planet.

Yet NASA estimates that the 6,416 known NEOs in the smaller size category, less than 1 kilometer wide, represent just five percent of the expected count. In other words, there are probably many more objects out there that represent a possible threat to Earth.

A/T: NUKES/WEAPONS IN SPACE NOT ALLOWED

**NUCLEAR EXPLOSIONS IN SPACE WOULD BE PERMISSIBLE UNDER THE NUCLEAR TEST BAN TREATY-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

It is clear that the object and purpose of the Treaty, as well as the subsequent practice of its signatories, have modified the meaning of the text. The intent of the drafters was to place limits on the testing of nuclear *weapons,* and the drafters took care to guard against weapons testing under the *subterfuge* of a peaceful purpose. But the Soviet Union eventually came to share the United States' position that certain legitimately peaceful purposes of nuclear explosions may indeed be desirable, given appropriate safeguards. And both superpowers understood from the beginning that, despite the text's seemingly sweeping prohibition on nuclear explosions in the atmosphere, in outer space, and underwater, the use of nuclear explosions in wartime was not forbidden.

Viewed within this context, nuclear explosions in space caused by a planetary defense system would be permissible under the Nuclear Test Ban Treaty. As previously discussed, a planetary defense device is not a weapon. Furthermore, consistent with the above quotes representing both the United States and Soviet viewpoints, planetary defense devices would be used in "self-defense," and "only for exceptionally urgent problems which cannot otherwise be solved." Therefore the better position, considering all relevant circumstances, is that neither the testing nor the actual use of a planetary defense nuclear device in space would be precluded by this Treaty.

**PLANETARY DEFENSE SYSTEMS ARE NOT MILITARY DEVICES-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

This customary international law, as well as the subsequent practice of the Parties, strongly supports the partial demilitarization view. If this view is indeed accepted, then planetary defense activities would be allowed under Article IV of the Outer Space Treaty, because they are defensive and non-aggressive in nature.

However, for purposes of planetary defense, which position prevails (the partial or total demilitarization view) may not finally be dispositive. If, as part of a planetary defense system, telescopes, sensors, and even some type of projectiles are established in orbit around Earth, or installed or tested on the moon or other "celestial bodies," it can be effectively argued that these are *not weapons* and are *not military* devices, because their sole purpose is to detect and defend against threatening natural objects from space. If this argument is accepted, then the first paragraph of Article IV of the Outer Space Treaty would clearly permit planetary defense in outer space, because no weapons would be involved. Likewise, the restrictions on weapons and military activities in the second paragraph would not apply, and planetary defense would be permissible on the moon or other celestial bodies.

**THE OUTER SPACE TREATY’S CALL FOR PEACEFUL PURPOSES DOESN’T PRECLUDE PLANETARY DEFENSE AGAINST NEOS-Kunich ‘97**

[John; Lt. Colonel, USAF, JD from Harvard Law; Planetary Defense: The Legality of Global Survival; The Air Force Law Review; 1997]

The partial demilitarization, or "Western" view, maintains that "use for peaceful purposes" should be interpreted as use for non-aggressive n45 purposes,and that military use of outer space is allowed so long as it is non-aggressive. This interpretation, which seems to be the more widely held view, n46 permits a much wider scope for military activity in outer space than the alternative. Supporters of this view argue that if "peaceful" is synonymous with utterly non-military, [\*132] then the second paragraph of Article IV is a meaningless redundancy. n47 They point out that if the Treaty's drafters had intended to apply the "peaceful" limitation to outer space, they would have explicitly done so, as they did in the second paragraph of that same article in reference to the moon and other celestial bodies. There, in addition to the "peaceful purposes" language, the drafters placed specific limitations on military bases, installations, fortifications, military maneuvers, and the use of military personnel on the moon and other celestial bodies. n48 None of these limitations are present in the first paragraph of Article IV.

**THE USE OF NUCLEAR WEAPONS FOR NEO DEFLECTION WILL NOT INCREASE PROLIFERATION-Barbee & Fowler ‘07**

[Brent, Aerospace Engineer at AIAA and Wallace, professor of Aerospace Engineering and Engineering Mechanics, The University of Texas; Spacecraft Mission Design for the Optimal Impulsive Deflection of Hazardous Near-Earth Objects (NEOs) using Nuclear Explosive Technology; NSS; 2007; <http://www.nss.org/resources/library/planetarydefense/2007-DeflectionOfNEOsUsingNuclearExplosiveTechnology.pdf;> retrieved 05 Jul 2011]

Despite the clear technical reasons for employing nuclear devices as NEO deflection mechanisms, there are those who disagree. Some people believe that using nuclear devices for NEO deflection would be taken advantage of by malicious world leaders as a means to justify further nuclear device stockpiling. There is a very strong argument that this is not true. No world leader would be able to make a case for creating substantially larger nuclear device stockpiles solely for NEO defense purposes because not very many nuclear devices are required for either testing on NEOs or being prepared for an actual hazardous NEO; sufficient nuclear devices exist today. Furthermore, a malicious leader will gain far more public support for nuclear device stockpiling by appealing to the public’s fear of another nation, which is readily personified and vilified, rather than trying to incite public fear of NEOs, which are remote distant objects that do not provoke the average person’s emotions nearly as much as national pride or fear of terrorism and war do. More importantly, nuclear devices are not going to disappear simply because some individuals view them as an icon of human aggression and destruction. These devices are tools like any other, and any space faring species, which humans aspire to be, most certainly requires tools that can generate large bursts of energy in the space environment for a variety of non-malicious purposes. In short, nuclear devices are a technology that humanity is going to be forced to learn to live with maturely, regardless of whether we ever use them for NEO deflection.

A/T: MORE IMMEDIATE THREATS

**WHILE OTHER THREATS MAY BE MORE IMMEDIATELY PRESSING, THE POTENTIAL IMPACT OF AN NEO COLLISION IS WORLDWIDE-Shapiro et al ‘10**

[Irwin; Chair of the Harvard Smithsonian Center for Astrophysics; *Defending Planet Earth:Near-Earth Object Surveys and Hazard Mitigation Strategies*; 2011; <http://books.nap.edu/openbook.php?record_id=12842;> retrieved 21 Jun 2011]

Unlike most other known natural hazards to humanity, such as earthquakes, volcanic eruptions, tsunamis, hurricanes, and tornadoes, NEO impacts present a very large spread of disaster scales ranging from small property damage to global extinction events. Larger impacts may result in global climatic changes that can result in famine and disease, infrastructure failure and, potentially, societal breakdown. Smaller impacts could be misinterpreted and thereby could conceivably even trigger wars. Numerous small incidents present little risk to people and property, but major impact events occur very infrequently. Impacts represent the extreme example of “low-probability, high-consequence” events. Although the probability of such a major impact within the next century may be small, a statistical risk of such an impact remains. Because of the nature of the impact threat, the expected fatality rate from impacts is an “actuarial” estimate based on calculations with attempted conservative assumptions. All the other estimates in Table 2.2 are based on the attribution of causes of actual fatalities from ongoing threats that may change in the future.

A/T: CONSISTENT ORBITS

**COMETS AND ASTEROID ORBITS ARE DISRUPTED BY GRAVITATIONAL PULL-Easterbrook ‘08**

[Gregg; contributing editor; The Sky Is Falling; The Atlantic; June 2008; <http://www.theatlantic.com/magazine/archive/2008/06/the-sky-is-falling/6807/1/;> retrieved 27 Jun 2011]

But if large numbers of comets and asteroids are still around, several billion years after the formation of the solar system, wouldn’t they by now be in stable orbits—ones that rarely intersect those of the planets? Maybe not. During the past few decades, some astronomers have theorized that the movement of the solar system within the Milky Way varies the gravitational stresses to which the sun, and everything that revolves around it, is exposed. The solar system may periodically pass close to stars or groups of stars whose gravitational pull affects the Oort Cloud, shaking comets and asteroids loose from their orbital moorings and sending them downward, toward the inner planets.

Space Based Solar Power Affirmative

**Plan: The United States Federal Government will commit $15 billion to demonstrate solar power and commit to be an anchor customer for a working commercial model.**

**Advantage 1. Solar Exploration**

**A. ECONOMIC DEVELOPMENT OF SPACE WILL DEPEND ON SOLAR POWER SATELLITES -Ad Astra ‘08**

[Space Based Solar Power; Ad Astra; Spring 2008; www.nss.org/adastra/AdAstra-SBSP-2008.pdf; retrieved 11 Jul 2011]

At the same time, current space missions are narrowly constrained by a lack of energy for launch and use in space. More ambitious missions will never be realized without new, reliable, and less-expensive sources of energy. Even more, the potential emergence of new space industries such as space tourism and manufacturing in space depend on advances in space power systems just as much as they do on progress in space transportation. New energy options are needed: sustainable energy for society, clean energy for the climate, and affordable and abundant energy for use in space. Space solar power is an option that can meet all of these needs.

**B. SBSP OFFERS THE FOUNDATION FOR SPACE EXPLORATION, LUNAR SETTLEMENTS, AND ASTEROID PROTECTION-Preble ‘09**

[Darel; Chair of the Space Solar Power Workshop**;** Space Solar Power: Star Player on the Bench; The Oil Drum; 19 April 2009; <http://www.theoildrum.com/node/5306;> retrieved 23 Jun 2011]

Many other space businesses and jobs would be enabled by SSP’s low launch costs - from space mining to new telescopes which are now being considered for the Moon’s far side. Just as the railroad helped settle and open the western US, SSP can even provide a ready market for products made on the Moon or in space, enabling prospects such as lunar settlement, which this nation and others are committed to build and develop. Yet such settlements will not long endure if they cannot provide useful trade products, just more flags and footprints. SSP should have NO financial entanglements with these tangential developments, important as some may consider them, other than possibly being a customer on a level playing field with competing products from Earth. (It is twenty times more energy efficient to ship a product to GSO from the Moon than from Earth, for example.)

Asteroid protection is becoming more vital to not only protect Earth, but also a large assortment of critical space satellite resources. These are already subject to a growing panoply of threats from both hostile and natural objects. The advent of SSP increases the relevance and urgency of this issue, protecting us from a growing threat, as Russell Schweickart’s B612 Foundation have detailed.

**C. SPACE COLONIZATION OFFERS A HEDGE AGAINST HUMAN EXTINCTION AND THE LOSS OF ALL OTHER LIFE ON EARTH, PASSING BOTH A COST-BENEFIT ANALYSIS AND MORAL TEST-Baum ‘09**

[Seth; Professor of Geography; Penn State University; Cost-Benefit Analysis of Space Exploration: Some Ethical Considerations*;* Space Policy; 2009; <http://sethbaum.com/ac/2009_CBA-SpaceExploration.pdf;> retrieved 16 Jul 2011]

While space colonization would provide a hedge against these very long-term astronomical threats, it would also provide a hedge against the more immediate threats that face humanity and other species. Such threats include nuclear warfare, pandemics, anthropogenic climate change, and disruptive technology [30]. Because these threats would generally only affect life on Earth and not life elsewhere,3 self- sufficient space colonies would survive these catastrophes, enabling life to persist in the universe. For this reason, space colonization has been advocated as a means of ensuring long- term human survival. Space exploration projects can help increase the probability of long-term human survival in other ways as well: technology developed for space exploration is central to proposals to avoid threats from large comet and asteroid impacts. However, given the goal of increasing the probability of long-term human survival by a certain amount, there may be more cost-effective options than space colonization (with costs defined in terms of money, effort, or related measures). More cost-effective options may include isolated refuges on Earth to help humans survive a catastrophe [36] and materials to assist survivors, such as a how-to manual for civilization [37] or a seed bank [38]. Further analysis is necessary to determine the most cost- effective means of increasing the probability of long-term human survival. A related question also relevant to space exploration is how to make tradeoffs between increases in survival probability and other benefits. This question treats survival not as a constraint for cost-effectiveness analysis but as a benefit that can be compared with other benefits. Such comparisons require a measure of the value of human survival. However, the value of survival lacks a precise figure. In traditional money-based CBA, it is not unreasonable to assign humanity’s survival an infinite value, or a value that is sufficiently large that it dominates everything else in CBA as if it were infinite. In Catastrophe: Risk and Response [39], US Court of Appeals judge Richard Posner gave human survival a value of $600 trillion; Posner described this as a crude underestimate intended to show that, even with such an underestimate, extensive effort to avoid human extinction passes CBA. Thus, following the common approach to non-market valuation, any reasonable estimate for the value of human survival suggests that this may be an important factor in space exploration CBA.

It is of note that the priority of reducing the risk of human extinction persists in forms of CBA which value nature in an ecocentric fashion, i.e. independently of any consideration of human interests. The basic reason is that without humanity leading long-term survival efforts (which would most likely include space colonization), the rest of Earth life would perish as a result of the astronomical processes described above. This point is elaborated by futurist Bruce Tonn, who argues on ecocentric grounds for reorienting society to focus on avoiding human extinction through both immediate avoidance of catastrophe and long-term space colonization . Tonn dubs this process of surviving beyond Earth’s eventual demise ‘‘transcending oblivion.” There is thus some convergence in the recommendations of the common anthropocentric, money-based CBA and the ecocentric CBA described here. This convergence results from the fact that (in all likelihood) only humans are capable of colonizing space, and thus human survival is necessary for Earth life to transcend oblivion.

**Advantage 2. Climate Change**

**A. THE DEVELOPING WORLD COULD LEAPFROG PAST INEFFICIENT, POLLUTING FORMS OF ENERGY PRODUCTION WITH SOLAR POWER SATELLITES -Farrar ‘08**

[Lara; correspondent; How to harvest solar power? Beam it down from space!; CNN.com; 30 May 2008]

Much of that electricity will come from coal-fired power plants, like the $4 billion so-called ultra mega complex scheduled to be built south of Tunda Wand, a tiny village near the Gulf of Kutch, an inlet of the Arabian Sea on India's west coast. Dozens of other such projects are already or soon will be under way.

Yet Mehta has another solution for India's chronic electricity shortage, one that does not involve power plants on the ground but instead massive sun-gathering satellites in geosynchronous orbits 22,000 miles in the sky.

The satellites would electromagnetically beam gigawatts of solar energy back to ground-based receivers, where it would then be converted to electricity and transferred to power grids. And because in high Earth orbit, satellites are unaffected by the earth's shadow virtually 365 days a year, the floating power plants could provide round-the-clock clean, renewable electricity.

"This will be kind of a leap frog action instead of just crawling," said Mehta, who is the director of India operations for Space Island Group, a California-based company working to develop solar satellites. "It is a win-win situation."

**B. FAILURE TO ADDRESS THE GROWING POLLUTION FROM THE DEVELOPING WORLD MEANS GLOBAL WARMING CANNOT BE SOLVED-Williams ‘08**

[Byron; syndicated columnist; Clinton, Obama Global Warming Plans Overlook China, India; Huffington Post; 17 Feb 2008; http://www.huffingtonpost.com/byron-williams/clinton-obama-global-war\_b\_87086.html; retrieved 22 Jul 2008]

Any environmental plan that does not include working directly with China and India to reduce their global emissions is merely campaign rhetoric.

The rapidly expanding economies of China and India are showing a dramatic increase in CO2 emissions. China, which is already the second largest polluter, behind the United States, increased its emissions by 33 percent between 1992 and 2002, India's emissions grew 57 percent during the same period.

China and India's economic growth depends largely on high polluting, coal-based manufacturing. According to projections, China will soon surpass the United States as the world's biggest emitter of greenhouse gases, particularly carbon dioxide, which scientists say cause global warming.

Last year, China proposed a plan that would improve energy efficiency while resisting any mandatory caps on greenhouse gas emissions.

Global warming is inclusive in nature, making no distinction from where it will draw its greenhouse gases. The next president, regardless of party, must try where the present administration failed. This, however, is easier said than done.

The next president must make the argument to China and India that the manner in which they are now realizing economic growth (the same manner the United States used for more than a century) is bad for the planet. Though the task may be an arduous one, it is a challenge that the next commander in chief must address forthrightly.

**C. IT IS IMPERATIVE THAT WE START TO DEVELOP A SIGNIFICANT PLAN TO REDUCE WARMING. SBSP CAN DO THAT-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

The aggravation and acceleration of a potential anthropogenic catastrophic global climate change, in my opinion, is the number one risk incurred from our combustion-based world economy. At the International Energy Conference in Seattle, I showed three pairs of satellite images as evidence that the earth glaciers are disappearing at an alarming rate.[2] Whether this warming trend can be reversed by human intervention is not clear, but this uncertainty in risk reduction doesn't justify the human inactions in adapting policies and countermeasures on renewable energy development for a sustainable world economy, and for curbing the likelihood of any risk event of anthropogenic catastrophic climate changes. What is imperative is that we start to do something in a significant way that has a chance to make a difference.

Why solar energy from space? Is it technologically feasible? Is it commercially viable? My answer is positively and absolutely yes. One of the reasons that less than one percent of the world's energy currently comes from the sun is due to high photovoltaic cell costs and PV inefficiencies in converting sunlight into electricity. Based on existing technology, a field of solar panels the size of the state of Vermont will be needed to power the electricity needs of the whole U.S. And to satisfy world consumption will require some one percent of the land used for agriculture worldwide. Hopefully this will change when breakthroughs are made in conversion efficiency of PV cells and in the cost of producing them, along with more affordable and higher capacity batteries.

**D.**  **A FAILURE TO ADDRESS WARMING WITHIN DECADES COULD LEAD TO A MASS EXTINCTION OF SPECIES AND BILLIONS OF HUMAN DEATHS-Williams ‘10**

[Chris; chair of the Science Department at Packer Collegiate Institute; *Ecology and Socialism: Solutions to Capitalist Ecological Crisis; 2010; Kindle Edition]*

If two degrees of warming is indeed a planetary “critical threshold,” then once we have passed it, we head inexorably for three degrees of warming, then four, five, and six. What would a world five to six degrees warmer look like? A glance back millions of years, to when crocodiles flourished in what is now Canada, gives us some idea. The Amazon will have disappeared and turned into a desert. The collapse of the Greenland ice sheet and the Antarctic ice shelf will produce sea-level rises of 25 meters, inundating coastal cities and placing large areas of land far underwater. Coral reefs will be dead from ocean acidification. Fish stocks will plunge due to acidity and decreased dissolved oxygen as oceans warm. Searing heat, the extreme violence of “hypercanes” caused by warmer oceans and greater kinetic energy in the atmosphere, and flash flooding will make growing crops impossible across large areas of formerly fertile continents. Southern Europe, the Southwestern U.S., and Central America, along with Central Asia and Africa and almost the whole of Australia will become desert. Humans will be constrained to “zones of habitability” near the poles to escape the twin extremes of drought and flood. All these changes will occur far too rapidly to allow for adaptation on the part of upwards of 50-60 percent of plant and animal species, which will cease to exist. The level of mass extinction could rival the climate-change-induced Permian-Triassic (P-T) mass extinction of 251 million years ago, which saw planetary life hanging by a thread as 95 percent of all species, plant and animal became extinct; it took 50 million years for the earth to return to its pre P-T level of biodiversity. Human population will drop by the billions even as mass migrations and civilizational breakdown become continuous features of life for those who survive. More worrisome still— if that’s possible—is that, while in the past such “rapid” climate swings generally occurred over thousands or hundreds of years, continuing on our present course could produce a similar swing in a matter of decades.

**E. MASSIVE LOSS OF SPECIES PUTS THE COLLECTIVE FATE OF HUMANITY AT RISK-Warner ‘94**

[Paul; Professor of International Politics, American University; Politics and Life Sciences; p. 177]

Massive extinction of species is dangerous, then, because one cannot predict which species are expendable to the system as a whole.As Philip Hoose remarks, "Plants and animals cannot tell us what they mean to each other." One can never be sure which species holds up fundamental biological relationships in the planetary ecosystem. And, because removing species is an irreversible act, it may be too late to save the system after the extinction of key plants or animals.According to the U.S. National Research Council,"The ramifications of an ecological change of this magnitude [vast extinction of species] are so far reaching that no one on earth will escape them." Trifling with the "lives" of species is like playing Russian roulette, with our collective future as the stakes.

**Advantage 3. Desalination**

**A. SBSP CAN GENERATE CLEAN FRESH WATER GLOBALLY-Tobiska ‘10**

[W. Kent; Ph.D., Aerospace Engineering Sciences, University of Colorado; Vision for Producing Fresh Water Using Space Power; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/tobiska.html;> retrieved 24 Jun 2011]

There is a strong argument presented here - produce industrial quantities of fresh water for semi-arid Southern California (SoCal) using decommissioned offshore oil and gas platforms that are fitted with solar arrays for diurnal power and augmented by space-based solar power for around-the-clock operation. This argument makes novel use of space-based assets to solve 21st Century problems.

Global benefits can be derived from Space Water and they include: i) a clean, no-carbon footprint energy legacy for centuries to come; ii) a credible method for global fresh water production; and iii) a transformative solution to the global climate crisis.

U.S. benefits include: i) a clean energy source for water production and for electricity; ii) military energy and water independence at forward bases; and iii) asserting global leadership for space asset development and utilization in the 21st Century.

**B. WATER CRISIS WILL FUEL VIOLENT CONFLICTS AND POLLUTION-Speth ‘09**

[James Gustav; former professor Yale School of Forestry and Environmental Studies and current professor of law, U. of Vermont; *The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability*; 2009; Kindle Edition]

The second crisis is the crisis of freshwater supply. Human demand for water climbed sixfold in the twentieth century, and the trend continues today. Humanity now withdraws slightly over half of accessible freshwater, and water withdrawals could climb to 70 percent by 2025.42 Meeting the world's demands for freshwater is proving problematic. About 40 percent of the world's people already live in countries that are classified as "water stressed," meaning that already 20 to 40 percent of the available freshwater is being used by human societies. Projections indicate that the percentage of people living in water-stressed countries could rise to 65 percent by 2O25.4s A large portion of freshwater withdrawals, about 70 percent, goes to agriculture. Since 1960, acreage under irrigation has more than doubled. A special problem is occurring in India, China, and elsewhere in Asia where tens of millions of tubewells are depleting "fossil" groundwaters. The New Scientist reports that "hundreds of millions of Indians may see their land turned to desert."" Overall, according to a study by top water specialists from around the world, world demand for water could double by 2050.45 "At the worst," the New York Times reported, "a deepening water crisis would fuel violent conflicts, dry up rivers and increase groundwater pollution.... It would also force the rural poor to clear ever-more grasslands and forests to grow food and leave many more people hungry."

**Advantage 4. Global Energy Production**

**A. SBSP IS THE WORLD’S MOST PROMISING SOLUTION TO THE ENERGY AND ENVIRONMENTAL CRISES-Flournoy ‘10**

[Don; Professor of Telecommunications @Ohio University; SUNSATS: The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/flournoy.html;> retrieved 24 Jun 2011]

The world is facing a perfect storm in which an energy crisis and an environmental crisis are occurring simultaneously. Earth's population continues to grow. Oil, gas and coal, the principal energy basis for the steadily improving standards of living among the more developed societies - and coveted by lesser developed societies - are contaminating earth's atmosphere as they are mined, processed and consumed. Those non-renewable fossil fuels are rapidly being used up. Within the next human generation, fossil fuels - plus all known alternative energy sources on earth - are predicted to fall far short of what will be needed.

Several government commissions, think tanks, energy companies and utilities in more than one country investigating space-based solar power have concluded that SunSats are the world's most promising long-term solution. The argument is that the solar energy available in space is several billion times greater than any amount we could ever use on earth. The sun's energy is always available and it is inexhaustible. Unlike the fossil fuels of earth, space solar power does not emit greenhouse gases. Moving to solar can reduce competition for the limited supplies of earth-based energy, which is predicted to be the basis for future wars.

**B. WE MUST BEGIN AN SSP PROJECT BY 2012 TO AVERT AN ENERGY SHORTAGE CATASTROPHE-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

The Energy Information Agency (EIA) of the US predicts that in the time between 2004 and 2030 the world's energy demand will almost double. An extra 8,500 GW of installed capacity is needed to meet the growing energy needs of an increasingly affluent and industrialized world. This amounts to 328 GW per year of installed baseload power generation. A typical terrestrial "mega-nuclear" plant having multiple reactors produces from 5 to 8 GW, takes 8 years to build, and costs 25 billion USD, or about 3.85 USD/watt. Worldwide, the translates into 1.25 trillion USD each year on power generation facilities.

Renewable energy sources, such as hydroelectric, wind, biomass, geothermal, and solar (passive, concentrated, and photovoltaic) are limited, according to the EIA. Even if fully utilitized and cost-effective, these sources are barely capable of meeting energy needs in 2030, but inadequate to meet the projected needs in 2050. Therefore, SSP needs to become a large and growing segment of mankind's power needs by no later than 2030. The Manhattan Project took 6 years, and the first nuclear reactor came 9 years later. The Apollo project also took 6 years, and routine space travel via the STS began 12 years after that. Thus, the latest date at which SSP work must be started is 2012.

**C. WE MUST ADVOCATE SBSP AS A SUSTAINABILITY STRATEGY FOR THE FUTURE OF HUMANITY-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

We must advocate solar energy as a sustainability strategy for the future of humanity. That is the way to pursue Solar Power Satellites. We should not, nor do we need to, restrict our vision by choosing between terrestrial and space-based solar. The dream of SPS can be realized much sooner by getting behind the use of terrestrial solar energy and the development of pertinent solar technology on a global scale. Development of nanoparticle ultra high efficiency, low weight, low cost PV cells, along with higher capacity and lower cost energy storage systems, will also benefit SPS development. Our ultimate goal is to tame the "very wheelworks of nature" and harness the energy of the sun. It's not important whether we achieve this goal via SPS or through terrestrial solar approaches, or whatever technological approaches may be created for large scale and affordable use of solar energy.

INHERENCY: GOVERNMENT IS NOT INTERESTED/ACTIVE

**SBSP IS LIMITED BY A LACK OF GOVERNMENT AGENCY INVOLVEMENT/DIRECTION-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

<http://www.thespacereview.com/article/931/1;> retrieved 17 Jun 2011]

Another big problem has been finding the right government agency to support R&D work on space solar power. Space solar power doesn’t neatly fit into any particular agency’s scope, and without anyone in NASA or DOE actively advocating it, it has fallen through the cracks in recent years. “NASA does science, they do astronauts, and they do aeronautics, but they don’t do energy for the Earth,” Mankins said. “On the other side, the Department of Energy doesn’t really do energy for space.” That situation, at least in regards to those two agencies, shows little sign of changing.

**BECAUSE AMERICAN POLICY IS SO OFTEN REACTIONARY, SBPS WILL NOT GET STARTED IN THE U.S.-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

The US has a long history of reactionary response. Yet, when the perceived threat diminishes, so goes the motivation for action. This is sometimes used to great effect by enemies of the US who provoke a strong response, then retreat, allowing the behemoth to exhaust its resources in overreaction. A recent, post 9/11 example is creating transportation fuels from food, kick-started by the surge in gasoline prices in 2007. Government and private funding for corn ethanol went from a peak to a trough in just two years. A similar cycle occurred in the late 1970s, also driven by gasoline prices, only to all-but-vanish by the early 1980s. Collectively, Americans are not long-term systems thinkers, preferring short-term point solutions. For these reasons, SSP will not get started in the US.

**THERE IS NO WAY, SHORT OF A MIRACLE, THAT THE US WILL START A SBSP PROGRAM-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

Manhattan and Apollo threats were man-made. What threats could induce the US to pursue SSP? Oil shortages have failed. International climate change initiatives have so far failed. Even an attack on US soil was insufficient to change American views towards energy. Positive incentives have also failed, including Nobel Prizes and petitions by developing nations. There is presently no superpower to challenge the US, so any remaining threats are perceived as being manageable.

By process of elimination, there are no known threats or inducements which could initiate a concerted US effort to develop solar power satellites. Therefore, if SSP is to come to pass, it will require a miracle, or at the very least, an unexpected degree of good luck. As Thomas Jefferson, third President of the United States said: "I'm a great believer in luck and I find the harder I work, the more I have of it." The remainder of this paper outlines a means by which hard work can prepare the US for a SSP initiative, should a miracle occur.

**NEITHER CONGRESS NOR ANY FEDERAL AGENCY IS WORKING ON SBSP-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

At present, neither NASA, nor the US Department of Energy (DOE) conduct any appreciable research on SSP. The Defense Advanced Research Project Agency (DARPA) does not presently have any budget for SSP. Although each of these three agencies would have a significant role to play in SSP development, deployment, and security, none is currently doing so. In the case of NASA and DOE, this is largely a political issue. They cannot take on such an initiative without direction from Congress. Another consequence of the unpredictable miracle is that the US Congress must have a champion or coalition to support SSP.

**SBSP IS FROZEN BY A POLICY DILEMMA OF OWNERSHIP-Cramer Shea ‘10**

[Karen; M.A. Science Technology and Public Policy with Specialty in Space Policy from the George Washington University; Why Has SPS R&D Received So Little Funding?; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/shea.html;> retrieved 24 Jun 2011]

Space Solar Power has suffered from a policy dilemma. The Department of Defense (DOD) wants to use solar power satellites (SPS) to deliver electrical power to its forward military bases but that agency cannot build them, since SPS is clearly not in its mission. The DOD is developing lasers and microwave beams for offensive military purposes, but taking a lead in using lasers and microwaves for the beaming of electrical power would be politically unacceptable. The DOD is very interested in being an SSP customer because this satellite energy application would dramatically improve efficiency and reduce costs of supplying power to its troops in the field. Another consideration is in reducing costs in lives, as the generator fuel trucks are easy targets.

**NEITHER NASA NOR THE DOD IS FUNDING SBSP RESEARCH-Cramer Shea ‘10**

[Karen; M.A. Science Technology and Public Policy with Specialty in Space Policy from the George Washington University; Why Has SPS R&D Received So Little Funding?; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/shea.html;> retrieved 24 Jun 2011]

Space solar power has been studied by both NASA and the DOE. Unfortunately, NASA considers SSP to be an energy issue and the DOE considers it to be a space issue. Neither is currently funding SSP research. Added to this, NASA is in crisis with the retirement of the Space Shuttle, while trying to operate the International Space Station and return to the Moon with a launch system that is behind schedule, over budget and losing capability. The 2009 Augustine Committee called for a $3 billion increase in the NASA budget just to keep up with its current commitments. NASA clearly cannot take the lead in SPS research and development.

SOLVENCY: SBSP MEETS AMERICAN ENERGY NEEDS

**ONLY SPACE BASED SOLAR POWER CAN MEET AMERICAN ELECTRICITY NEEDS-Snead ‘08**

[James; The End of Easy Energy and What To Do About It; 19 Nov 2008; <http://mikesnead.net/resources/spacefaring/white_paper_the_end_of_easy_energy_and_what_to_do_about_it.pdf;> retrieved 11 Jul 2011]

Closing the U.S.’s and the world’s significant shortfalls in dispatchable electrical power will require substantial additional generation capacity that can only be addressed through the use of space solar power. Because of the substantial shortfall in needed 2100 fuels production, producing even more sustainable fuels to burn as a replacement for oil, coal, and natural gas to generate the needed additional electrical power is not practical. As a result, additional baseload electrical power generation capacity must be developed. The remaining potential sources of dispatchable electrical power generation are advanced nuclear energy and space solar power. While advanced nuclear energy certainly holds the promise to help fill this gap, fulfilling its promise has significant challenges to first overcome. Demonstrated safety; waste disposal; nuclear proliferation; fuel availability; and, forfusion and some fission approaches, required further technology development limit the ability to project significant growth in advanced nuclear electrical power generation.Space solar power (SSP)—involving the use of extremely large space platforms (20,000 or

more tons each) in geostationary orbit (GEO) to convert sunlight into electrical power and transmit this power to large ground receivers—provides the remaining large-scale baseload alternative. Relying on SSP would require 1,854 5-GWe SSP systems to eliminate the world’s shortfall in needed 2100 dispatchable electrical power generation capacity. Of these, 244 SSP systems would be used to eliminate the U.S. shortfall in needed 2100 dispatchable electrical power generation capacity. The following two charts summarize this paper’s projection of the potential contribution of SSP in meeting the U.S.’s and the world’s dispatchable electrical power generation needs in 2100.

**SPACE SOLAR WOULD COMPLETELY SOLVE WORLD ENERGY NEEDS- Cox ‘11**

[William John; The Race for Space Solar Energy; The People’s Voice; 26 March 2011; <http://www.thepeoplesvoice.org/TPV3/Voices.php/2011/03/26/the-race-for-space-solar-energy>; retrieved 9 August 2011]

Space-solar energy is the greatest source of untapped energy which could, potentially, completely solve the world’s energy and greenhouse gas emission problems.

SOLVENCY: SBSP WILL WORK

**SBSP COULD BE PRODUCED COMMERCIALLY WITHIN A DECADE-Atkinson ‘09**

[Nancy; staff writer; New Company Looks to Produce Space Power Within a Decade; Universe Today; 18 Feb 2009; <http://www.universetoday.com/25754/new-company-looks-to-produce-space-based-solar-power-within-a-decade/#more-25754;> retrieved 17 June 2011]

Is space-based solar power (SBSP) a technology whose time has come? The concept and even some of the hardware for harnessing energy from the sun with orbiting solar arrays has been around for some time. But the biggest challenge for making the concept a reality, says entrepreneur Peter Sage of Space Energy, Inc., is that SBSP has never been commercially viable. But that could be changing. Space Energy, Inc. has assembled an impressive team of scientists, engineers and business people, putting together what Sage calls “a rock-solid commercial platform” for their company. And given the current looming issues of growing energy needs and climate change, Space Energy, Inc. could be in the right place at the right time. “Although it’s a very grandiose vision, it makes total sense,” Sage told Universe Today. “This is an inevitable technology; it’s going to happen. If we can put solar panels in space where the sun shines 24 hours a day, if we have a safe way of transmitting the energy to Earth and broadcasting it anywhere, that is a serious game changer.” If everything falls into place for this company, they could be producing commercially available SBSP within a decade.

**SBSP IS MORE TECHNICALLY FEASIBLE THAN EVER BEFORE-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

Those concepts, he argued, are outdated given the advancements in technology in the last three decades. The efficiency of photovoltaic arrays has increased from 10 to over 40 percent, thus requiring far smaller arrays to generate the same amount of power. Advances in robotics would allow assembly of “hypermodularized” systems, launched piece by piece by smaller vehicles, with little or no astronaut labor. “We think it’s now more technically feasible than ever before,” he said. “We think we have a path to knowing whether or not it’s economically feasible.”

**TECHNOLOGICAL ADVANCES AND ENERGY PRICES HAVE MADE SBSP A SERIOUS CANDIDATE FOR 21ST CENTURY ENERGY NEEDS-Marshall ‘09**

[John; Space Solar Power: The Next Frontier; 13 April 2011; [http://www.next100.com/2009/04/space-solar-power-the-next-fro.php;](http://www.google.com/url?q=http%3A%2F%2Fwww.next100.com%2F2009%2F04%2Fspace-solar-power-the-next-fro.php%3B&sa=D&sntz=1&usg=AFQjCNFrbqu7JBJQKLbsZolpsdOKzoQyLg) retrieved 17 Jun 2011]

In 1997, John C. Mankins, manager of NASA's Advanced Projects Office, wrote:

Based on the recently-completed "fresh look" study, space solar power concepts may be ready to reenter the discussion. Certainly, solar power satellites should no longer be envisioned as requiring unimaginably large initial investments in fixed infrastructure before the emplacement of productive power plants can begin. Moreover, space solar power systems appear to possess many significant environmental advantages when compared to alternative approaches to meeting increasing terrestrial demands for energy - including requiring considerably less land area than terrestrially-based solar power systems.

The economic viability of such systems depends, of course, on many factors and the successful development of various new technologies - not least of which is the availability of exceptionally low cost access to space. However, the same can be said of many other advanced power technologies options. Space solar power may well emerge as a serious candidate among the options for meeting the energy demands of the 21st century.

**THE PAST DEMONSTRATED THAT WE HAVE THE CAPACITY TO LEAP INTO A CIVILIZATION BASED ON SOLAR ELECTRICITY-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

Can mankind achieve the next giant leap into the solar-electric civilization? The past can be our guide. We have shown ourselves capable of such space achievements as the Manhattan and Apollo projects. We can make it happen - but not if we fail to educate and mobilize the public and politicians around the globe. The key changes and support needed are less technical and economic than social and political aspects[11]. Indeed, it's a policy issue, and it is encouraging to see that the government of Japan has taken a lead position to support the SBSP development[12]. When it comes down to a space race or war, we can achieve nearly anything. But can we rally the public and politicians for peace and sustainable human development? Can we promote the Solar Power Satellites idea for what it will be: a Manhattan project for peace?

Dr. Robert Goddard liked to say, "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." I would like to conclude this paper with what I said at the end of my talk at the Seattle energy conference, "As intelligent creatures rooted in the cosmic origin, humanity was meant to survive and spread its presence all over the universe by milking the energy of the stars."

**THE TECHNOLOGY CURRENTLY EXISTS- Cox ‘11**

[William John; The Race for Space Solar Energy; The People’s Voice; 26 March 2011; <http://www.thepeoplesvoice.org/TPV3/Voices.php/2011/03/26/the-race-for-space-solar-energy>; retrieved 9 August 2011]

The technology currently exists to launch solar-collector satellites into geostationary orbits around the Earth to convert the Sun’s radiant energy into electricity 24 hours a day and to safely transmit the electricity by microwave beams to rectifying antennas on Earth.

Following its proposal by Dr. Peter Glaser in 1968, the concept of solar power satellites was extensively studied by the U.S. Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA). By 1981, the organizations determined that the idea was a high-risk venture; however, they recommended further study.

With increases in electricity demand and costs, NASA took a "fresh look" at the concept between 1995 and 1997. The NASA study envisioned a trillion-dollar project to place several dozen solar-power satellites in geostationary orbits by 2050, sending between two gigawatts and five gigawatts of power to Earth.

The NASA effort successfully demonstrated the ability to transmit electrical energy by microwaves through the atmosphere; however, the study’s leader, John Mankins, now says the program "has fallen through the cracks because no organization is responsible for both space programs and energy security."

SOLVENCY: SBSP CAN BE USED WITH EXISTING ENERGY GRID

**SOLAR POWER SATELLITES ARE UNIQUELY CAPABLE OF PROVIDING ENERGY WITHOUT CHANGING THE GLOBAL FUEL INFRASTRUCTURE-National Security Space Office ‘07**

[Space Based Solar Power as an Opportunity for Strategic Security; National Security Space Office; 10 Oct 2007; http://www.nss.org/settlement/ssp/library/nsso.htm; retrieved 12 Jul 2011]

This technology enables a carbon-neutral (closed carbon-cycle) hydrocarbon economy driven by clean renewable sources of power, which can utilize the existing global fuel infrastructure without modification. This opportunity is of particular interest to traditional oil companies. The ability to use renewable energy to serve as the energy feedstock for existing fuels, in a carbon neutral cycle, is a ”total game changer” that deserves significant attention.

Both fossil and fissile sources offer significant capabilities to our energy mix, but dependence on the exact mix must be carefully managed. Likewise, the mix abroad may affect domestic security. While increased use of nuclear power is not of particular concern in nations that enjoy the rule of law and have functioning internal security mechanisms, it may be of greater concern in unstable areas of rouge states. The United States might consider the security challenges of wide proliferation of enrichment-based nuclear power abroad undesirable. If so, having a viable alternative that fills a comparable niche might be attractive. Overall, SBSP offers a hopeful path toward reduced fossil and fissile fuel dependence.

**EVENTUALLY SBSP CAN BE USED TO FUEL TRADITIONAL GROUND TRANSPORTATION-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

To the extent mankind’s electricity is produced by fossil fuel sources, SBSP offers a capability over time to reduce the rate at which humanity consumes the planet’s finite fossil hydrocarbon resources. While presently hard to store, electricity is easy to transport, and is highly efficient in conversion to both mechanical and thermal energy. Except for the aviation transportation infrastructure, virtually all of America’s energy could eventually be delivered and consumed as electricity. Even in ground transportation, a movement toward plug‐in hybrids would allow a substantial amount of traditional ground transportation to be powered by SBSP electricity.

For those applications that favor or rely upon liquid hydrocarbon fuels, America’s national labs are pursuing several promising avenues of research to manufacture carbon‐neutral synthetic fuels (synfuels) from direct solar thermal energy or radiated/electrical SBSP. The lab initiatives are developing technologies to efficiently split energy‐neutral feedstocks or upgrade lower‐grade fuels (such as biofuels) into higher energy density liquid hydrocarbons. Put plainly, SBSP could be utilized to split hydrogen from water and the carbon monoxide (syngas) from carbon dioxide which can then be combined to manufacture any desired hydrocarbon fuel, including gasoline, diesel, kerosene and jet fuel. This technology is still in its infancy, and significant investment will be required to bring this technology to a high level of technical readiness and meet economic and efficiency goals.

SOLVENCY: DEMONSTRATION SATELLITE

**A GOVT DEMONSTRATION WILL MATURE THE SBSP CONCEPT AND CATALYZE COMMERCIAL DEVELOPMENT-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

No government or private entity has ever completed a significant space‐borne demonstration, understandable to the public, to provide proof‐in‐principle and create strategic visibility for the concept (the study group did discover one European commercial consortium that was attempting to build a MW‐class in‐space demonstration within the next 5 years). While a series of experiments for specific component selection, maturation, and space qualification is also in order, a convincing in‐space demonstration is required to mature this concept and catalyze actionable commercial interest and development. There are also critical concept unknowns that can only be uncovered by flying actual hardware.

o Recommendation: The SBSP Study Group recommends that the U.S. Government should sponsor a formally funded, follow‐on architecture study with industry and international partners that could lead to a competition for an orbital demonstration of the key underlying technologies and systems needed for an initial 5‐50 MWe continuous SBSP system.

**A DEMONSTRATION SATELLITE, COSTING $100 MILLION, WOULD SHOW THE PROMISE OF SBSP -Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

The idea of a demonstration satellite was endorsed by Shubber Ali, an entrepreneur and self-described “cynic” who also participated on the NewSpace panel. “The first step in this case needs to be a cheap, simple satellite, just to prove that we can beam power back down,” he said. A satellite that generated just 10 kilowatts of power—less than some commercial GEO communications satellites—could be developed for on the order of $100 million, he said.

**THE GOVERNMENT MUST PROVIDE R&D SUPPORT AND TECHNOLOGY DEMONSTRATIONS-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

The overwhelming initial cost of development and deployment has remained the primary obstacle. As noted, number one on the list of cost barriers is the cost of space transportation. Solar power satellites are only economically feasible if there is low cost space transport. For SPS to be successful, we need an organized consortium consisting of private businesses, venture capitalists from major international partners, along with government support of R&D and technology demonstrations by industrial nations. We need this concerted effort to bring down associated risks in safety, reliability and technology maturity. The Comsat model for the successful launching and commercialization of communications satellite industry should be a viable approach for Solar Power Satellite implementation.

**A GOVERNMENT FUNDED SPS DEMONSTRATION PROJECT IS LONG OVERDUE-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

Our society has repeatedly overlooked (or dismissed) the potential of space based solar power. The U.S. government funded an SPS study totaling about 20 million dollars in the late 1970s at the height of the early oil crisis, and then practically abandoned this project with nearly zero dollars spent up to the present day. A government funded SPS demonstration project is overdue. Ralph Nansen, a friend of mine, who was the former project manager of the Apollo program at Boeing and who later managed the DOE-NASA funded SSP proof of concept study in the late 1970s, detailed the Boeing study in his excellent 1995 book Sun Power: The Global Solution for the Coming Energy Crisis[6]. In 2009, he authored another book entitled Energy Crisis: Solution From Space[7]. I highly recommend the reading of each of these two books for those interested in this topic. Of course, Dr. Peter Glaser's 1968 book and other papers[8] are superb reading on this topic as well.

**THE US GOVERNMENT SHOULD FACILITATE, RESEARCH, AND ADOPT SBSP AS AN EARLY DEMONSTRATION-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

Recommendation #1: The study group recommends that the U.S. Government should organize effectively to allow for the development of SBSP and conclude analyses to resolve remaining unknowns

• Recommendation #2: The study group recommends that the U.S. Government should retire a major portion of the technical risk for business development

• Recommendation #3: The study group recommends that the U.S. Government should create a facilitating policy, regulatory, and legal environment for the development of SBSP

• Recommendation #4: The study group recommends that the U.S. Government should become an early demonstrator/adopter/customer of SBSP and incentivize its development.

**NASA SHOULD MAKE ITS PRIMARY GOAL THE DEPLOYMENT OF A DEMONSTRATION MODEL SPS-Bova ‘08**

[Ben; president emeritus of the National Space Society; An Energy Fix Written in the Stars; Washington Post; 12 Oct 2008]

It will take foresight and leadership to start a solar power satellite program. That's why, Mr. Future President, I believe that you should make it NASA's primary goal to build and operate a demonstration model SPS, sized to deliver a reasonably impressive amount of electrical power -- say, 10 to 100 megawatts -- before the end of your second term. Such a demonstration would prove that full-scale solar power satellites are achievable. With federal loan guarantees, private financing could then take over and build satellites that would deliver the gigawatts we need to lower our imports of foreign oil and begin to move away from fossil fuels.

**A LAUNCH OF FOUR TEST SATELLITES WOULD ALLOW FOR IMPROVEMENT AS A MARKET FOR THE POWER BUILDS-Cramer Shea ‘10**

[Karen; M.A. Science Technology and Public Policy with Specialty in Space Policy from the George Washington University; Why Has SPS R&D Received So Little Funding?; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/shea.html;> retrieved 24 Jun 2011]

To meet the demands of launching the components of four solar power satellites into geosynchronous orbit, the launch industry would have to rapidly up-size. Putting the power of the government behind this effort would assure development of improved facilities and technologies. Four satellites would allow the SSP technology to go through several generations of improvement while the market was being established. Once their capabilities are proven, with four electricity generating satellites in orbit, the industry will have a track record on which to secure investment capital for additional launches. It is hoped that because of the investment and new technologies applied launch costs will have been lowered.

**A NEW POLICY APPROACH, WITH THE GOVERNMENT ASSISTING IN DEMONSTRATION SATELLITES, WILL END SBSP STALL-Cramer Shea ‘10**

[Karen; M.A. Science Technology and Public Policy with Specialty in Space Policy from the George Washington University; Why Has SPS R&D Received So Little Funding?; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/shea.html;> retrieved 24 Jun 2011]

Space solar power has no serious technical issues standing in its way, but it is facing crippling policy dilemmas. By taking a new policy approach, we may be able to get out of a decades-long quagmire. Energy and space are within the mandate of the Department of Commerce. Help with the deployment of four full scale space solar power satellites will incentivize the launch industry to develop new technologies and more efficient techniques and facilities.

**BUILDING ONE IS ENOUGH TO BREAK PAST THE BARRIERS-Boswell ‘04**

[David; Whatever happened to solar power satellites?; The Space Review; 30 August 2004; <http://www.thespacereview.com/article/214/1>; retrieved 9 August 2011]

There are a number of reasons why we won’t be seeing huge orbiting solar collectors beaming us lots of energy anytime soon. Starting the development of such a system by building small proof of concept satellites is completely within our reach, though. There are economic, political, and engineering hurdles in the way, but none of these should be enough to stop the idea if we choose to pursue it. Once a successful demonstration has been achieved, there may be enough interest in government or in private industry to continue working toward fully-operational solar power satellites.

SOLVENCY: GOVERNMENT SUPPORT IS CRITICAL

**GOVERNMENT POLICY AND REGULATORY SUPPORT WILL BE CRUCIAL TO SBSP SUCCESS-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

Government policy and regulatory support will be crucial to success, as will the funding of R&D and related technology demonstrations. U.S. government support for space solar during the 1980s was negligible. NASA initiated its "A Fresh Look" studies in the mid-1990's. Subsequently, the U.S. Department of Energy abstained from any involvement. During this time, the Japanese government and industry became interested in the SPS concept. The Japanese updated the reference system design developed in the System Definition Studies of the late 1970's, conducted some limited testing and proposed a low orbit 10 megawatt demonstration satellite. So far, their effort has been curtailed by their economic problems and by their lack of manned space capability. SPS Interest by other nations has persisted, but only at low levels of activity.

**SBSP COULD BE JUMPSTARTED WITH LOW-INTEREST LOANS FROM THE GOVERNMENT-Bova ‘08**

[Ben; president emeritus of the National Space Society; An Energy Fix Written in the Stars; Washington Post; 12 Oct 2008]

I admit, solar power satellites won't be cheap. Constructing one would cost about as much as building a nuclear power plant: on the order of $1 billion. That money, though, needn't come from the taxpayers; it could be raised by the private capital market. Oil companies invest that kind of money every year in exploring for new oil fields. But the risk involved in building an SPS, as with any space operation, is considerable, and it could be many years or even decades before an investment begins to pay off. So how can we get private investors to put their money into solar power satellites?

This nation tackled a similar situation about a century ago, when faced with building big hydroelectric dams. Those dams were on the cutting edge of technology at the time, and they were risky endeavors that required hefty funding. The Hoover Dam, the Grand Coulee Dam and others were built with private investment -- backed by long-term, low-interest loans guaranteed by the U.S. government. They changed the face of the American West, providing irrigation water and electrical power that stimulated enormous economic growth. Phoenix and Las Vegas wouldn't be on the map except for those dams.

Solar power satellites could be funded through the same sort of government-backed loans. Washington has made such loan guarantees in the past to help troubled corporations such as Chrysler and Lockheed. Why not use the same technique to encourage private investment in solar power satellites? If we can bail out Wall Street, why not spend a fraction of that money to light up Main Street?

SOLVENCY: ANCHOR CUSTOMER

**FINANCIAL INCENTIVES AND SIGNING UP AS AN ANCHOR CUSTOMER WILL IMPROVE THE BUSINESS CASE FOR SBSP-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The business case is much more likely to close in the near future if the U.S. Government agrees to:

* Sign up as an anchor tenant customer, and
* Make appropriate technology investment and risk‐reduction efforts by the U.S. Government, and
* Provide appropriate financial incentives to the SBSP industry that are similar to the significant incentives that Federal and State Governments are providing

**THE GOVERNMENT COULD RAPIDLY ACCELERATE SBSP TECH BY HELPING RESEARCH AND BECOMING A CUSTOMER-Lemonick ‘09**

[Michael; senior writer at Climate Central; Solar Power from Space:Moving Beyond Science Fiction; Environment 360; 31 Aug 2009; <http://e360.yale.edu/content/feature.msp?id=2184;> retrieved 23 Jun 2011]

By undertaking some of the research and being an early customer for SBSP, the government could rapidly accelerate development of the technology. Historians of aviation agree that the government’s decision to back air mail played a major role in developing the aircraft industry, leading to technological innovations and economies of scale. The same phenomenon could take an emerging but outlandish-sounding technology and push it into the energy mainstream.

**IF THE GOVERNMENT BECOMES AN EARLY ADOPTER, IT WILL SPUR INVESTMENT-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

Several major challenges will need to be overcome to make SBSP a reality, including the creation of low‐cost space access and a supporting infrastructure system on Earth and in space. Solving these space access and operations challenges for SBSP will in turn also open space for a host of other activities that include space tourism, manufacturing, lunar or asteroid resource utilization, and eventually settlement to extend the human race. Because DoD would not want to own SBSP satellites, but rather just purchase the delivered energy as it currently does via traditional terrestrial utilities, a repeated review finding is that the commercial sector will need Government to accomplish three major tasks to catalyze SBSP development. The first is to retire a major portion of the early technical risks. This can be accomplished via an incremental research and development program that culminates with a space‐borne proof‐of‐concept demonstration in the next decade. A spiral development proposal to field a 10 MW continuous pilot plant en route to gigawatts‐class systems is included in Appendix B. The second challenge is to facilitate the policy, regulatory, legal, and organizational instruments that will be necessary to create the partnerships and relationships (commercial‐commercial, government‐commercial, and government‐government) needed for this concept to succeed. The final Government contribution is to become a direct early adopter and to incentivize other early adopters much as is accomplished on a regular basis with other renewable energy systems coming on‐line today.

SOLVENCY: TIME TO ACT IS NOW

**IT’S IMPERATIVE THAT THE US BEGIN DEVELOPING SBSP IMMEDIATELY-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

Despite this early interim review success, there are still many more questions that must be answered before a full‐scale commercial development decision can be made. It is proposed that in the spirit of the original collaborative SBSP Study Group charter, that this interim report becomes a living document to collect, summarize, and recommend on the evolution of SBSP. The positive indicators observed to surround SBSP by this review team suggest that it would be in the US Government’s and the nation’s interest to sponsor an immediate proof‐of‐concept demonstration project and a formally funded, follow‐on architecture study conducted in full collaboration with industry and willing international partners. The purpose of a follow‐on study will be to definitively rather than speculatively answer the question of whether all of the barriers to SBSP development can be retired within the next four decades and to create an actionable business case and construction effort roadmap that will lead to the installation of utility‐grade SBSP electric power plants. Considering the development timescales that are involved, and the exponential growth of population and resource pressures within that same strategic period, it is imperative that this work for “drilling up” vs. drilling down for energy security begins immediately.

**PLANNING FOR THIS COMPLEX PROJECT MUST START NOW- Gauger ‘10**

[Joleroy; Energy Costs Eliminated By Satellite System; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/gauger.html>; retrieved 9 August 2011]

Successfully implementing a Solar Power Satellite Program will take a multi-discipline, multi-national, geopolitical effort. Planning for that level of complexity must begin now. This article gives the principal reasons for going to space for "free power," and seeks to illustrate some of that complexity. Solar energy is "free", just like the water in a hydroelectric system. There is no cost for fuel.

The sun delivers energy to earth at the rate of 1.37 kilowatts per square meter during daylight hours. This amounts to 174 petawatts (one petawatt is 10 to the fifteenth power). About 89 petawatts reach the earth's surface. A satellite positioned in geosynchronous orbit at approximately 22,300 miles above earth (with an area of solar cells of 10 kilometers squared) will be bombarded by 13.7 gigawatts with only brief blackouts twice a year. With cell conversion efficiencies of only 10%, the electricity potentially produced will be 10 gigawatts delivered to the space-based microwave transmitter; somewhat less will be delivered to the receiver and relayed into the modified power distribution networks located near the user on earth.

Not one but several gigawatt-satellites will be required to generate the power needed over the next twenty to twenty five years. The continuing degradation of the environment accelerated by population growth, our inadequate efforts to balance carbon-based fuels with those from "green" sources and the increasing worldwide gross national product is good reason to get started with a program of energy from space.

SOLVENCY: OTHER NATIONS WILL DEPLOY SBSP

**SBSP IS INEVITABLE TECHNOLOGY THAT SOMEONE WILL DEVELOP-Atkinson ‘09**

[Nancy; staff writer; New Company Looks to Produce Space Power Within a Decade; Universe Today; 18 Feb 2009; [http://www.universetoday.com/25754/new-company-looks-to-produce-space-based-solar-power-within-a-decade/#more-25754;](http://www.google.com/url?q=http%3A%2F%2Fwww.universetoday.com%2F25754%2Fnew-company-looks-to-produce-space-based-solar-power-within-a-decade%2F%23more-25754%3B&sa=D&sntz=1&usg=AFQjCNHPeNfraN5Acyl4l23mA_90yNff0Q) retrieved 17 June 2011]

SBSP has ability to literally change the course of history, and impact the quality of life for people everywhere. Sage said this project is an entrepreneurs’ dream.

“I speak for our entire team here, we’re not just focused on how much money are we going to make,” Sage said. “We’re focused on the fact that this is an inevitable technology and someone is going to do it. Right now we’re the best shot. We’re also focused on the fact that, according to every scenario we’ve analyzed, the world needs space based solar power, and it needs it soon, as well as the up-scaling of just about every other source of renewable energy that we can get our hands on.”

“Space based solar power will happen whether we crack cold fusion, or whether we suddenly go to 80% efficiency on ground based solar power (currently its only at 50%),” Sage continued. “It has to happen based on the nature on what it is. With that in mind, I’ve been willing to put everything I have on the line to be able to make this work, and that was three years, ago. To see how far we’ve come in the past six to eight months has been amazing.”

“This is going to happen.”

**IF THE USE FAILS TO LEAD NOW ON SBSP, ANOTHER NATION WILL-Cramer Shea ‘10**

[Karen; M.A. Science Technology and Public Policy with Specialty in Space Policy from the George Washington University; Why Has SPS R&D Received So Little Funding?; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/shea.html;> retrieved 24 Jun 2011]

The time is now for the development of space solar power. If the U.S. government commits to it as a matter of public policy, a new SPS industry will emerge, repaying the public investment many times over. If the U.S. does not do so, Japan, China, India or Russia will take the lead in space solar power development and the U.S. will continue to send billions of dollars a year abroad to insure that our energy needs are met.

**JAPAN PLANS TO DEPLOY A SYSTEM BY 2040-Fukada ‘01**

[Takahiro; staff writer; Japan Plans To Launch Solar Power Station In Space By 2040; Space Daily; 31 Jan 2001; <http://www.spacedaily.com/news/ssp-01a.html;> retrieved 17 Jun 2011]

Undaunted by its less than glorious track record in space, Japan's ministry of economy, trade and industry (METI) has ambitious plans to launch a giant solar power station by 2040.

"We are starting research for a solar power generation satellite from fiscal year 2001 in April," Osamu Takenouchi, of METI's airplane, weapons and space industry division told AFP.

"We are planning to start operating the system in 2040," Takenouchi added.

**EUROPE’S LARGEST SPACE COMPANY IS PLANNING A DEMONSTRATION-Edwards ‘10**

[Lin; European space company wants solar power plant in space; Physorg.com; 21 Jan 2010;

<http://www.physorg.com/news183278937.html;> retrieved 17 Jun 2011]

EADS Astrium, Europe's biggest space company, plans to put a solar power satellite in orbit to demonstrate the collection of solar power in space and its transmission via infrared laser to provide electricity on Earth.

Chief executive officer of Astrium, François Auque, said the system is at the testing stage, but that a viable system collecting and transmitting power from space could be within reach soon. Auque said space solar power is an attractive idea because it is an inexhaustible and clean form of energy. Unlike solar plants on Earth, orbital solar collectors can work around the clock, and there is no interference from clouds or atmospheric dusts or gases, which means the energy hitting photovoltaic cells in orbit is much greater than it would be for the same panels on the ground.

**A SMALL NUMBER OF COMPANIES AND NATIONS PLAN TO DEPLOY SPACE-BASED POWER WITHIN A DECADE-Totty ‘09**

[Michael; staff writer; Five Technologies That Could Change Everything; Wall Street Journal; 19 Oct 2009; <http://online.wsj.com/article/SB10001424052748703746604574461342682276898.html;> retrieved 23 Jun 2011]

For more than three decades, visionaries have imagined tapping solar power where the sun always shines—in space. If we could place giant solar panels in orbit around the Earth, and beam even a fraction of the available energy back to Earth, they could deliver nonstop electricity to any place on the planet.

The technology may sound like science fiction, but it's simple: Solar panels in orbit about 22,000 miles up beam energy in the form of microwaves to earth, where it's turned into electricity and plugged into the grid. (The low-powered beams are considered safe.) A ground receiving station a mile in diameter could deliver about 1,000 megawatts—enough to power on average about 1,000 U.S. homes.

The cost of sending solar collectors into space is the biggest obstacle, so it's necessary to design a system lightweight enough to require only a few launches. A handful of countries and companies aim to deliver space-based power as early as a decade from now.

**JAPAN IS PLANNING TO DEPLOY A SYSTEM BY 2030-Kaplan ‘09**

[Jeremy; staff; Japan to Beam Solar Power from Space on Lasers; Fox News; 09 Nov 2009; <http://www.foxnews.com/scitech/2009/11/09/japan-beam-solar-power-space-lasers/;> retrieved 17 Jun 2011]

Japan is aiming to collect solar power in space and zap it down to Earth using laser beams or microwaves. The government has picked companies and researchers to turn the multi-billion pound dream of unlimited clean energy into reality by 2030.

Japan has few energy resources of its own and is heavily reliant on oil imports. The predicament has forced the country to become a leader in solar and other renewable energies. This year it set ambitious greenhouse gas reduction targets, but its boldest plan to date is the Space Solar Power System.

It involves an array of photovoltaic dishes, reaching across several square miles, that hover in geostationary orbit outside the Earth's atmosphere.

"Since solar power is a clean and inexhaustible energy source, we believe that this system will be able to help solve the problems of energy shortage and global warming," Mitsubishi Heavy Industries, one of the project participants, said. "The sun's rays abound in space."

ADVANTAGE 1: SOLAR EXPLORATION

**SBSP WILL LEAD TO ASTEROID MINING AND PERMANENT HUMAN SETTLEMENT IN THE SOLAR SYSTEM-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

Several major challenges will need to be overcome to make SBSP a reality, including the creation of low‐cost space access and a supporting infrastructure system on Earth and in space. Several past studies have shown that the opportunity to export energy as the first marketable commodity from space will motivate commercial sector solutions to these challenges. The delivered commodity can be used for a variety of purposes to include base‐load terrestrial electrical power, wide‐area broadcast power, carbon‐neutral synthetic fuels production, or as an in‐space satellite energy utility. Solving these space access and operations challenges for SBSP will in turn also open space for a host of other activities that include space tourism, manufacturing, lunar or asteroid resource utilization, and eventually expansion of human presence and permanent settlement within our solar system.

**THERE IS NO BETTER TECHNOLOGY TO FACILITATE EXPLORATION OF THE SOLAR SYSTEM THAN SOLAR POWER SATELLITES-National Security Space Office ‘07**

[Space Based Solar Power as an Opportunity for Strategic Security; National Security Space Office; 10 Oct 2007; http://www.nss.org/settlement/ssp/library/nsso.htm; retrieved 12 Jul 2011]

The SBSP Study Group found that SBSP directly supports the articulated goals of the U.S. National Space Policy and Vision for Space Exploration which seeks to promote international and commercial participation in exploration that furthers U.S. scientific, security, and economic interests, and extends human presence across the solar system.

No other opportunity so clearly offers a path to realize the Vision as articulated by Dr. Marburger, Science Advisor to the President: As I see it, questions about the vision boil down to whether we want to incorporate the Solar System in our economic sphere, or not. Our national policy, declared by President Bush and endorsed by Congress last December in the NASA authorization act, affirms that the fundamental goal of this vision is to advance U.S. scientific, security, and economic interests through a robust space exploration program. So at least for now the question has been decided in the affirmative. No other opportunity is likely to tap a multi]trillion dollar market that could provide an engine to emplace infrastructure that could truly extend human presence across the solar system and enable the use of lunar and other space resources as called for in the Vision.

**SBSP WILL ALLOW HUMAN EXPANSION INTO SPACE, IMPORTANT FOR THE PERMANENT SURVIVAL OF THE SPECIES-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

SPS component technologies will also enable human economic expansion and settlement into space, which is important for the permanent survival of our species. To this end, a "vertical expansion of humanity" into our solar system in the new millennium can be every bit as important as the "horizontal expansion" achieved by our ancestors beginning in the 1400s. Indeed, SPS will provide a natural platform for promoting human collaboration in an area that has the potential to make a real difference in smoothing out global economy imbalances due to gross disparities in energy resources, thereby preventing inevitable confrontations. SPS can be also a major steppingstone in transforming our current combustion world economy into a sustainable and clean world economy that is solar-electric powered.

**SBSP IS THE MOST IMPORTANT STEP FORWARD IN SPACE EXPLORATION-Flournoy ‘10**

[Don; Professor of Telecommunications @Ohio University; SUNSATS: The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/flournoy.html;> retrieved 24 Jun 2011]

Figuring out how to generate energy in space and make it available on-demand anywhere on earth will be an undertaking unparalleled in human history. Its significance, in the long run, will be far greater than placing a man on the moon or building a human habitat on mars, because ready access to energy on earth (and elsewhere) is key to all exploration of the universe. Because SunSats can tap the one energy supply that cannot be depleted, any corporation or country that is in the space energy business will have a perpetual competitive advantage.

**SOLAR POWER SATELLITES HAVE LONG-TERM APPLICATION FOR SPACE EXPLORATION AND COMMERCIAL DEVELOPMENT-Zwaniecki ‘07**

[Andrrzej; staff writer; Space Solar Energy Has Future; Space Daily; 21 Aug 2007]]

Mankins believes the U.S. government is likely to return to the space solar power idea because of its many potential benefits and applications, including providing power for space exploration and commercial development of space resources.

In September 2006, the House of Representatives' science subcommittee reviewed the concept as part of a hearing on climate change technologies. In addition, the Department of Defense is conducting a feasibility study of space-based solar power. The study is scheduled to be completed in September.

Nevertheless, Mankins admitted that his advocacy of the technology is somewhat romantic.

"But when you look at the kind of things we as a modern society spend billions of dollars on, [sup-porting] the idea of limitless clean energy from space is not such a bad goal," he said.

**ONLY EXECUTING A US SBSP ENERGY STRATEGY WILL LEAD TO SPACE COLONIES, LUNAR SETTLEMENTS AND MORE-Snead ‘09**

[James; senior member of the American Institute of Aeronautics and Astronautics; The vital need for America to develop space solar power; The Space Review; 04 May 2009; <http://www.thespacereview.com/article/1364/1;> retrieved 23 Jun 2011]

Successfully developing SSP and building the integrated spacefaring logistics infrastructure necessary to demonstrate SSP and prepare for serial production of the geostationary platforms can only be successfully undertaken by a true spacefaring nation. The United States is not there yet because, as the US National Space Policy emphasizes, we have not yet developed the “robust, effective, and efficient space capabilities” needed for America to effectively utilize space this century.

Planning and executing a rational US energy policy that undertakes the development of SSP will jump-start America on the path to acquiring the mastery of industrial space operations we need to become a true spacefaring nation. This path will follow our nation’s hard-earned success, as seafarers and aviators, of building a world-leading maritime industry in the 18th and 19th centuries and an aviation industry in the 20th century. With this new spacefaring mastery, today’s dreams of expanded human and robotic exploration of space, of humans on Mars, of space colonies, of lunar settlements, and so on, will all move from the realm of wishful daydreams into an exciting future of actionable possibilities. The goal of nearly all American pro-space organizations is to make such a future a reality. Energetically supporting the incorporation of SSP into US energy planning and strongly advocating for the start of the development of SSP is how pro-space organizations can *now* take action to make their vision part of America’s broad-based spacefaring future. This is, indeed, a win-win opportunity that we cannot afford to miss.

**SBSP WILL MAINTAIN US DOMINANCE OF SPACE AND GIVE THE US THE POTENTIAL TO BE A TRUE SPACE FARING NATION-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The SBSP Study Group found that SBSP directly addresses the concerns of the Presidential Aerospace Commission which called on the US to become a true spacefaring civilization and to pay closer attention to our aerospace technical and industrial base, our “national jewel” which has enhanced our security, wealth, travel, and lifestyle.

An SBSP program as outlined in this report is remarkably consonant with the findings of this commission, which stated:

The United States must maintain its preeminence in aerospace research and innovation to be the global aerospace leader in the 21st century. This can only be achieved through proactive government policies and sustained public investments in long‐term research and RDT&E infrastructure that will result in new breakthrough aerospace capabilities. Over the last several decades, the U.S. aerospace sector has been living off the research investments made primarily for defense during the Cold War…Government policies and investments in long‐term research have not kept pace with the changing world. Our nation does not have bold national aerospace technology goals to focus and sustain federal research and related infrastructure investments. The nation needs to capitalize on these opportunities, and the federal government needs to lead the effort. Specifically, it needs to invest in long‐term enabling research and related RDT&E infrastructure, establish national aerospace technology demonstration goals, and create an environment that fosters innovation and provide the incentives necessary to encourage risk taking and rapid introduction of new products and services.

**SBSP OFFERS ENORMOUS POTENTIAL FOR SPACE EXPLORATION AND NATIONAL SECURITY-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf;)]

The magnitude of the looming energy and environmental problems is significant enough to warrant consideration of all options, to include revisiting a concept called Space Based Solar Power (SBSP) first invented in the United States almost 40 years ago. The basic idea is very straightforward: place very large solar arrays into continuously and intensely sunlit Earth orbit (1,366 watts/m2) , collect gigawatts of electrical energy, electromagnetically beam it to Earth, and receive it on the surface for use either as baseload power via direct connection to the existing electrical grid, conversion into manufactured synthetic hydrocarbon fuels, or as low‐intensity broadcast power beamed directly to consumers. A single kilometer‐wide band of geosynchronous earth orbit experiences enough solar flux in one year to nearly equal the amount of energy contained within all known recoverable conventional oil reserves on Earth today. This amount of energy indicates that there is enormous potential for energy security, economic development, improved environmental stewardship, advancement of general space faring, and overall national security for those nations who construct and possess a SBSP capability.

**THE DEVELOPMENT OF SBSP WILL PROVIDE TECH TRANSFER USEFUL FOR PLANETARY DEFENSE AND SPACE EXPLORATION-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The SBSP Study Group found that retirement of the SBSP technical challenges begets other significant strategic benefits for exploration, commerce and defense, that in‐and‐of‐themselves may justify a national program.

* At present, the United States has very limited capabilities to build large structures, very large apertures or very high power systems in orbit. It has very limited in‐space maneuver and operational capability, and very limited access to space. It cannot at present move large amounts of mass into Earth orbit. The United States correspondingly has extremely limited capabilities for in‐space manufacturing and construction or in‐situ space resource utilization. It has no capability for beamed power or propulsion. SBSP development would advance the state of the art in all of the above competencies.
* The expertise gained in developing large structures for space based solar power could allow entirely new technologies for applications such as image and real‐time surface and airborne object tracking services, as well as high bandwidth telecommunications, high‐definition television and radio, and mobile, broadcast services. It would enable entirely new architectures, such as power platforms that provide services to multiple payloads, autonomous self‐constructing structures, or wireless cooperative formations. The Solar Electric Transfer Vehicles (SETV) needed to lift the Space Solar Power Satellites out of low‐earth orbit, and perhaps even form its components, would completely revolutionize our ability to move large payloads within the Earth‐Moon system.
* The technology to beam power over long distances could lower application satellite weights and expand the envelope for Earth‐ and space‐based power beaming applications. A truly developed Space‐Based Solar Power infrastructure would open up entirely new exploration and commercial possibilities, not only because of the access which will be discussed in the section on infrastructure, but because of the power available on orbit, which would enable concepts as diverse as comet / asteroid protection systems, de‐orbit of space debris, space‐to‐space power utilities, and beamed propulsion possibilities including far‐term concepts as a true interstellar probe such as Dr. Robert Forward’s StarWisp Concept.

ADVANTAGE 2: SBSP WILL PREVENT WARMING

**THE DEVELOPING WORLD COULD LEAPFROG PAST INEFFICIENT, POLLUTING FORMS OF ENERGY PRODUCTION WITH SOLAR POWER SATELLITES -Farrar ‘08**

[Lara; correspondent; How to harvest solar power? Beam it down from space!; CNN.com; 30 May 2008]

Much of that electricity will come from coal-fired power plants, like the $4 billion so-called ultra mega complex scheduled to be built south of Tunda Wand, a tiny village near the Gulf of Kutch, an inlet of the Arabian Sea on India's west coast. Dozens of other such projects are already or soon will be under way.

Yet Mehta has another solution for India's chronic electricity shortage, one that does not involve power plants on the ground but instead massive sun-gathering satellites in geosynchronous orbits 22,000 miles in the sky.

The satellites would electromagnetically beam gigawatts of solar energy back to ground-based receivers, where it would then be converted to electricity and transferred to power grids. And because in high Earth orbit, satellites are unaffected by the earth's shadow virtually 365 days a year, the floating power plants could provide round-the-clock clean, renewable electricity.

"This will be kind of a leap frog action instead of just crawling," said Mehta, who is the director of India operations for Space Island Group, a California-based company working to develop solar satellites. "It is a win-win situation."

**ONE OF THE MOST TEMPTING POTENTIAL MARKETS FOR SPACE BASED SOLAR POWER IS DEVELOPING WORLD MEGA-CITIES-Landis ‘04**

[Geoffrey; Glenn Research Center, NASA; Reinventing the Solar Power Satellite; NASA Report; February 2004; http://www.gltrs.grc.nasa.gov/reports/2004/TM-2004-212743.pdf; retrieved 14 Jul 2011]

There are a large number of potential markets for space solar power. The greatest need for new power is in the industrializing third world; unfortunately, this market segment is by most analyses the least able to pay.

Possibly the most interesting market is third-world "Mega-cities," where a "Mega-city" is defined as a city with population of over ten million, such as São Paolo, Mexico City, Shanghai, or Jakarta. By 2020 there are predicted to be 26 mega-cities in the world, primarily in the third world; the population shift in the third world from rural to urban has been adding one to two more cities to this category every year, with the trend accelerating. Even though, in general, the third world is not able to pay high prices for energy, the current power cost in mega-cities is very high, since the power sources are inadequate, and the number of consumers is large. Since the required power for such cities is very high-- ten billion watts or higher-- they represent an attractive market for satellite power systems, which scale best at high power levels since the transmitter and receiver array sizes are fixed by geometry. In the future, there will be markets for power systems at enormous scales to feed these mega-city markets. Therefore, it is very attractive to look at the mega-city market as a candidate market for satellite power systems.

**SOLAR POWER SATELLITES WOULD ALLOW CLEAN ENERGY IN THE DEVELOPING WORLD, MITIGATING THE IMPACT OF FUTURE DEVELOPMENT-Foust ‘07**

[Jeff; editor and publisher of The Space Review; A renaissance for space solar power?; 13 Aug 2007; http://www.thespacereview.com/article/931/1; retrieved 14 Jul 2011]

For nearly four decades, one concept has tantalized space professionals and enthusiasts alike: space solar power. The ability to collect solar power in space, continuously and in effectively limitless quantities, and then transmit that energy back to Earth, could radically reshape not only the space industry but also society in general. That clean (or, in the current vernacular, carbon neutral) energy would, advocates claim, help meet the growing energy needs of an increasingly developed world without relying on sources that degrade the environment and/or come from politically unstable regions of the globe. That demand for energy, in turn, would create tremendous demand for launch and other space services, driving down costs that would, in turn, open other markets.

**SOLAR POWER SATELLITES OFFER A POTENTIAL FOR TRILLIONS OF DOLLARS OF BENEFITS IN ENERGY DEVELOPMENT IN THE DEVELOPING WORLD-National Security Space Office ‘07**

[Space Based Solar Power as an Opportunity for Strategic Security; National Security Space Office; 10 Oct 2007; http://www.nss.org/settlement/ssp/library/nsso.htm; retrieved 12 Jul 2011]

Most of America’s spending in space does not provide any direct monetary revenue. SBSP, however, may create new markets and the need for new products that will provide many new, high-paying technical jobs and net significant tax revenues. Great powers have historically succeeded by finding or inventing products and services not just to sell to themselves, but to others. Today, investments in space are measured in billions of dollars. The energy market is trillions of dollars, and there are many billions of people in the developing world that have yet to connect to the various global markets. Such a large export market could generate substantial new wealth for our nation and our world. Investments to mature SBSP are similarly likely to have significant economic spin]offs, each with their own independent revenue stream, and open up or enable other new industries such as space industrial processes, space tourism, enhanced telecommunications, and use of off]world resources. Not all of the returns may be obvious. SBSP is a both infrastructure and a global utility. Estimating the value of utilities is Difficult since they benefit society as a whole more than any one user in particular--consider what the contribution to productivity and GDP are by imagining what the world would be like without electric lines, roads, railroads, fiber, or airports. Not all of the economic impact is immediately captured in direct SBSP jobs, but also in the services and products that spring up to support those workers and their communities. Historically such infrastructure projects have received significant government support, from land grants for railroads, to subsidized rural electrification, to development of atomic energy. While the initial-capability on-ramp may be slow, SBSP has the capability to be a very significant portion of the world energy portfolio by mid-century and beyond.

**ALL THE TALK ABOUT RISKS AND DIFFICULTY, WE REALLY SHOULD FOCUS ON THE RISK FACED BY HUMANITY IF WE FAIL TO ADDRESS WARMING-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

As a technical and technology risk assessment expert, I could show with confidence that we face orders of magnitude more risk doing nothing to curb our fossil-based energy addictions than we will in making a fundamental shift in our energy supply. This is because the risks of a catastrophic anthropogenic climate change can be potentially the extinction of human species, a risk that is simply too high for us to take any chances. Of course, there will be economic consequences to all societies when we restrict the burning of fossil fuels in an effort to abate "global warming." What we are talking about are options and choices between risks. All human activities involve risk taking; we cannot avoid risks but only make trade-offs, hopefully choosing wisely. In this case, there has to be a risk-based probabilistic thought process when it comes to adopting national or international policies in dealing with global warming and energy issues.

**SBSP CAN COMPETE AS A TOOL TO FIGHT WARMING-Lemonick ‘09**

[Michael; senior writer at Climate Central; Solar Power from Space:Moving Beyond Science Fiction; Environment 360; 31 Aug 2009; <http://e360.yale.edu/content/feature.msp?id=2184;> retrieved 23 Jun 2011]

In the past decade two other factors have emerged to boost the prospects of SBSP: climate change and interest from the military.

There is a growing recognition that non-carbon energy sources will be crucial if the world is going to avoid the worst effects of climate change. It’s almost inevitable that carbon emissions will end up being taxed one way or another, and when they are, renewables like SBSP will immediately become more competitive economically.

**SBSP CAN PREVENT THE THREAT TO SURVIVAL ON EARTH CAUSED BY CLIMATE CHANGE-Medin ‘10**

[Kristin; Chief Industrial Designer, NewSpace DesignLabs; Disruptive Technology: A Space-Based Solar Power Industry Forecast; The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/medin.html;> retrieved 24 Jun 2011]

As more nations ascend into the "first world" and "second world" rankings in a fully realized SBSP economy, their citizens will come to expect higher standards of living in access to housing, commodities, information and healthcare made possible in part by easier access to energy, and more efficient transportation, communications and data networking. A change of perspective is possible. Rather than viewing tomorrow's world population as merely an expanding "grid" of energy users, that population can be viewed as a renewable resource of creative ideas for tackling the world's challenges.

Instead of climate change causing a threat to the survival of life on earth, those additional minds and bodies working collaboratively have the potential to prevent such a fate, especially when these minds and bodies have equal access to resources world-wide. Such a scenario could exist with a fully realized SBSP infrastructure.

ADVANTAGE 2: GLOBAL CLIMATE CHANGE IMPACTS

**GLOBAL WARMING IS AT A GLOBAL TIPPING POINT WHICH COULD SOON BECOME IRREVOCABLE-Bellamy Foster ‘09**

[Jeremy; professor of sociology at the University of Oregon; A Failed System: The World Crisis of Capitalist Globalization and its Impact on China; Monthly Review; 11 Jan 2009; <http://monthlyreview.org/2009/03/01/a-failed-system-the-world-crisis-of-capitalist-globalization-and-its-impact-on-china;> retrieved 29 Jun 2011]

The global warming threat is rapidly closing in. The melting of sea ice in the Arctic, which some scientists believe could be ice free in the summer in less than a decade, is seen as threatening an “albedo flip,” a drastic reduction in the reflectivity of solar radiation and an acceleration of climate change. Meanwhile, the melting of the ice sheets in West Antarctica and Greenland points to an irreversible “tipping point” within a decade that portends rising world sea levels that will eventually engulf major population centers in low-lying areas. The combination of momentous environmental tipping points and positive feedback mechanisms accelerating climate change have convinced a growing number of climatologists that irrevocable and catastrophic climate change is inevitable unless actions are taken in the next decade or so drastically to reduce greenhouse gas emissions. The atmosphere is near the ceiling of CO2 and other greenhouse gases that will produce the 2°C increase in average global temperatures that the United Nations’ Intergovernmental Panel on Climate Change has sought to avoid. Moreover, the world is on a course under business as usual that could well lead to average global temperature increases two or even three times as high during this century, spelling an inferno for life on the planet.

Indeed, new scientific data suggests that a 2°C increase would itself be disastrous, in terms of rising sea levels and the setting off of various self-reinforcing feedback mechanisms that could accelerate climate change throughout the earth system. This means that allowing for a stabilization of greenhouse gas concentration in the atmosphere at 550 parts per million (ppm), as envisioned in the Stern Review—characterized by most mainstream economists as a “radical” response to controlling carbon emissions—or even a buildup of carbon to 450 ppm (seen as consistent with a 2°C ceiling in average global temperature rise) are now viewed by many leading scientists as running the risk of catastrophic change.

**UNCHECKED GLOBAL WARMING WILL DOOM A MILLION SPECIES TO EXTINCTION-Roach ‘04**

[John; By 2050 Warming to Doom Million Species, Study Says; National Geographic; 12 Jul 2004; http://news.nationalgeographic.com/news/2004/01/0107\_040107\_extinction.html; retrieved 22 Jul 2008]

By 2050, rising temperatures exacerbated by human-induced belches of carbon dioxide and other greenhouse gases could send more than a million of Earth's land-dwelling plants and animals down the road to extinction, according to a recent study.

"Climate change now represents at least as great a threat to the number of species surviving on Earth as habitat-destruction and modification," said Chris Thomas, a conservation biologist at the University of Leeds in the United Kingdom.

**FAILURE TO CONTROL EMISSIONS WILL LEAD TO SPECIES EXTINCTION AND FAMINE-Zarembo ‘08**

[Alan; staff writer; Climate change: Just deal with it?; Los Angeles Times; 26 Mar 2008]

The science of global warming was laid out in a series of reports last year by the U.N. Intergovernmental Panel on Climate Change, which shared the Nobel Peace Prize with former Vice President Al Gore. The reports said that temperatures were likely to climb 3 to 8 degrees Fahrenheit by century's end if emissions continued to grow.

They detailed a likely future of worsening famine in Africa, expanding floods as sea levels rise as much as 23 inches, and accelerated species extinction. To avoid the worst, the reports warned that emissions must be reduced 50% to 80% by mid-century, keeping temperature rise below 2 degrees.

**IF WE CROSS THE TIPPING POINT THERE WILL BE NO RETURN FROM EXTERMINATION OF MILLIONS OF SPECIES-Speth ‘09**

[James Gustav; former professor Yale School of Forestry and Environmental Studies and current professor of law, U. of Vermont; *The Bridge at the Edge of the World: Capitalism, the Environment, and Crossing from Crisis to Sustainability*; 2009; Kindle Edition]

The real possibility of these amplifying feedbacks has alarmed some of our top scientists. James Hansen, the courageous NASA climate scientist, is becoming increasingly outspoken as his investigations lead him to more and more disturbing conclusions. He offered the following assessment in 2007: "Our home planet is now dangerously near a `tipping point.' Human-made greenhouse gases are near a level such that important climate changes may proceed mostly under the climate system's own momentum. Impacts would include extermination of a large fraction of species on the planet, shifting of climatic zones due to an intensified hydrologic cycle with effects on freshwater availability and human health, and repeated worldwide coastal tragedies associated with storms and a continuously rising sea level.... "Civilization developed during the Holocene, a period of relatively tranquil climate now almost 12,000 years in duration. The planet has been warm enough to keep ice sheets off North America and Europe, but cool enough for ice sheets on Greenland and Antarctica to be stable. Now, with rapid warming of o.6°C in the past 30 years, global temperature is at its warmest level in the Holocene. "This warming has brought us to the precipice of a great `tipping point.' If we go over the edge, it will be a transition to `a different planet,' an environment far outside the range that has been experienced by humanity. There will be no return within the lifetime of any generation that can be imagined, and the trip will exterminate a large fraction of species on the planet. "The crystallizing scientific story reveals an imminent planetary emergency. We are at a planetary tipping point. We must move onto a new energy direction within a decade to have a good chance to avoid setting in motion unstoppable climate change with irreversible effects.

**AN INCREASE OF 2 DEGREES IN GLOBAL TEMPERATURE WILL PUSH 40% OF SPECIES TO EXTINCTION-Stern ‘06**

[Nicholas; I. G. Patel Chair at the London School of Economics and Political Science; Stern Review on the Economics of Climate Change; 2006; http://www.hm-treasury.gov.uk/independent\_reviews/stern\_review\_economics\_climate\_change/stern\_review\_report.cfm; retrieved 11 Jul 2008]

Average global temperature increases of only 1-2°C (above pre-industrial levels) could commit 15-40 percent of species to extinction. As temperatures rise above 2- 3°C, as will very probably happen in the latter part of this century, so the risk of abrupt and large-scale damage increases, and the costs associated with climate change – across the three dimensions of mortality, ecosystems and income – are likely to rise more steeply. In mathematical terms, the global damage function is convex.

No region would be left untouched by changes of this magnitude, though developing countries would be affected especially adversely. This applies particularly to the poorest people within the large populations of both sub-Saharan Africa, and South Asia. By 2100, in South Asia and sub-Saharan Africa, up to 145 - 220 million additional people could fall below the $2-a-day poverty line, and every year an additional 165,000 - 250,000 children could die compared with a world without climate change.

**IF WE FAIL TO ACT SOON, THE IMPACTS OF GLOBAL WARMING WILL SPIRAL DISASTROUSLY OUT OF CONTROL-Hansen ‘08**

[Dr. James; head of NASA Goddard Institute for Space Studies; Twenty Years Later: Tipping Points Near on Global Warming; Huffington Post; 23 Jun 2008; http://www.huffingtonpost.com/dr-james-hansen/twenty-years-later-tippin\_b\_108766.html; retrieved 11 Jul 2011]

Today I testified to Congress about global warming, 20 years after my June 23, 1988 testimony, which alerted the public that global warming was underway. There are striking similarities between then and now, but one big difference.

Again a wide gap has developed between what is understood about global warming by the relevant scientific community and what is known by policymakers and the public. Now, as then, frank assessment of scientific data yields conclusions that are shocking to the body politic. Now, as then, I can assert that these conclusions have a certainty exceeding 99 percent.

The difference is that now we have used up all slack in the schedule for actions needed to defuse the global warming time bomb. The next president and Congress must define a course next year in which the United States exerts leadership commensurate with our responsibility for the present dangerous situation.

Otherwise it will become impractical to constrain atmospheric carbon dioxide, the greenhouse gas produced in burning fossil fuels, to a level that prevents the climate system from passing tipping points that lead to disastrous climate changes that spiral dynamically out of humanity's control.

**GLOBAL WARMING POSES A CATASTROPHIC THREAT TO THE WORLD. WE MUST REDUCE GREENHOUSE GAS EMISSIONS-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/hsu.html;> retrieved 23 Jun 2011]

The evidence of global warming is alarming. The potential for a catastrophic climate change scenario is dire. Until recently, I worked at Goddard Space Flight Center, a NASA research center in the forefront of space and earth science research. This Center is engaged in monitoring and analyzing climate changes on a global scale. I received first hand scientific information and data relating to global warming issues, including the latest dynamics of ice cap melting and changes that occurred on either pole of our planet. I had the chance to discuss this research with my Goddard colleagues, who are world leading experts on the subject.

I now have no doubt global temperatures are rising, and that global warming is a serious problem confronting all of humanity. No matter whether these trends are due to human interference or to the cosmic cycling of our solar system, there are two basic facts that are crystal clear: a) there is overwhelming scientific evidence showing positive correlations between the level of CO2 concentrations in the earth's atmosphere with respect to the historical fluctuations of global temperature changes; and b) the overwhelming majority of the world's scientific community is in agreement about the risks of a potential catastrophic global climate change. That is, if we humans continue to ignore this problem and do nothing, if we continue dumping huge quantities of greenhouse gases into earth's biosphere, humanity will be at dire risk.

ADVANTAGE 3: SBSP CAN MAKE DESALINIZATION CHEAPER AND BETTER

**SBSP CAN SUBSTANTIALLY IMPROVE DESALINIZATION OF WATER-Tobiska ‘10**

[W. Kent; Ph.D., Aerospace Engineering Sciences, University of Colorado; Vision for Producing Fresh Water Using Space Power; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/tobiska.html;> retrieved 24 Jun 2011]

The use of solar arrays for powering seawater desalination is not new nor is the idea of using heat flow tubes in the distillation process. Solar arrays are coupled with seawater desalination in the eastern Mediterranean and Persian Gulf. The prime disadvantages of using solar arrays are that solar energy is limited to approximately half a day (no solar power at night), seasonal Sun angles reduce solar array efficiency, and clouds reduce power from solar arrays.

If fresh water production were implemented using an offshore platform, solar arrays are one feasible method for generating electrical power for either RO or distillation processes. However, for efficient fresh water production, a facility must be operated 24 hours a day. The use of solar power from orbiting satellites (Solar Power Satellites - SPS) is a method that can substantially increment the solar array power generated from natural sunlight.

ADVANTAGE 3: WATER IMPACTS

**CLIMATE CHANGE WILL DRAMATICALLY REDUCE THE QUALITY AND QUANTITY OF FRESH WATER-Tobiska ‘10**

[W. Kent; Ph.D., Aerospace Engineering Sciences, University of Colorado; Vision for Producing Fresh Water Using Space Power; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/tobiska.html;> retrieved 24 Jun 2011]

The consequences of climate change on fresh water are severe. By 2050, climate change will likely decrease the annual average river runoff (less water available) in mid-latitude drier regions and the dry tropics. In addition, there will likely be increasing runoff (flooding) at high latitudes and in some wet tropical areas. The average person in semi-arid areas such as the Mediterranean Basin, western USA, southern Africa, Australia, and northeastern Brazil will likely see decreased water supply. In contrast, people in northern Europe, central and northern USA, northern China, and the wet tropical regions in Southeast Asia, Africa, and South America will see increased flooding events even during the winter.

Climate change affects the global water infrastructure including hydropower, flood defense, drainage, and irrigation systems as well as water management practices (IPCC, 2008). The drought and flooding effects on freshwater systems adds to other stresses such as population growth, changing economic activity, land-use changes, and urbanization. These stresses occur because water demand will grow globally in the coming decades due to increased population and affluence.

ADVANTAGE 4: SBSP CRITICAL FOR ENERGY PRODUCTION

**A SINGLE SPS COULD DELIVER 10 GIGAWATTS OF ENERGY TO THE GROUND CONTINUALLY-Bova ‘08**

[Ben; president emeritus of the National Space Society; An Energy Fix Written in the Stars; Washington Post; 12 Oct 2008]

Solar energy *is* a favorite of environmentalists, but it works only when the sun is shining. But that's the trick. There is a place where the sun never sets, and a way to use solar energy for power generation 24 hours a day, 365 days a year: Put the solar cells in space, in high orbits where they'd be in sunshine all the time.

You do it with the solar power satellite (SPS), a concept invented by Peter Glaser in 1968. The idea is simple: You build large assemblages of solar cells in space, where they convert sunlight into electricity and beam it to receiving stations on the ground.

The solar power satellite is the ultimate clean energy source. It doesn't burn an ounce of fuel. And a single SPS could deliver five to 10 gigawatts of energy to the ground continually. Consider that the total electrical-generation capacity of the entire state of California is 4.4 gigawatts.

**SBPS IS THE ONLY RENEWABLE SOLUTION THAT CAN LEAD TO A RATIONAL ENERGY TRANSITION PLAN-Snead ‘09**

[James; senior member of the American Institute of Aeronautics and Astronautics; The vital need for America to develop space solar power; The Space Review; 04 May 2009; <http://www.thespacereview.com/article/1364/1;> retrieved 23 Jun 2011]

We are left with SSP. Unless the US federal government is willing to forego addressing the very real possibility of energy scarcity in dispatchable electrical power generation, SSP is the one renewable energy solution capable of beginning engineering development and, as such, being incorporated into such a rational sustainable energy transition plan. Hence, beginning the engineering development of SSP now becomes a necessity.

**SBSP OFFERS VAST CAPACITY FOR CLEAN, WORLDWIDE ENERGY DEPLOYMENT-Snead ‘09**

[James; senior member of the American Institute of Aeronautics and Astronautics; The vital need for America to develop space solar power; The Space Review; 04 May 2009; <http://www.thespacereview.com/article/1364/1;> retrieved 23 Jun 2011]

Interest in SSP has reemerged in response to the public’s growing appreciation of the need to develop new sustainable energy sources. Compared to other terrestrial renewable alternatives, GEO SSP has four important advantages:

* Its scale of potential generation capacity is very large, an important consideration in formulating policies and plans to avoid future energy scarcity.
* It should have the ability to provide high quality electrical power—nearly 365 days of the year, 24 hours a day—for baseload electrical power supply comparable to nuclear energy.
* It should have nearly worldwide access and usability enabling countries to achieve a degree of energy independence even when traditional renewable energy sources are not practical.
* It should have important terrestrial environmental benefits, including avoiding thermal waste heat ejection and minimizing the land area otherwise needed for terrestrial renewable energy generation.

**SBSP HAS THE POTENTIAL TO PRODUCE MUCH OF THE WORLD’S ENERGY BY MID-CENTURY-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The SBSP Study Group found that a small amount of entry capital by the US Government is likely to catalyze substantially more investment by the private sector.

This opinion was expressed many times over from energy and aerospace companies alike. Indeed, there is anecdotal evidence that even the activity of this interim study has already provoked significant activity by at least three major aerospace companies. Should the United States put some dollars in for a study or demonstration, it is likely to catalyze significant amounts of internal research and development. Study leaders likewise heard that the DoD could have a catalytic role by sponsoring prizes or signaling its willingness to become the anchor customer for the product.

The SBSP Study Group found that SBSP appears to have significant growth potential in the long run, and a national investment in SBSP may return many times its value.

Most of America’s spending in space does not provide any direct monetary revenue. SBSP, however, may create new markets and the need for new products that will provide many new, high‐paying technical jobs and net significant tax revenues. Great powers have historically succeeded by finding or inventing products and services not just to sell to themselves, but to others. Today, investments in space are measured in billions of dollars. The energy market is trillions of dollars, and there are many billions of people in the developing world that have yet to connect to the various global markets. Such a large export market could generate substantial new wealth for our nation and our world. Investments to mature SBSP are similarly likely to have significant economic spin‐offs, each with their own independent revenue stream, and open up or enable other new industries such as space industrial processes, space tourism, enhanced telecommunications, and use of off‐world resources. Not all of the returns may be obvious. SBSP is a both infrastructure and a global utility. Estimating the value of utilities is difficult since they benefit society as a whole more than any one user in particular—consider what the contribution to productivity and GDP are by imagining what the world would be like without electric lines, roads, railroads, fiber, or airports. Not all of the economic impact is immediately captured in direct SBSP jobs, but also in the services and products that spring up to support those workers and their communities. Historically such infrastructure projects have received significant government support, from land grants for railroads, to subsidized rural electrification, to development of atomic energy. While the initial‐capability on‐ramp may be slow, SBSP has the capability to be a very significant portion of the world energy portfolio by mid‐century and beyond.

**SBSP WILL PROVIDE A CONTINUOUS SOURCE OF CLEAN ENERGY ANYWHERE IT’S NEEDED-Billings ‘09**

[Lee; Getting Solar Off the Ground; SEED Magazine; 28 Jul 2009; [http://seedmagazine.com/content/article/getting\_solar\_off\_the\_ground/;](http://www.google.com/url?q=http%3A%2F%2Fseedmagazine.com%2Fcontent%2Farticle%2Fgetting_solar_off_the_ground%2F%3B&sa=D&sntz=1&usg=AFQjCNHMBYozrCsGE2KJMua2rrW3CJfJbg) retrieved 17 Jun 2011]

Seed: What makes it superior to other forms of alternative energy?

WM: The way power is actually generated and handled in the world involves something called “dispatchable” power. Alternative energy is generally intermittent, and thus not dispatchable. Dispatchable means a utility can make a contract with someone that says, “On December 21st of 2011, I want you to carry 1,000 megawatts of my load for six hours.” So they make a financial contract, and these things are traded back and forth. This economic system behind [power generation] is the cornerstone of what keeps our lights on.

SBSP gives you a continuous source of electricity that you can lay down independent of geography. You can put a receiver in New Jersey and a receiver outside of Seattle, and you can switch the power between those from our orbital system with essentially a flip of a switch.

**WHILE THERE WILL BE CHALLENGES, IT’S CRITICAL THAT HUMANS BEGIN THE EFFORT TO CAPTURE THE CLEAN, LIMITLESS ENERGY SBSP OFFERS-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The reservoir of Space‐Based Solar Power is almost unimaginably vast, with room for growth far past the foreseeable needs of the entire human civilization for the next century and beyond. In the vicinity of Earth, each and every hour there are 1.366 gigawatts of solar energy continuously pouring through every square kilometer of space. If one were to stretch that around the circumference of geostationary orbit, that 1 km‐wide ring receives over 210 terawatt‐years of power annually. The amount of energy coursing through that one thin band of space in just one year is roughly equivalent to the energy contained in ALL known recoverable oil reserves on Earth (approximately 250 terawatt years), and far exceeds the projected 30TW of annual demand in mid century. The energy output of the fusion‐powered Sun is billions of times beyond that, and it will last for billions of years—orders of magnitude beyond all other known sources combined. Space‐Based Solar Power taps directly into the largest known energy resource in the solar system. This is not to minimize the difficulties and practicalities of economically developing and utilizing this resource or the tremendous time and effort it would take to do so. Nevertheless, it is important to realize that there is a tremendous reservoir of energy—clean, renewable energy—available to the human civilization if it can develop the means to effectively capture it.

**GIVEN THE INCREASING DEMAND FOR ENERGY, WE HAVE TO MAKE SBSP WORK TO MEET CLEAN ENERGY NEEDS-Atkinson ‘09**

[Nancy; staff writer; New Company Looks to Produce Space Power Within a Decade; Universe Today; 18 Feb 2009; [http://www.universetoday.com/25754/new-company-looks-to-produce-space-based-solar-power-within-a-decade/#more-25754;](http://www.google.com/url?q=http%3A%2F%2Fwww.universetoday.com%2F25754%2Fnew-company-looks-to-produce-space-based-solar-power-within-a-decade%2F%23more-25754%3B&sa=D&sntz=1&usg=AFQjCNHPeNfraN5Acyl4l23mA_90yNff0Q) retrieved 17 June 2011]

According to a white paper written by aerospace engineer James Michael Snead, “The End of Easy Energy and What Are We Going To Do About It,” in order to meet the world’s projected increase in energy needs by 2100 which likely will be at least three times what is being produced today, today’s sustainable energy production must expand by a factor of over 25. Under that scenario, even if the US were to build 70 new nuclear plants, add the equivalent of 15 more Hoover Dams, expand the geothermal capacity by 50 times what it is today, install over a million large land or sea wind turbines covering 150,000 square miles, build 60,000 square miles of commercial solar voltaic farms, and on top of that convert 1.3 billion dry tons of food mass to bio fuels, still only 30% of the power needs would be filled by 2100, or perhaps even earlier.

“Looking at every single technology we can as a civilization to try and fill the energy gap in a clean and resourceful, sustainable way, technologies like SBSP have to be made to work,” said Sage.

**THERE IS ROOM FOR 177 TERRAWATTS OF POWER GENERATION, TEN TIMES CURRENT ENERGY USE-Henson ‘11**

[Keith; electrical engineer; Space Solar Power – Recent Conceptual Progress; The Oil Drum; 03 June 2011; <http://www.theoildrum.com/node/7898;> retrieved 23 Jun 2011]

Power satellites are an idea that has been around since the late 1960s [1] but not developed commercially because we don't know how to build an inexpensive space transport system. That may have changed recently, at least in theory.

We have known for decades that solar power satellites *can* send energy to the earth. Communication satellites do it every day, just not at levels useful for power. Power satellites scale to humanity's need; a calculation by G. Harry Stein back in the 1980s noted that there was room for 177 TW in geosynchronous orbit (more than ten times current energy use).

The concept is to make electric power in space (thermal or photovoltaic [2]), turn the power into microwaves, beam the microwaves to Earth and convert them back to electric power at "rectennas." The rectennas are simple (though large) structures that stop so little sunlight that the intention is to place them over farmland within a few hundred km of cities.

**SBSP MAY BE THE ONLY PRACTICAL WAY TO MEET HUMAN NEEDS. THERE IS NO ALTERNATIVE-Flournoy ‘10**

[Don; Professor of Telecommunications @Ohio University; SUNSATS: The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/flournoy.html;> retrieved 24 Jun 2011]

In practical terms, building international businesses around solar energy from space may be the only way we can keep alive our individual and collective dreams for a better life. Having abundant, safe, non-polluting energy could represent a tipping point for human productivity and creativity, that one essential ingredient enabling us to not just to survive but to live up to our potential as a human race. If indeed solar energy could make that difference, let us hope that it will happen, as there are no other sustainable solutions currently up for consideration that have the potential to meet our expectations.

**SBSP IS THE MOST LIKELY CANDIDATE FOR A RENEWABLE, CLEAN SOURCE OF ENERGY-Medin ‘10**

[Kristin; Chief Industrial Designer, NewSpace DesignLabs; Disruptive Technology: A Space-Based Solar Power Industry Forecast; The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/medin.html;> retrieved 24 Jun 2011]

Now, multiple nations are exploring the prospects for launching a new breed of satellites designed to harvest solar power in space, transmitting it from geosynchronous orbit to terrestrial receivers. If these plans turn out, solar power satellites will radically change the ways we harness and distribute energy. Solar power from space is far more efficient than terrestrial capture due to the filtering effects of our atmosphere and the day and night cycles experienced everywhere on earth. Solar power is thought to be our most likely candidate for a clean-base, renewable and dependable source for energy. According to Dr. Feng Hsu, Technical Lead and Manager over Integrated Risk Management at NASA, Goddard, roughly 350,000,000 terawatt hours of energy falls towards earth per year.

ADVANTAGE 4: MUST TRANSITION TO SUSTAINABLE ENERGY

**THE THREAT OF ENERGY SCARCITY DEMANDS THAT WE BEGIN A TRANSFORMATION TO SUSTAINABLE ENERGY-Snead ‘09**

[James; senior member of the American Institute of Aeronautics and Astronautics; The vital need for America to develop space solar power; The Space Review; 04 May 2009; <http://www.thespacereview.com/article/1364/1;> retrieved 23 Jun 2011]

Today, Americans live at the peak of the era of easy energy. By the end of the century and perhaps decades earlier, this will change as most of the world, including the United States, will be running on sustainable energy sources. The greater extent to which additional easy energy resources are excluded from exploration and production, the sooner we will by necessity transition to a general reliance on sustainable energy sources and the sooner we may experience energy scarcity by having insufficient sustainable energy supplies. Time is not on our side in addressing this challenge! The threat of energy scarcity, even in the United States, is very real. It will likely become a primary public policy driver as public awareness of the challenges inherent in transitioning to sustainable energy, as discussed in the following, are better understood.

**SBSP IS THE CLEANEST SOURCE OF VIRTUALLY UNLIMITED POWER-Preble ‘09**

[Darel; Chair of the Space Solar Power Workshop**;** Space Solar Power: Star Player on the Bench; The Oil Drum; 19 April 2009; <http://www.theoildrum.com/node/5306;> retrieved 23 Jun 2011]

SPS requires no fuel – zero pollution – and has no operations personnel. It is an antenna with green farms or ranches beneath the rectenna. SSP is the cleanest source of virtually unlimited baseload energy. Ground solar takes 100 times as much land usage to provide the same power as baseload SSP, similar to baseload power plants. Eventually Sunsat Corp could even provide much of its own fuel, through electromagnetic launch which even now has been developed as a first stage.

**SSP IS THE ONLY RENEWABLE ENERGY TECH CAPABLE OF MEETING WORLDWIDE ENERGY DEMAND FOR THE FUTURE-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

SSP is the only renewable energy technology capable of meeting the projected worldwide demand for the next generation of humans, and all of their descendants. As the present stewards of the earth, there is a great onus on the present generation to start work on the ultimate solution as soon as possible. An ancient Chinese proverb advocates that we "dig the well before we are thirsty". A law of the Native American society known as the Iroquois Nation is "In every deliberation, we must consider the impact on the seventh generation". Benjamin Franklin's advice on addressing problems before they grow unmanageable is "a stitch in time, saves nine." Grateful Dead lyrics by John Perry Barlow teach: "We don't own this place, though we act as if we did; it's a loan from the children of our children's kids." While Americans individually can recognize the wisdom of these aphorisms, for the collective US nation to act accordingly will probably require a miracle.

**SPS CAN ASSUME A GREATER SHARE OF GLOBAL POWER DEMAND, AVERTING CLIMATE DISASTERS AND WARS OVER ENERGY-Schubert ‘10**

[Peter; Ph.D; Packer Engineering; Costs, Organization and Roadmap for SSP; Online Journal of Space Communication; Winter 2010 ;http://spacejournal.ohio.edu/issue16/schubert.html; retrieved 24 Jun 2011]

Should such a miracle come to pass, the cost, organization, and roadmap to commercial scale SSP has been identified herein. The Organization for Space Energy Research (OSER) will be a not-for-profit entity formed at a Midwestern engineering university directing a 230 million USD per year applied research budget. Its charter will be to identify an optimal SSP architecture and develop key enabling technologies. Started with federal fiscal year 2012 funding, OSER can demonstrate SSP viability in 6 years, and guide the first 5 GW installation to completion in 12 more years. In this way, SSP can take over an ever-increasing share of global power demand such that energy wars, climate disasters, or economic collapse can be averted or ameliorated.

**MEETING ENERGY NEEDS THROUGH SBSP WILL ALLOW A SUSTAINABLE LIFE FOR ALL HUMAN CIVILIZATION-Medin ‘10**

[Kristin; Chief Industrial Designer, NewSpace DesignLabs; Disruptive Technology: A Space-Based Solar Power Industry Forecast; The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/medin.html;> retrieved 24 Jun 2011]

Modern civilization has come to depend on energy to support quality of life, maintain global scale economies and sustain research. In the context of compromised fossil fuel reserves and increased demand for renewable resources, we can look to space to meet, hopefully to exceed, our energy demands of the future. With the implementation of SBSP, other industries will find a home in space, delivering a new generation of goods and services that benefit humanity. At the same time, new job and new careers will emerge to support these burgeoning businesses. As we solve our energy needs through SBSP, we can think more confidently about ensuring the sustainability of civilization. We can focus on addressing the important issues of tomorrow with increased global cooperation.

**ONLY SBSP CAN PROVIDE THE AMOUNT OF ENERGY NEEDED. WE WILL RUN OUT OF ENERGY WELL BEFORE 2010-Nansen ‘10**

[Ralph; 31 year space engineer @ Boeing; Low Cost Access to Space is Key to Solar Power Satellite Deployment; Online Journal of Space Communication; Winter 2010;http://spacejournal.ohio.edu/issue16/nansen.html; retrieved 24 Jun 2011]

Today we face the compounding problems of a world recession, passing the peak of world oil production, global warming due to carbon dioxide in the atmosphere from burning fossil fuels, and the threat of wars over Middle East oil.

The search is on for the new sources of energy required to support future economic and social development. Those sources must now pass a more strict set of criteria. They are expected to not only replace oil and coal to stop global warming, they must meet the growing global demand for energy that can be expected to rise each decade. Developing sources of renewable energy will meet some of the demand, but only Solar Power Satellites will be able to deliver the quantities envisioned. The United States currently consumes 25 percent of the world's oil usage, with only 5 percent of the population.[1] That ratio is about to dramatically change. James Michael Snead, President of the Spacefaring Institute LLC, writes that "…even if we use every source of clean energy --- terrestrial solar, wind, and geothermal --- and every source of dirty energy --- coal, oil, and nuclear --- we will run out of energy well before 2100."[2]

**SOLAR POWER SATELLITES WILL ALLOW THE WORLD TO AVERT A GLOBAL ENERGY CATASTROPHE COMING THIS GENERATION-Mardon ‘06**

[A.A.; Professor, Penza State Pedagogical University; THE POTENTIAL PUSH AND PULL OF THE DEVELOPMENT AND CONSTRUCTION OF SOLAR POWER SATELLITES TO EARTH ORBIT COLONIZATION AND INNER SOLAR SYSTEM COLONIZATION: ASTEROIDS AS A SOURCE OF CONSTRUCTION MATERIAL; Spacecraft Reconnaissance of Asteroid and Comet Interiors; 2006; retrieved 21 July 2011]

Currently the majority of our world’s civilization is based on both solid carbon and hydrocarbon sources of energy. It is obvious to even an elementary student that this situation of what our world’s energy supply is based on will not last forever it might not even last for more than at the most another generation. The United States and the West is fighting its second ‘oil’ war in half a generation. If the economic resources that were devoted to prop up our carbon based energy civilization was instead used to develop alternative energy supplies especially Solar Power Satellites then it might be possible to avert a global energy catastrophe by the end of this generation. Solar Power Satellites are a viable technically possible technology that with cooperation and integration of the world’s various space capable nations could start to produce energy being beamed back to Earth within ten years.

**FAILURE TO HAVE AN ADEQUATE SUPPLY OF ENERGY BEFORE PEAK OIL SHORTAGES WILL LEAD TO FAILED STATES ACROSS THE GLOBE-National Security Space Office ‘07**

[Space Based Solar Power as an Opportunity for Strategic Security; National Security Space Office; 10 Oct 2007; http://www.nss.org/settlement/ssp/library/nsso.htm; retrieved 12 Jul 2011]

If traditional fossil fuel production of peaks sometime this century as the Department of Energy’s own Energy Information Agency has predicted, a first order effect would be some type of energy scarcity. If alternatives do not come on]line fast enough, then prices and resource tensions will increase with a negative effect on the global economy, possibly even pricing some nations out of the competition for minimum requirements. This could increase the potential for failed states, particularly among the less developed and poor nations. It could also increase the chances for great power conflict. To the extent SBSP is successful in tapping an energy source with tremendous growth potential, it offers an ”alternative in the third dimension” to lessen the chance of such conflicts.

**US MUST ADOPT ALTERNATIVE FUELS OR FACE ECONOMIC CHAOS--Stanford '07**

[Jeff; “Biofuel boom or fossil doom?;” Canadian Business; 13-27 August 2007; Wilson Database]

U.S. President Harry Truman created the National Petroleum Council (NPC) in 1946 out of the remnants of the Petroleum Industry War Council, a group brought together to co-ordinate government and industry action during the Second World War. Today the NPC--chaired by former Exxon Mobil CEO Lee R. Raymond--continues its mission as a federal advisory committee made up of 175 industry members tasked with providing the U.S. energy secretary with information about the nation's oil and gas industry. When current secretary Samuel Bodman wrote a letter to the council in 2005 requesting an analysis of the stability of U.S. energy supply, the NPC got to work on a reply.

The verdict was finally announced on July 18: There are "accumulating risks to continuing expansion of oil and natural gas production," but the use of alternative energies like biofuels will help the United States avoid economic chaos.

ADVANTAGE 5: SBSP CRITICAL FOR MILITARY POWER PROJECTION

**SBSP WILL NOT ONLY ALLOW AMERICAN FORCES TO PROJECT POWER, IT WILL REDUCE CONFLICT OVER ENERGY-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

For the DoD specifically, beamed energy from space in quantities greater than 5 MWe has the potential to be a disruptive game changer on the battlefield. SBSP and its enabling wireless power transmission technology could facilitate extremely flexible “energy on demand” for combat units and installations across an entire theater, while significantly reducing dependence on vulnerable over‐land fuel deliveries. SBSP could also enable entirely new force structures and capabilities such as ultra long‐endurance airborne or terrestrial surveillance or combat systems to include the individual soldier himself. More routinely, SBSP could provide the ability to deliver rapid and sustainable humanitarian energy to a disaster area or to a local population undergoing nation‐building activities. SBSP could also facilitate base “islanding” such that each installation has the ability to operate independent of vulnerable ground‐based energy delivery infrastructures. In addition to helping American and allied defense establishments remain relevant over the entire 21st Century through more secure supply lines, perhaps the greatest military benefit of SBSP is to lessen the chances of conflict due to energy scarcity by providing access to a strategically secure energy supply.

**THE MILITARY COULD USE SBSP TO ENSURE THAT THE US NOT GET INVOLVED IN A NIGHTMARE WAR OVER RESOURCES AND ENERGY-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

In recent months, however, a new potential champion for space solar power has emerged, and from a somewhat unlikely quarter. Over the last several months the National Security Space Office (NSSO) has been conducting a study about the feasibility of space solar power, with an eye towards military applications but also in broader terms of economic and national security.

Air Force Lt. Col. Michael “Coyote” Smith, leading the NSSO study, said during a session about space solar power at the NewSpace 2007 conference in Arlington, Virginia last month that the project had its origins in a study last year that identified energy, and the competition for it, as the pathway to “the worst nightmare war we could face in the 21st century.” If the United States is able to secure energy independence in the form of alternative, clean energy sources, he said, “that will buy us a form of security that would be phenomenal.”

**SBSP COULD PROVIDE HIGHLY MOBILE ENERGY FOR FORWARD AREAS IN MILITARY-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

“The military would like nothing better than to have highly mobile energy sources that can provide our forces with some form of energy in those forward areas,” Smith said. One way to do that, he said, is with space solar power, something that Smith and a few fellow officers had been looking at in their spare time. They gave a briefing on the subject to Maj. Gen. James Armor, the head of the NSSO, who agreed earlier this year to commission a study on the feasibility of space solar power.

There was one problem with those plans, Smith said: because this project was started outside of the budget cycle, there was no money available for him to carry out a conventional study. “I’ve got no money,” he said, “but I’ve got the ability to go out there and make friends, and friends are cheap.” So Smith and his cadre of friends have carried out the research for the study in the open, leveraging tools like Google Groups and a blog that hosts discussions on the subject.

**SBSP CAN BE A DISRUPTIVE GAME CHANGER FOR THE US MILITARY, ALLOWING MUCH MORE RAPID AND FLEXIBLE DEPLOYMENT-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

For the DoD specifically, beamed energy from space in quantities greater than 5 MWe has the potential to be a disruptive game changer on the battlefield. SBSP and its enabling wireless power transmission technology could facilitate extremely flexible “energy on demand” for combat units and installations across an entire theater, while significantly reducing dependence on vulnerable over‐land fuel deliveries. SBSP could also enable entirely new force structures and capabilities such as ultra long‐endurance airborne or terrestrial surveillance or combat systems to include the individual soldier himself. More routinely, SBSP could provide the ability to deliver rapid and sustainable humanitarian energy to a disaster area or to a local population undergoing nation‐building activities. SBSP could also facilitate base “islanding” such that each installation has the ability to operate independent of vulnerable ground‐based energy delivery infrastructures. In addition to helping American and Allied defense establishments remain relevant over the entire 21st Century through more secure supply lines, perhaps the greatest military benefit of SBSP is to lessen the chances of conflict due to energy scarcity by providing access to a strategically security energy supply.

**FAILURE TO DEVELOP A SECURE AFFORDABLE SUPPLY OF ENERGY JEOPARDIZES MILITARY’S PEACEKEEPING AND DEFENSE ROLE-National Space Security Office ‘08**

[Space Based Solar Power; Ad Astra; Spring 2008; www.nss.org/adastra/AdAstra-SBSP-2008.pdf; retrieved 11 Jul 2011]

The very real risks of climate change, energy nationalism and scarcity, unconstrained technology explosion, and potential resource conflicts weigh heavily on the futurist minds of the action officers of the Air Force Future Concepts and Transformations Office and National Security Space Office (NSSO) “Dreamworks.” These officers are charged with visualizing the world 25-or-more years from now, and informing and guiding Air Force and space strategy development. For a military that is fundamentally dependent on high-energy capabilities to protect its nation and the international commons for the good of all humanity, not only are the strategic risks associated with energy scarcity that lie ahead great, but so too are the operational and tactical vulnerabilities for the finest war-fighting and peacekeeping machine humans have ever known.

ADVANTAGE 5: SBSP WILL REDUCE WAR

**REDUCING OUR RELIANCE ON CURRENT FOSSIL FUEL INFRASTRUCTURE WILL REDUCE THE MOST IMPORTANT MOTIVATION FOR WAR IN THE 21ST CENTURY-Dinerman ‘08**

[Taylor; author and journalist; War, Peace, and Space Solar Power; The Space Review; 15 Sep 2008; <http://www.thespacereview.com/article/1209/1;> retrieved 23 Jun 2011]

While politicians in the US and Europe debate the best way to ensure access to the International Space Station (ISS), a more profound lesson from the crisis is evident. The world can no longer afford to depend upon easily disrupted pipelines for critical energy supplies. The one that ran from Azerbaijan through Georgia to Turkey was, no doubt, an important factor in setting off the events of August 2008.

In the future other pipelines, such as the one that may run from the coast of Pakistan to western China, may be just as important and as vulnerable as the one that runs through Georgia. Removing this kind of infrastructure from its central role in the world’s energy economy would eliminate one of the most dangerous motivations for war that we may face in the 21st century.

If the world really is entering into a new age of resource shortages—or even if these shortages are simply widely-held illusions—nations will naturally try their best to ensure that they will have free and reasonably priced access to the stuff they need to survive and to prosper. Some of the proposed regulations aimed at the climate change issue will inevitably make matters worse by making it harder for nations with large coal deposits to use them in effective and timely ways.

The coming huge increase in demand for energy as more and more nations achieve “developed” status has been discussed elsewhere. It is hard to imagine that large powerful states such as China or India will allow themselves to be pushed back into relative poverty by a lack of resources or by environmental restrictions. The need for a wholly new kind of world energy infrastructure is not just an issue involving economics or conservation, but of war and peace.

Moving a substantial percentage of the Earth’s energy supply off the planet will not, in and of itself, eliminate these kinds of dangers, but it will reduce them. Nations that get a large percentage of their electricity from space will not have to fear that their neighbors will cut them off from gas or coal supplies. The need for vulnerable pipelines and shipping routes will diminish.

**SEEN AS A WAR AVOIDANCE TECHNOLOGY, SBSP BECOMES MUCH MORE AFFORDABLE-Dinerman ‘08**

[Taylor; author and journalist; War, Peace, and Space Solar Power; The Space Review; 15 Sep 2008; <http://www.thespacereview.com/article/1209/1;> retrieved 23 Jun 2011]

While most space solar power advocates believe that the basic technology already exists, the engineering challenges are huge, as are the capital requirements. Seen as a simple business proposition space solar power (SSP) is a long way from becoming a viable economic source of energy. It could be subsidized the way that wind power or terrestrial solar has been. Even with subsidies, it is hard to see that the private sector would pay for the development work due to the unknown technological risks and to the long time scale.

However, if SSP were perceived as a “war avoidance” mechanism or technology, the investment logic changes. The profit-seeking side of the private sector does not see its role as inflicting peace on an unstable and violent world. Traditionally that has been the role of governments, and in recent decades the so-called NGOs or non-profit sector.

ADVANTAGE 6: ECONOMY

**SBSP DEVELOPMENT WILL LAUNCH A NEW ERA OF SPACE-BASED COMMERCE AND INDUSTRIALIZATION FOR THE US-Snead ‘09**

[James; senior member of the American Institute of Aeronautics and Astronautics; The vital need for America to develop space solar power; The Space Review; 04 May 2009; <http://www.thespacereview.com/article/1364/1;> retrieved 23 Jun 2011]

An interesting and timely debate has begun within the American pro-space community about the need to support the start of the commercial development of space solar power (SSP). Given strongly held personal and organizational preferences for space science, suborbital commercial human spaceflight, the human exploration of Mars, etc., it’s not surprising that achieving a consensus to support and strongly advocate for starting the commercial development of SSP has not yet been reached. I argue that the time for such support has arrived. Such support will not only help America and many other nations avoid energy scarcity later this century, but it will also help advance America into a new era of the space age focused on space industrialization that will broadly benefit all pro-space agendas.

**SBSP WILL REVITALIZE THE AMERICAN ECONOMY BY CREATING MILLIONS OF JOBS IN MANY FIELDS-Preble ‘09**

[Darel; Chair of the Space Solar Power Workshop**;** Space Solar Power: Star Player on the Bench; The Oil Drum; 19 April 2009; <http://www.theoildrum.com/node/5306;> retrieved 23 Jun 2011]

SSP takes advantage of our historic investment in aerospace and other technical expertise to increase STEM jobs. SSP technology is near-term-available with multiple attractive approaches and would create millions of inspiring and important jobs. SSP would revitalize America by taking advantage of a multitude of space-development-related technologies that are vitally relevant to our current problems, including space transportation, telerobotics, photovoltaics, control systems, communications, aerospace engineering, wireless power transfer, environmental science including “space weather” knowledge.

**SBSP WILL REBUILD A PRODUCTIVE AMERICAN ECONOMY, WITH ABUNDANT CLEAN ENERGY-Preble ‘10**

[Daniel; scientific programming and supercomputing manager at Georgia State University; The Sunsat Act - Transforming our Energy, Economy and Environment; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/preble.html;> retrieved 24 Jun 2011]

Our global economy depends on low cost energy. In reaction to peaking oil prices, our economy is "in a shambles." We must rebuild our energy supply. Many energy alternatives have been explored and subsidized since the Arab Oil embargo shock of 1973, yet our oil, gas and energy dependency has grown. Our energy security is declining. Rebuilding our primary energy supply is hard. Fortunately, technology has opened the door to a clean new baseload energy player, Space Solar Power (SSP). The difference between communication satellites (comsats) now in use and the power satellites (sunsats) we need, is that sunsats would optimize for efficient power transfer, while comsats have optimized their signal to noise ratio. Just as the Comsat Act of 1962 created our robust commercial satellite communications industry, the key legislation that would enable SSP to become a major energy source is entitled the Sunsat Act. The Sunsat Act would create a commercial power satellite industry.

A/T: LAUNCH COSTS

**INCREASED DEMAND AND LEVERAGED EXISTING TECHNOLOGY WILL MAKE LAUNCH COSTS PRACTICAL FOR SBSP-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

What I really want to point out here is that we can solve the cost issue and make Solar Power Satellites a commercially viable energy option. We can do this through human creativity and innovation on both technological and economic fronts. Yes, current launch costs are critical constraints. However, in addition to continuing our quest for low cost RLV (reusable launch vehicle) technologies, there are business models for overcoming these issues.

Several such models have been studied and are now being pursued by some American private aerospace entrepreneurial companies, such as the SE (Space Energy Group) and the SIG (Space Island Group) based in Switzerland and California. The SE approach is based on systematic development of solar technologies for terrestrial and for space environment applications. The company expects to rely on extensive terrestrial solar technology development as the stepping stone, focusing on the space-grade thin film PV technology innovations for launch cost reductions. The SIG idea is to modify and utilize legacy components of the Space Shuttle, turning the huge volumes of the external Shuttle tanks into a commercial asset for the space-based research and orbital tourism industry. Increased demand in space tourism will certainly bring about higher launch rates, which should drive down space transportation costs. Who would have thought that ordinary people could afford air travel just a few decades after the Wright brothers had succeeded in flying their first aircraft?

**A VIGOROUS SPS PROGRAM WILL PROVIDE THE MARKET AND INCENTIVES FOR CHEAP SPACE LAUNCHES-Bova ‘08**

[Ben; president emeritus of the National Space Society; An Energy Fix Written in the Stars; Washington Post; 12 Oct 2008]

What's more, a vigorous SPS program would provide a viable market for private companies, such as SpaceX and Virgin Galactic, that are developing rocket launchers. Like most new industries, these companies are caught in a conundrum: They need a market that offers a payoff, but no market will materialize until they can prove that their product works. The fledgling aircraft industry faced this dilemma in the 1920s. The federal government helped provide a market by giving it contracts to deliver mail by air, which eventually led to today's commercial airline industry.

A vigorous SPS program could provide the market that the newborn private space-launch industry needs. And remember, a rocket launcher that can put people and payloads into orbit profitably can also fly people and cargo across the Earth at hypersonic speed. Anywhere on Earth can be less than an hour's flight away. That's a market worth trillions of dollars a year.

**THE PROBLEM OF LAUNCH COST CAN BE SOLVED WITH UPFRONT INVESTEMENT-Nansen ‘10**

[Ralph; 31 year space engineer @ Boeing; Low Cost Access to Space is Key to Solar Power Satellite Deployment; Online Journal of Space Communication; Winter 2010 ;http://spacejournal.ohio.edu/issue16/nansen.html; retrieved 24 Jun 2011]

The barrier to their development is still the lack of a low-cost space transportation system for launching the satellite hardware. Without a reusable launch system there is little hope to deploying a significant capability to generate competitive cost electric energy from space. The problem is not technology; it is the up-front investment money and understanding of what is required. In the 21st century, NASA's goals and approaches are no longer compatible with those of a commercial development program such as Solar Power Satellites.

**ECONOMIES OF SCALE WILL MAKE THE LAUNCH COSTS AN INSIGNIFICANT BURDEN-Champman ‘10**

[Phillip; geophysicist and astronautical engineer, Ph. D from MIT; Deploying Sunsats; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/chapman.html;> retrieved 24 Jun 2011]

The purpose of this paper is to demonstrate that the economies of scale in any significant space-based solar power (SBSP) program will permit launch at acceptable cost, even without major advances in launch technology. To be definite, a fairly modest sunsat deployment program is assumed, with the first launch taking place in 2015, leading to an installed sunsat capacity of 800 GWe in 2050. This goal will represent somewhere between 6% and 9% of the total global capacity that we will need by then.

The analysis uses simple standard models to approximate the performance and cost of LVs, with subsystem characteristics comparable to those of existing engines and vehicles. The only major technical innovation considered is the introduction of reusable LV stages, and the only major change in spaceflight practice is launch from an equatorial site. There is no attempt to optimize the launch architecture. Improved designs and advanced technologies will offer significantly lower costs than the rough estimates obtained here.

**LAUNCH COST IS NOT A REASON TO DELAY SBSP. THE TIME TO DEVELOP THE PROGRAM IS NOW-Champman ‘10**

[Phillip; geophysicist and astronautical engineer, Ph. D from MIT; Deploying Sunsats; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/chapman.html;> retrieved 24 Jun 2011]

It is clear from Figure 3 that the principal problems in closing the business case for a launch services provider that supports SBSP are related to financing the venture rather than to the cost of operations or the eventual profitability. For example, a launch price of $450/kg leads to a maximum deficit of $60 billion in the 12th year of the deployment schedule, and the cumulative cashflow does not become positive until the 22nd year – but the end result in 2050 is a profit of $180 billion. The delay in profitability exceeds the planning horizon of most venture capitalists, so the project probably requires both a strong government commitment to completing the deployment as well as some form of financial guarantee. Creative financing could help: for example, the launch price could be set at $600/kg in the early years, with a contractual obligation to refund some of the money once the cashflow went positive.

The particular systems assumed in this analysis (LOX/LH2 in both stages, winged recovery, etc.) should not be taken as recommendations for design of RLVs for this application. The purpose is only to show by example that the cost of launch to LEO is not a reason to delay implementation of SBSP as a major contributor to energy supply in the United States and around the world. The need is urgent and the best time to begin a serious development program is right now.

A/T: FOSSIL FUELS ARE CHEAPER

**SBSP DOES NOT HAVE TO COMPETE WITH TRADITIONAL FOSSIL FUELS TO BECOME VIABLE-Atkinson ‘09**

[Nancy; staff writer; New Company Looks to Produce Space Power Within a Decade; Universe Today; 18 Feb 2009; [http://www.universetoday.com/25754/new-company-looks-to-produce-space-based-solar-power-within-a-decade/#more-25754;](http://www.google.com/url?q=http%3A%2F%2Fwww.universetoday.com%2F25754%2Fnew-company-looks-to-produce-space-based-solar-power-within-a-decade%2F%23more-25754%3B&sa=D&sntz=1&usg=AFQjCNHPeNfraN5Acyl4l23mA_90yNff0Q) retrieved 17 June 2011]

He says this is an important point. “We’re not setting ourselves up to compete with coal, or nuclear, or ground based solar or wind. I don’t want to pick a fight with any of those industries saying that we’re trying to take a piece of their pie. What we’re saying is that right now, from a responsible perspective in terms of being a good steward for the environment, we need to look at every single source of energy that we can get our hands on, primarily green, and develop it regardless, because we’re going to need it. SBSP is one of the few forms of energy that has the ability to be base-load, i.e., 24-7, and it’s the only form of energy that can be broadcast on demand.”

**GIVEN THE INCREASED COST OF OIL, THERE IS MORE INTEREST IN SBSP-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

It’s easy to see why people are willing to give space solar power another look. High oil prices, worries about the political stability of places like the Middle East that are key sources of energy, and heightened concerns about climate change have created a mad scramble in the last several years for alternative energy, from wind and terrestrial solar to biofuels like E85 ethanol. John Mankins, who managed the last major NASA space solar power study, the “Fresh Look” study in the late 1990s, said during a Marshall Institute forum on space solar power in Washington last week that there was little interest at the time because oil was $15 a barrel; now it’s about five times as expensive.

**PEAK OIL LIKELY TO SEE DRAMATIC INCREASES OF FOSSIL FUELS--Jensen '07**

[Brennen; “No More Oil? A Charity Gives New Life to 50-Year-Old Prediction of Falling Supply;” The Chronicle of Philanthropy; 4 October 2007; Wilson Databases]

It is widely acknowledged that for the past 20 years, people have used more oil each year than has been discovered. Indeed, last year two barrels of oil were used up for every new barrel discovered underground.

"You can assume that gas prices will go through the roof," Mr. Andrews says of what to expect as the world slides down the backside of Hubbert's Peak. "People will feel badly ambushed by this when it happens."

A/T: FUSION AND RENEWABLES

**WE COULD DELIVER A WORKING SATELLITE FOR LESS THAN HALF THE COST OF ONE ITER REACTOR-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

Marty Hoffert, a New York University professor who has been a long-time advocate of space solar power, contrasted the current plight with that of fusion, the one other energy source Hoffert believes could provide energy security to the world. While space solar power goes virtually unrecognized by the US and other governments, an international consortium is spending up to $20 billion on a test fusion reactor, ITER, in France. “For half that money I think we could deliver a working solar power satellite, whereas ITER is just going to show the proof of feasibility” of controlled nuclear fusion without generating any power, he said.

“Certain ideas just fall through the cracks because there isn’t a champion in the agency,” in either the DOE or NASA, Hoffert said.

**GROUND SOLAR WILL CREATE ENVIRONMENTAL IMPACTS AND REDUCE ARABLE LAND; CANNOT SOLVE-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

Unlike terrestrial solar facilities, microwave receiving rectennas allow greater than 90% of ambient light to pass through, but absorb almost all of the beamed energy, generating less waste heat than terrestrial solar systems because of greater coupling efficiency. This means that the area underneath the rectenna can continue to be used for agricultural or pastoral purposes. To deliver any reasonably significant amount of base‐load power, ground solar would need to cover huge regions of land with solar cells, which are major sources of waste heat. As a result, these ground solar farms would produce significant environmental impacts to their regions. The simultaneous major increases to the regional temperature, plus the blockage of sunlight from the ground, will likely kill off local plants, animals and insects that might inhabit the ground below or around these ground solar farms. This means that that a SBSP rectenna has

less impact on the albedo or reflectivity of the Earth than a terrestrial solar plant of equivalent generating capacity. Moreover, the energy provided could facilitate water purification and irrigation, prevent frosts, extend growing seasons (if a little of the energy were used locally) etc. In the plains of the U.S. (e.g., South Dakota, etc), in sub‐Saharan Africa, etc. etc. there are vast areas of arable land that could be both productive farm land and sites for SBSP rectennas.

**SBPS SOLVES THE LIMITATIONS OF GROUND-BASED SOLAR-Binns ‘11**

[Corey; Space-based solar power: satellites could gather energy from the sun and beam it down to Earth, Popular Science; July 2011; pg. 64]

On the ground, solar power has its limitations. Solar cells are not especially efficient. It rains. The sun disappears at night. A space-based solar panel can generate five times the energy of a similar panel on Earth by circumventing both weather and hours lost to darkness. A 2007 study by the National Space Society estimates that a half-mile-wide band of photovoltaics in geosynchronous orbit with Earth could generate the energy equivalent of all the oil remaining on the planet over the course of one year. Though costly, launching working solar satellites is possible today. It's transmitting the captured energy to Earth that presents a challenge--one that scientists are just starting to work on.

If beaming power from space sounds disconcerting, the concept is remarkably safe and simple. Satellites outfitted with solar panels would gather the sun's energy 24 hours a day and then convert that energy into an infrared laser beam. The high-efficiency laser would transmit 80 percent of the captured energy to ground-based receivers; one design calls for 60-foot-wide laser beams and 9,700-square-foot ground-based receiving stations. If clouds hinder the beam from traveling though Earth's atmosphere, the satellite could redirect the energy to other satellites or receivers in the network.

**NONE OF THE ALTERNATIVES TO SBSP OFFER THE HUGE SPACE, ENERGY AND ENVIRONMENTAL BENEFITS-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

The SBSP Study Group found that while the United States requires a suite of energy options, and while many potential options exist, none offers the unique range of ancillary benefits and transformational capabilities as SBSP.

It is possible that the world’s energy problems may be solved without resort to SBSP by revolutionary breakthroughs in other areas, but none of the alternative options will also simultaneously create transformational national security capabilities, open up the space frontier for commerce, greatly enable space transportation, enhance high‐paying, high‐tech jobs, and turn America into an exporter of energy and hope for the coming centuries.

**SBSP SOLVES ALL OF THE RELIABILITY AND EFFICIENCY PROBLEMS OF SOLAR AND WIND POWER-Mardon and Balogun ‘11**

[Austin, member of the International Academy of Astronautics and Pauline; Solar Satellites Key to Green Energy; Edmonton Journal; 12 Jun 2011; <http://www.edmontonjournal.com/story_print.html?id=4933251&sponsor=;> retrieved 23 Jun 2011]

The major criticisms against solarpower facilities, such as wind farms, are unreliability and inefficiency. Solar power depends on environmental factors beyond human control and that makes investors anxious. These facilities also require areas with high amounts of sunlight, usually hundreds if not thousands of acres of valuable farmland and all for relatively little power production.

This is why, in the 1960s, scientists proposed solar-powered satellites (SPSs). SPSs have about the most favourable conditions imaginable for solar energy production, short of a platform on the sun.

Earth's orbit sees 144 per cent of the maximum solar energy found on the planet's surface and takes up next to no space in comparison to land-based facilities.

Satellites would be able to gather energy 24 hours a day, rather than the tenuous 12-hour maximum that land-based plants have, and direct the transmitted energy to different locations, depending on where power was needed most.

A/T: TECHNOLOGY ISN’T THERE YET

**THE 70S MODELS ARE NOT THE SBSP OF TODAY-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

[http://www.thespacereview.com/article/931/1;](http://www.google.com/url?q=http%3A%2F%2Fwww.thespacereview.com%2Farticle%2F931%2F1%3B&sa=D&sntz=1&usg=AFQjCNHLB3AkrbVXRm6SEBWLACs3JcNP3A) retrieved 17 Jun 2011]

One obstacle facing space solar power is that most people have not heard of it, and many of those who have associate it with the huge, expensive concepts studied back in the 1970s. Those proposals featured arrays many kilometers long with massive trusses that required dozens or hundreds of astronauts to assemble and maintain: Mankins joked that a giant Borg cube from *Star Trek* would have easily fit into one corner of one of the solar power satellite designs. “You ended up with a capital investment—launchers, in-space infrastructure, all of those things—on the order of $300 billion to $1 trillion in today’s dollars before you could build the first solar power satellite and get any power out of it,” he said.

**THERE ARE NO TECHNOLOGICAL OR THEORETICAL OBSTACLES PREVENTING A DEMONSTRATION PROJECT-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

Is SPS a viable option? Yes, in my opinion, it can and should be a major source of base-load electricity generation powering the needs of our future. SPS satisfies each of the key criteria except for cost based on current space launch and propulsion technology. We all know that the expense of lifting and maneuvering material into space orbit is a major issue for future energy production in space. The development of autonomous robotic technology for on-orbit assembly of large solar PV (or solar thermal) structures along with the needed system safety and reliability assurance for excessively large and complex orbital structures are also challenges. Nevertheless, no breakthrough technologies or any theoretical obstacles need to be overcome for a solar power satellite demonstration project to be carried out.

**THE ENTIRE SBSP SYSTEM IS TECHNOLOGICALLY FEASIBLE TODAY-Lemonick ‘09**

[Michael; senior writer at Climate Central; Solar Power from Space:Moving Beyond Science Fiction; Environment 360; 31 Aug 2009; <http://e360.yale.edu/content/feature.msp?id=2184;> retrieved 23 Jun 2011]

Doubts abound that space-based solar power will come to pass anytime soon, and for good reason: The technology involves launching a series of large satellites into space, using robotic technology to assemble the solar arrays, transmitting the energy 22,000 miles to earth using microwave technology, and then converting that energy to electricity on the ground.

The fact is, however, that all of that is now feasible — if pricey — thanks to technological advances in recent years. These include cheaper and more reliable launch technology, lighter and stronger materials for solar stations, significant improvements in the robotic technology needed to assemble the solar arrays, far more efficient solar cells, more precise digital devices to direct that energy accurately to earth, and significantly smaller and more powerful microwave transmitters and receivers.

**THERE HAVE BEEN FEW STUDIES ABOUT SBSP SINCE THE 70S-Foust ‘07**

[Jeff; editor; A Renaissance for Space Solar Power; The Space Review; 13 aug 2007;

<http://www.thespacereview.com/article/931/1;> retrieved 17 Jun 2011]

Not everyone is sold, however, on the viability or cost-effectiveness of space solar power, leading to long-running debates on the topic. Those disputes have remained largely academic, though, since there has been little support for research in the field: after the original studies by NASA and the Department of Energy (DOE) ended in the late 1970s, the only concerted effort, other than some isolated studies in Europe and Japan, was NASA’s “Fresh Look” studies in the late 1990s in cooperation with the National Science Foundation (NSF). Space solar power has withered on the vine since then, but a confluence of events has provided proponents with a new opportunity to reinvigorate the subject.

**MORE TIME WILL MAKE SOLAR CELLS BETTER AND CHEAPER, BUT NO TECH BREAKTHROUGH IS NEEDED-Betancourt ‘10**

[Kiantar; JD student, University of Maryland; Legal Challenges Facing Solar Power Satellites; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/betancourt.html;> retrieved 24 Jun 2011]

Also, since 1977, the efficiency of solar cells has increased from around 10% to over 40%. The efficiency of solid-state amplifiers has increased from 20% to 80%. Solar power satellites using these new technologies should weigh around 25 tons, much smaller than the 250 ton satellites originally contemplated by Dr. Peter E. Glaser, the scientist who introduced the SBSP concept.[14] Dr. Glaser’s 1960’s proposal required hundreds of astronauts in space to build solar power satellites.[15] This is no longer the case as advances in computing and robotics will now allow satellites to be self-assembling made up of many small parts. More time and research will help to lower the initial cost and improve efficiency to the scale needed for SBSP implementation, but no new breakthrough discovery or invention is thought to be necessary.

**THE TECHNOLOGICAL HURDLES ARE COMING DOWN-Edwards ‘10**

[Lin; European space company wants solar power plant in space; Physorg.com; 21 Jan 2010;

<http://www.physorg.com/news183278937.html;> retrieved 17 Jun 2011]

The concept of harvesting solar power in space has been discussed for at least the last three decades, but the problems of power loss during transmission and the expense and difficulty of assembling large arrays of solar collectors in space have seemed almost insurmountable. However, Astrium is not the only company close to bringing the idea to fruition. Last September Japan announced it is planning to put a small demonstration solar collecting satellite in orbit by 2015. This system will transmit the power to Earth using microwaves.

EADS Astrium is seeking investors and partners such as the EU, national governments, space agencies, or power companies, to fund and contribute in other ways to the development of its operational orbital solar collection and transmission system.

**AS ENERGY COSTS INCREASE AND TECHNOLOGY IMPROVES, SBSP IS BECOMING MORE VIABLE-Billings ‘09**

[Lee; Getting Solar Off the Ground; SEED Magazine; 28 Jul 2009; <http://seedmagazine.com/content/article/getting_solar_off_the_ground/;> retrieved 17 Jun 2011]

During the heyday of the Space Age in the late 60s, researchers conceived of solutions to this problem that relied on placing solar arrays, or “powersats,” in orbit. The powersats would beam the collected power down to Earth as microwaves, which can easily penetrate the atmosphere with scarcely any energy lost. Space-based solar power (SBSP) seemed feasible, except for one thing: Launching the necessary infrastructure into high orbit would be prohibitively expensive, especially when cheaper fossil fuels were readily available.

Today, as with many other alternative energy proposals, interest in SBSP has been rejuvenated by the rising direct and indirect costs of fossil fuels, and several SBSP companies have formed. Earlier this year, Pacific Gas & Electric, a major California utility company, signed an agreement to purchase hundreds of megawatts of power from Solaren, an SBSP company, beginning in 2016. Last month, another SBSP company, PowerSat Corporation, filed two patents for technologies that the company claims can shave billions of dollars off the launch costs for an SBSP system. Seed’s Lee Billings spoke with PowerSat’s CEO, William Maness, about the company’s technology and the revival of SBSP.

**SBSP IS NO MORE SCIENCE FICTION THAN SATELLITE TELEVISION-Billings ‘09**

[Lee; Getting Solar Off the Ground; SEED Magazine; 28 Jul 2009; [http://seedmagazine.com/content/article/getting\_solar\_off\_the\_ground/;](http://www.google.com/url?q=http%3A%2F%2Fseedmagazine.com%2Fcontent%2Farticle%2Fgetting_solar_off_the_ground%2F%3B&sa=D&sntz=1&usg=AFQjCNHMBYozrCsGE2KJMua2rrW3CJfJbg) retrieved 17 Jun 2011]

Seed: What’s the toughest part of talking with people about SBSP?

WM: I’ve spent the last eight years of my life fighting the “giggle factor.” When politicians or investors hear about SBSP, they get a little smile on their face, probably thinking about when they saw it in *SimCity 2000*. It drives me nuts because this isn’t science fiction. Powersats are no more science fiction than satellite television. What this is about is enabling the continued, controlled growth of our society and our standard of living in a way that doesn’t destroy the planet. I don’t want anyone to have to think about where their electricity comes from. But in order to get there, people like me have to think a lot about what happens behind the scenes when the lights get switched on.

**TECHNOLOGIES EXIST FOR ALL PHASES OF SOLAR POWERED SATELLITE SYSTEMS-Mankins ‘97**

[John C.; A Fresh Look at Space Solar Power: New Architectures, Concepts and Technologies; Space Future; 1997; <http://www.spacefuture.com/archive/a_fresh_look_at_space_solar_power_new_architectures_concepts_and_technologies.shtml>; retrieved 8 August 2011]

A number of innovative and advanced technologies were investigated by the "fresh look" study for each major aspect of an SSP system, including: the space segment, the ground segment, space infrastructure, and transportation.

Space Segment Conventional structures as were very innovative approaches, such as large gossamer structures. In addition to implementation of the space segment as a single, unitary system, constituting the systems or arrays from a number of independent sub-units were considered. Alternative configurations were examined, including conventional solar array/transmitter layouts with three-axis stabilization, and innovative configurations that exploit a gravity gradient approach.

A/T: MICROWAVE SAFETY

**THE MICROWAVE ENERGY WILL POST POSE A HEALTH RISK TO HUMANS-Logan ‘09**

[Dr. James; PhD and 18 year career at NASA; Safety of Space-Based Solar Power; Feb 2009; <http://www.spaceenergy.com/i/pdf/safety_paper.pdf;> retrieved 17 Jun 2011]

The biological effects and health implications of microwave radiation have been an intense subject of study for many years. We know that non‐ionizing radiation is not mutagenic. It does not increase the frequency of mutations in DNA, for example, above the natural background level. Instead of creating charged ions when passing through matter, non‐ionizing electromagnetic radiation has energy sufficient only for ‘excitation.’ Rather than removing an electron, the energy can only move an electron to a higher energy state; this results in local heating which is, to date, the only demonstrated biological effect of microwave exposure. Cumulative data from multiple scientific and medical studies have allowed the establishment of detailed microwave exposure limits for humans under a wide variety of exposure conditions.

**THE MICROWAVE POWER AT THE CENTER OF AN SBSP BEAM IS 3% OF A MICROWAVE OVEN-Logan ‘09**

[Dr. James; PhD and 18 year career at NASA; Safety of Space-Based Solar Power; Feb 2009; [http://www.spaceenergy.com/i/pdf/safety\_paper.pdf;](http://www.google.com/url?q=http%3A%2F%2Fwww.spaceenergy.com%2Fi%2Fpdf%2Fsafety_paper.pdf%3B&sa=D&sntz=1&usg=AFQjCNEmvGvbQnaCy7TsKATs3Jh_iyk3VA) retrieved 17 Jun 2011]

In a typical SBSP system, the beam transmitting the energy from space would be approximately 2 to 4 kilometers wide. The strength of the beam is highest in the center and rapidly decreases to very low levels at the periphery of the beam. The peak power density at the center of the beam at it intersects the rectenna is on the order of 300 watts per square meter (W/m2) or 30 miliwatts per square centimeter (mW/cm2).

To put 30 mW/cm2 in perspective, the energy generated inside a typical kitchen microwave oven is approximately 1000 mW/cm2. This means the power density at the center of an SBSP beam is only 3% as strong as a typical countertop microwave oven.

**THE MICROWAVE BEAM WILL HAVE NO IMPACT ON BIRDS OR BEES-Logan ‘09**

[Dr. James; PhD and 18 year career at NASA; Safety of Space-Based Solar Power; Feb 2009; [http://www.spaceenergy.com/i/pdf/safety\_paper.pdf;](http://www.google.com/url?q=http%3A%2F%2Fwww.spaceenergy.com%2Fi%2Fpdf%2Fsafety_paper.pdf%3B&sa=D&sntz=1&usg=AFQjCNEmvGvbQnaCy7TsKATs3Jh_iyk3VA) retrieved 17 Jun 2011]

[NOTE: Such peak power densities envisioned for SBSP could never even come close to ‘cooking’ birds in flight. Studies have shown that at 25 mW/cm2, some birds exhibit behaviors suggesting they might be able to detect microwave radiation. If true, some migratory birds, flying above the rectenna, might suffer disruption of their flying paths. At higher ambient temperatures, larger birds, having greater body mass and thus absorbing a relatively greater amount of microwave radiation, could tend to experience more heat stress than smaller ones. No doubt birds would learn to avoid areas of the sky associated with transient local heating. No evidence hasbeen found that continuous power densities from 1 to 50 mW/cm2 (at 2.45 GHz) have any biological effects on honeybees].

**ONLY SENSIBLE PRECAUTIONARY MEASURES WOULD BE NEEDED IN THE RECTENNA AREA-Logan ‘09**

[Dr. James; PhD and 18 year career at NASA; Safety of Space-Based Solar Power; Feb 2009; [http://www.spaceenergy.com/i/pdf/safety\_paper.pdf;](http://www.google.com/url?q=http%3A%2F%2Fwww.spaceenergy.com%2Fi%2Fpdf%2Fsafety_paper.pdf%3B&sa=D&sntz=1&usg=AFQjCNEmvGvbQnaCy7TsKATs3Jh_iyk3VA) retrieved 17 Jun 2011]

During normal operations microwave intensity in the area above the rectenna (and perhaps even around the rectenna in some circumstances) exceeds the human exposure standards documented in the previous section. Except for maintenance personnel, human exposure would normally not be permitted in these areas. However, in the case of occupationally required presence, the only protective measures required to reduce exposures to permissible levels are simple personal protective equipment such as glasses, gloves and reflective garments.

**INFRARED LASERS COULD ELIMINATE ANY OF THE CONCERNS ABOUT MICROWAVES-Edwards ‘10**

[Lin; European space company wants solar power plant in space; Physorg.com; 21 Jan 2010;

<http://www.physorg.com/news183278937.html;> retrieved 17 Jun 2011]

Earlier concepts of beaming power to Earth from space were criticized because they relied on microwaves to transmit the power to the ground, which has safety concerns, so Astrium plans to use infrared lasers instead, which means that even if they were misdirected people and objects hit by the laser beams could not be scorched.

The transmission of power via infrared laser has been tested in Astrium’s laboratories, and they are now concentrating on improving the system’s efficiency. Work on developing converters to convert received infrared energy to electricity is proceeding rapidly, and Astrium is collaborating in this work with scientists at the University of Surrey, in the UK. The company is hoping to achieve 80% efficiency in the conversion.

According to Astrium’s chief technology officer, Robert Laine, at present the power handled by the system is limited by the size of the laser that can be built. A demonstration mission would also be necessary to prove the system works, and this should be possible within the present decade.

**MICROWAVES POSE NO DANGER TO HUMANS OR ANIMALS-Bova ‘08**

[Ben; president emeritus of the National Space Society; An Energy Fix Written in the Stars; Washington Post; 12 Oct 2008]

Some people worry about beaming gigawatts of microwave energy to the ground. But the microwave beams would be spread over a wide area, so they wouldn't be intense enough to harm anyone. Birds could fly through the thinly spread beams without harm. Nevertheless, it would be best for the receiving stations to be set up in unpopulated areas. The deserts of the American Southwest would be an ideal location. You could gain votes in Arizona, New Mexico, Nevada and California!

**THERE ARE NO PUBLIC HEALTH OR ENVIRONMENTAL CONCERNS ABOUT MICROWAVE TECH-Betancourt ‘10**

[Kiantar; JD student, University of Maryland; Legal Challenges Facing Solar Power Satellites; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/betancourt.html;> retrieved 24 Jun 2011]

Public health and safety issues with microwave use have been examined extensively. Microwaves used in space solar power have no ionizing effect and there is no danger of cancer or genetic alterations due to microwave radiation.[16] The potential danger of microwaves, like energy from the sun and from artificially light sources, relates directly to the energy’s density in a given area. The design of SBSP systems calls for power densities well within safe limits at the planet’s surface. For example, the average power density of the sun’s rays is about 100 mW/cm2 while the design maximum of satellite solar power systems is 25 mW/cm2 on the planet’s surface.[17] Even high flying birds would still remain well within safe limits.[18] Scientist should still plan further safety studies, a necessary precaution for technology on this scale.

A/T: INTERNATIONAL OBJECTIONS/CPLAN

**THERE ARE NO NATIONAL OR INTERNATIONAL LAWS THAT BLOCK THE SBSP-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf;)]

The SBSP Study Group found that no outright policy or legal showstoppers exist to prevent the development of SBSP. Full‐scale SBSP, however, will require a permissive international regime, and construction of this new regime is in every way a challenge nearly equal to the construction of the satellite itself.

The interim review did not uncover any hard show‐stoppers in the international legal or regulatory regime. Many nations are actively studying Space‐Based Solar Power. Canada, the UK, France, the European Space Agency, Japan, Russia, India, and China, as well as several equatorial nations have all expressed past or present interest in SBSP. International conferences such as the United Nations‐connected UNISPACE III are continually held on the subject and there is even a UN‐affiliated non‐governmental organization, the Sunsat Energy Council, that is dedicated to promoting the study and development of SBSP. The International Union of Radio Science (URSI) has published at least one document supporting the concept, and a study of the subject by the International Telecommunications Union (ITU) is presently ongoing.

**THE US IS A LOGICAL LEADER FOR INTERNATIONAL JOINT EFFORTS TO DEVELOP SBSP-Hsu ‘10**

[Feng; Sr. Vice President Systems Engineering & Risk Management, Space Energy Group; Harnessing the Sun: Embarking on Humanity's Next Giant Leap; Online Journal of Space Communication; Winter 2010; [http://spacejournal.ohio.edu/issue16/hsu.html; re](http://spacejournal.ohio.edu/issue16/hsu.html;r)trieved 23 Jun 2011]

It is imperative that a multi-governmental organization or entity be put in place. For the U.S. - or any single nation - to implement a full-scale SPS project alone will be extremely difficult, if not inconceivable, due to the many political, regulatory and technological reasons stated. However, it is equally important that there be a lead nation providing the necessary leadership in such a complex and interdependent international effort. The various project elements involving multiple government and industry partnerships must be clearly defined. The United States is a logical leader in this area because of the breadth of its technology infrastructure and capability, as well as the magnitude of financial resources available in its industry and financial community. Building, launching and operating a system of Solar Power Satellites in space orbit is going to be a technology and engineering endeavor requiring great human effort and ingenuity. If we can go to the Moon and achieve the splitting of atoms, we can also overcome the inefficiency problems of solar-electric conversion, and we can achieve affordable access to space. We can make Solar Power Satellites a cost competitive source of energy for all of humanity.

**SBSP WILL PROVIDE A REASON FOR ALL NATIONS TO PROTECT THE NATURAL RESOURCE OF SPACE-Medin ‘10**

[Kristin; Chief Industrial Designer, NewSpace DesignLabs; Disruptive Technology: A Space-Based Solar Power Industry Forecast; The Next Generation Of COMSATS; Online Journal of Space Communication; Winter 2010; <http://spacejournal.ohio.edu/issue16/medin.html;> retrieved 24 Jun 2011]

Another, less often considered, benefit is that solar power satellites give all nations reasons to protect space as a natural resource for the benefit of all mankind. Space Law is in itself a future career path. As national economies become more space-bound, there will be a need for further resolution and definition of space peace treaties, such as the Commercial Space Act initiated by the United States in 1998, and laws governing the peaceful use of space for commercial development.

**AMERICAN LEADERSHIP CAN LEAD TO GLOBAL ENERGY AND CLIMATE SOLUTIONS-Rouge, et al ‘07**

[Joseph; Acting Director, National Security Space Office; *Space‐Based Solar Power*

*As an Opportunity for Strategic Security*; 10 2007; retrieved 24 Jun 2011; [http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf]](http://www.nss.org/settlement/ssp/library/final-sbsp-interim-assessment-release-01.pdf%5D)

If the United States is interested in energy, sustainable development, climate change, and the peaceful use of space, the international community is even hungrier for solutions to these issues. While the US may be able to afford increased energy prices, the very availability and stability of energy is a threat to other countries’ internal stability and ability for development. SBSP offers a way to bypass much terrestrial electrical distribution infrastructure investment and to purchase energy from a reliable source at receiver stations that can be built by available domestic labor pools without significant adverse environmental effects, including greenhouse gas emissions.

A/T: SBSP AS A WEAPON

**SBSP BEAMS COULD NEVER BE USED AS WEAPONS-Logan ‘09**

[Dr. James; PhD and 18 year career at NASA; Safety of Space-Based Solar Power; Feb 2009; [http://www.spaceenergy.com/i/pdf/safety\_paper.pdf;](http://www.google.com/url?q=http%3A%2F%2Fwww.spaceenergy.com%2Fi%2Fpdf%2Fsafety_paper.pdf%3B&sa=D&sntz=1&usg=AFQjCNEmvGvbQnaCy7TsKATs3Jh_iyk3VA) retrieved 17 Jun 2011]

[NOTE: Microwave beams associated with SBSP operations could never be used as weapons. Microwave weapons, if they are ever developed, will use very high‐power pulses at short ranges. Their design is quite different from that projected for SBSP].

Space Debris Affirmative

**Note:** *There are two files you may find useful if you decide to use this Affirmative. Extensions for the space exploration advantage can be found in the Helium-3 Affirmative and additional space debris scenarios—hegemony and economy—are located in the Space Debris Disadvantage in the Copernicus Negative Positions book. This Affirmative is currently written as a traditional Inh-Harms-Solvency Aff, but would be quite easy to modify.*

**Observation 1. THERE IS NO COORDINATED WILL TO SOLVE SPACE DEBRIS IN THE STATUS QUO**

**A. NO ONE IS ACTING TO CONTROL DEBRIS NOW-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

In regards to space operations, while improvement of space situational awareness (SSA) is a major focus for debris tracking, it may not be needed for remediation purposes. Dr. Johnson stated that debris tracking itself is not necessarily a prerequisite for debris elimination, noting that the U.S. Space Catalog is “reasonably complete” at 10 centimeters (viewing debris 10 centimeters in diameter and larger).103 Conversations with Dr. Johnson also elicited a wealth of information about the current state of international governance.104 “National governments do not yet see a need to put money into debris removal,” he stated. “There is no commercial application yet…. Who is going to pay for [it]? Where will the money come from?”105 Calling UN adoption of IADC debris mitigation guidelines a “tremendous success,” Johnson explained its sphere of influence. “The space community has to adhere…by means of simple peer pressure.”

**Observation 2. HARMS**

**A. THE AMOUNT OF DEBRIS IS BUILDING TO A CRITICAL MASS, AFTER WHICH DEBRIS WILL CASCADE, CRIPPLING OUR MILITARY SPACE SYSTEMS AND COMMERCIAL SATELLITES-Doctorow ‘11**

[Cory; staff writer; Space debris to go critical, reduce all satellites to junk?; BoingBoing; 11 May 2011; <http://boingboing.net/2011/05/11/space-debris-to-go-c.html;> retrieved 16 Jun 2011]

The amount of debris in the orbits used by our communications and weather satellites is building toward critical mass, a point of no return in which debris starts to smash into active satellites, turning them into more debris that smashes more sats, and so on. There's no cost-effective solution to the space-junk problem and none are on the horizon. Marshall Kaplan (Johns Hopkins Space Department) believes that it's inevitable that all the satellites in use will be percussively decommissioned and their orbits will be unusable. He speculates that we'll replace them with lower orbit satellite constellations that relay to one another in order to achieve the coverage attained by today's high-orbit sats. Here's Gen. William Shelton, commander of USAF Space Command:

The traffic is increasing. We've now got over 50 nations that are participants in the space environment," Shelton said last month during the Space Foundation's 27th National Space Symposium. Given existing space situational awareness capabilities, over 20,000 objects are now tracked.

"We catalog those routinely and keep track of them. That number is projected to triple by 2030, and much of that is improved sensors, but some of that is increased traffic," Shelton said. "Then if you think about it, there are probably 10 times more objects in space than we're able to track with our sensor capability today. Those objects are untrackable ... yet they are lethal to our space systems -- to military space systems, civil space systems, commercial -- no one's immune from the threats that are on orbit today, just due to the traffic in space."

**B. TOO MUCH SPACE DEBRIS COULD LEAD TO A CHAIN REACTION OF COLLISIONS, CREATING A BELT OF DEBRIS AROUND THE EARTH-Schwartz ‘10**

[Evan; The Looming Space Junk Crisis: It’s Time to Take Out the Trash; Wired; 24 May 2010; <http://www.wired.com/magazine/tag/kessler-syndrome/;> retrieved 16 Jun 2011]

On clear winter nights, when the trees are bare, Donald Kessler likes to set up a small telescope on the back deck of his house in Asheville, North Carolina, and zoom in on the stars shining over the Blue Ridge Mountains. It’s not the most advanced home observatory, but the retired NASA scientist treasures his Celestron telescope, which was made in 1978. That also happens to be the year Kessler published the paper that made his reputation in aerospace circles. Assigned to the Environmental Effects Project Office at NASA’s Johnson Space Center in Houston, the astrophysicist had gotten interested in the junk that humans were abandoning in the wild black yonder—everything from nuts and tools to defunct satellites and rocket stages the size of school buses.

In that seminal paper, “Collision Frequency of Artificial Satellites: The Creation of a Debris Belt,” Kessler painted a nightmare scenario: Spent satellites and other space trash would accumulate until crashes became inevitable. Colliding objects would shatter into countless equally dangerous fragments, setting off a chain reaction of additional crashes. “The result would be an exponential increase in the number of objects with time,” he wrote, “creating a belt of debris around the Earth.”

At age 38, Kessler had found his calling. Not that his bosses had encouraged him to look into the issue—”they didn’t like what I was finding,” he recalls. But after the paper came out, NASA set up the Orbital Debris Program Office to study the problem and put Kessler in charge. He spent the rest of his career tracking cosmic crap and forming alliances with counterparts in other nations in an effort to slow its proliferation. His description of a runaway cascade of collisions—which he predicted would happen in 30 to 40 years—became known as the Kessler syndrome.

**C. FAILURE TO CONTROL SPACE DEBRIS IN THE NEXT DECADE WILL LEAD TO UNCONTROLLABLE CASCADE-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

NASA scientists have warned about the threat of the cascade effect since the late 1970s.60 In the decades since, experts have worried that collisions caused by the cascade effect ““would expand for centuries, spreading chaos through the heavens””61 and multiplying space ““debris to levels threatening sustainable space access.””62 ““Today, next year or next decade, some piece of whirling debris will start the cascade, experts say.””63 According to Nicholas L. Johnson, NASA’’s chief scientist for orbital debris, the cascade is now “inevitable”” unless something is done to remove the debris.64 Experts believe that if nothing is done to address the space debris problem, the amount of orbiting space debris greater than ten centimeters in size will increase to over 50,000 objects in the next fifty years. Considering that the number of objects in orbit has increased drastically since the beginning of 2007, the problem is, unfortunately, only worsening.

**D. SPACE DEBRIS POSES A CRITICAL THREAT TO AMERICAN NATIONAL SECURITY-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

These gloomy prognostications about the threats to our space environment should be troubling to Americans. The United States relies on the unhindered use of outer space for national security.151

According to a space commission led by former Secretary of Defense Donald Rumsfeld, ““[t]he [United States] is more dependent on space than any other nation.””152 According to Robert G. Joseph, former

Undersecretary for Arms Control and International Security at the State Department, ““space capabilities are vital to our national security and to our economic well-being.””153 Therefore, a catastrophic collision between space debris and the satellites on which that national security so heavily depends poses a very real and current threat to the national security interests of the United States.

**Plan: The USFG will develop and use a laser debris removal system.**

**Observation 3. Solvency**

**A. WE DON’T NEED TO REMOVE ALL DEBRIS; FOCUSING ON THE MOST CRITICAL PIECES WILL OFFER MUCH MORE SAFETY-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

A recent NASA study that simulated active debris removal over the next 200 years showed that certain pieces of space debris are more dangerous than others, in that they are more likely to cause debris-creating collisions (Liou and Johnson 2007). These more dangerous objects have masses of 1,000 to 1,500 kilograms and 2,500 to 3,000 kilograms; orbital inclina­tions of 70 to 75, 80 to 85, and 95 to 100 degrees; and orbital altitudes of 800 to 850, 950 to 1,000, and 1,450 to 1,500 kilometers. The study found that annually removing as few as five of these objects will significantly stabilize the future space debris environment (Liou and Johnson 2007, 3).

These results suggest that the threat posed by space debris could be significantly reduced by annually removing several large pieces from criti­cal orbits. This would make effective space debris removal much more straightforward and potentially manageable by one nation or a small group of nations. In other words, the countries responsible for the majority of the current space debris population—China, Russia, and the United States­ not only should take responsibility, but also now can take responsibility. Efforts to develop removal systems should begin immediately.

**B. A DEBRIS REMOVAL DEMONSTRATION IS CRITICAL FOR RESEARCH AND PRACTICAL APPLICATIONS-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

United States space policies have evolved to a formal recognition of the debris problem through the creation of national space debris mitigation guidelines. Although decades of research have given policymakers multiple options for debris remediation, the research remains untested. A debris removal demonstration is needed and should be domestically proposed and international in scope. Signaling the serious nature of the problem through global outreach, such a demonstration would enable the scientific community to move beyond theoretical debris removal techniques to practical applications. A conduit for funding of applied research would then be opened, with an exercise of actual debris removal as the next logical step toward enhanced science and policy.

**C. LASERS ARE A TECHNOLOGICALLY MATURE, SCALABLE SOLUTION TO THE DEBRIS PROBLEM-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

If improved accuracy catalogs or tracking data become available then it is feasible that the system could engage thousands of (non-high impact) objects per year, or conversely that up to hundreds of high impact objects could be shielded by one facility per year. This is an order of magnitude more objects than one needs to remove in order to stabilize the growth (Liou & Johnson, 2009). Preventing collisions on such a large scale would therefore likely reduce the rate of debris generation such that the rate of debris reentry dominates and the Kessler syndrome is reversed. Continued operation over a period similar to the decay timescale from the orbital regions in question (typically decades) could thus reverse the problem. Additionally, scaling such a system (eg. multiple facilities) on the ground would be low cost (relative to space missions) and can be done with currently mature technology, making it a good near term solution. Further, if the current analysis proves optimistic, raising the power to 10kW and having 3-4 such facilities would increase the number of conjunctions that it is possible to mitigate by a further order of magnitude, and also would raise the maximummass and reduce the minimum A=M threshold for the system.

**D. IT IS CRITICAL TO ACT NOW TO REMOVE DEBRIS, BEFORE THE PROBLEM BECOMES INSURMOUNTABLE-David ‘10**

[Leonard; Space Columnist; A Real Mess in Orbit: Space Junk to Hang Around Longer Than Expected; Space.com; 03 Aug 2010; retrieved 11 Jul 2011; [http://www.space.com/8875-real-mess-orbit-space-junk-hang-longer-expected.html]](http://www.space.com/8875-real-mess-orbit-space-junk-hang-longer-expected.html%5D)

"The key point is that when we start removing large objects, it will take a lot of time and a lot of removals to prevent a few collisions ? or else we will have to come up with a better means to pick them," said Darren McKnight, technical director at Integrity Applications Incorporated in Chantilly, Va.

"Unfortunately, once the hazard is unacceptable and the impetus is created for action, it will likely take years for the active debris removal systems to be developed, tested and proven operationally effective," McKnight told SPACE.com. "In addition, it will take even longer for the associated incentive, regulatory, and policy formulations to evolve."

In McKnight's view, debris removal is a "Pay me now or pay me more later" proposition.

"That is where we are right now. There is insufficient hazard for an individual operator to perform debris removal, based on the hazard to an individual satellite. But the overall environmental stability is clearly at a state where continued lack of action will make the problem harder and more expensive to deal with at some point," McKnight said.

**E. REMOVING FIVE LARGE OBJECTS A YEAR WILL STABILIZE THE ENVIRONMENT-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

In addition to the UN COPUOS's debris mitigation guidelines, collision avoidance (COLA) and active debris removal (ADR) have been presented as necessary steps to curb the runaway growth of debris in the most congested orbital regimes such as low-Earth sun synchronous orbit (Liou & Johnson, 2009). While active spacecraft COLA does provide some reduction in the growth of debris, alone it is insufficient to offset the debris-debris collisions growth component (Liou, 2011). Liou & Johnson (2009) have suggested that stabilizing the LEO environment at current levels would require the ongoing removal of at least 5 large debris objects per year going forward (in addition to a 90% implementation of the post mission disposal guidelines).

**F. THE UNITED STATES IS THE IDEAL NATION TO TAKE THE LEAD-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

There are several reasons why the United States should take this leader­ship role, rather than China or Russia. First and foremost, the United States would be hardest hit by the loss of satellites services. It owns about half of the roughly 800 operating satellites in orbit and its military is significantly more dependent upon them than any other entity (Moore 2008). For example, GPS precision-guided munitions are a key component of the “new American way of war” (Dolman 2006, 163-165), which allows the United States to remain a globally dominant military power while also waging war in accordance with its political and ethical values by enabling faster, less costly war fighting with minimal collateral damage (Sheldon 2005). The U.S. Department of Defense recognized the need to protect U.S. satellite systems over ten years ago when it stated in its 1999 Space Policy that, “the ability to access and utilize space is a vital national inter­est because many of the activities conducted in the medium are critical to U.S. national security and economic well-being” (U.S. Department of Defense 1999, 6). Clearly, the United States has a vested interest in keep­ing the near-Earth space environment free from threats like space debris and thus assuring U.S. access to space.

**Advantage 1: Space Exploration**

**A. FAILURE TO CONTROL DEBRIS WILL LEAD TO A CASCADING SERIES OF COLLISIONS THAT WILL MAKE SPACE TRAVEL A THING OF THE PAST, ENDING DREAMS OF SPACE COLONIZATION-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

The ““cascade effect”” is ““the greatest fear of those who study the problem of orbital debris.””50 Even before the February 2009 satellite collision, many scientists agreed ““that the number of objects in orbit had surpassed a critical mass,””51 the point at which ““orbital debris would collide with other space objects, which in turn would create new debris that would cause [a chain reaction of] even more collisions.””52 This ““chain reaction”” is often referred to as the cascade effect.

Some experts believe that once space debris collisions begin, they will be impossible to stop.54 The fear is that these cascading ““collisions will eventually produce an impenetrable cloud of

fragmentation debris that will encase Earth[, making] space travel . . . ‘‘a thing of the past’’ and . . . obstruct[ing] our dream of colonizing outer space.””55 Experts warn that if the cascade effect

occurs, space will be unusable for centuries due to the time it will take for all of the debris to eventually disintegrate in Earth’’s atmosphere.

**B. INCLUDE SPACE EXPLORATION IMPACT FROM HE-3 CASE HERE**

INHERENCY

**THERE IS NO EXISTING INTERNATIONAL LAW OR CONSENSUS ABOUT DEBRIS-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

The devastating consequences described in the previous Part could be avoided through the implementation of a binding international agreement on space debris. Such an agreement must

require, among other things, that countries make efforts to rid the space environment of the debris that they produce. The agreement must also require countries to create cost-effective methods to solve the current space debris problem, rather than simply mitigating future additions to the problem. To explain the necessity of such an agreement, however, it is important to first discuss why current international law on this issue is insufficient to address the monumental space debris predicament. Simply put, ““there is no legal concept of ‘‘space debris’’ under international space law and thus no mechanisms to regulate it.””173 The discussion centers around how space, and subsequently space debris, is defined.

**THE SENATE IS UNLIKELY TO PASS AN INTERNATIONAL AGREEMENT BUT FOR THE SAKE OF AMERICAN SECURITY IT MUST-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

Without question, any treaty creating an international space debris fund will be difficult to get through the Senate’’s advice and consent process,340 especially in the current global financial crisis. The space debris problem, however, has placed America at a crossroads regarding the future security of space. Some experts predict the inevitability of the cascade effect if space debris is not removed, and others predict that space debris may cause the start of World War III.341 As a result, the path that the United States chooses next may determine its future security.342

**INACTION ON DEBRIS IS CAUSING GREATER THREAT OF IMPACT-Deccan Herald ‘10**

[Threat of Space debris looms large; Deccan Herald; 30 October 2010; <http://www.deccanherald.com/content/109092/threat-space-debris-looms-large.html>; retrieved 9 August 2011]

But why should we be worried about debris floating in the space? When an explosion occurs, the debris move together but over a period of time they begin to spread in the orbit, form a ring and become a natural background noise around the Earth.

Prof Adimurthy said that sometimes the debris may fall on the Earth causing loss of life and property. Till now, around 100 huge objects have been collected from the Earth, which have however not caused any damages.

On the long-term effects of Space debris he said "Research by scientists predict that inaction about disposing of the Space debris would lead to a cascading effect. However, it is a very expensive proposition."

HARMS: DEBRIS PROBLEM IS GROWING

**THE AMOUNT OF DEBRIS SURROUNDING THE EARTH IS GROWING DRAMATICALLY EACH YEAR-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

From 2004 to 2010, the annual growth rate of tracked debris increased every year except 2008.68 At the beginning of 2010, Earth’’s orbit held 2,347 more space debris objects measuring more than ten

centimeters in size than it held at the beginning of 2009, a 15.6 percent increase.69 The greatest annual increase in space debris to date occurred in 2007.70 At the beginning of 2008, Earth’’s orbit held 2,507 more space debris objects measuring more than ten centimeters than it held at the start of 2007.71 This marked a 20.12 percent increase in the space debris population in just one year.72 A large portion of this increase is attributable to China and Russia, as discussed in the following subparts.

**AGGRESSIVE SPACE ACTIVITIES WITHOUT DEBRIS SAFEGUARDS WILL MAKE COLLISIONS FAR MORE FREQUENT-Kessler ‘09**

[Donald; PhD, 30 year researcher about orbital debris at NASA; 08 Mar 2009; [http://webpages.charter.net/dkessler/files/KesSym.html;](http://www.google.com/url?q=http%3A%2F%2Fwebpages.charter.net%2Fdkessler%2Ffiles%2FKesSym.html%3B&sa=D&sntz=1&usg=AFQjCNF6jZmFYJBoiqla5QFcdsOX0iorKw) retrieved 16 Jun 2011]

Aggressive space activities without adequate safeguards could significantly shorten the time between collisions and produce an intolerable hazard to future spacecraft. Some of the most environmentally dangerous activities in space include large constellations such as those initially proposed by the Strategic Defense Initiative in the mid-1980s, large structures such as those considered in the late-1970s for building solar power stations in Earth orbit, and anti-satellite warfare using systems tested by the USSR, the U.S., and China over the past 30 years. Such aggressive activities could set up a situation where a single satellite failure could lead to cascading failures of many satellites in a period of time much shorter than years.

As is true for many environmental problems, the control of the orbital debris environment may initially be expensive, but failure to control leads to disaster in the long-term. Catastrophic collisions between catalogued objects in low Earth orbit are now an important environmental issue that will dominate the debris hazard to future spacecraft.

**SPACEFARING NATIONS MUST ACCEPT THE INEVITABILITY OF MORE COLLISIONS IF NO EFFORT IS MADE TO CONTROL DEBRIS-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

Space debris threatens valuable space-based assets essential to communications, global commerce, and national defense. Debris in lower earth orbit poses the greatest immediate threat to these assets and was the primary focus of this project.

Policy is a critical consideration when introducing debris elimination technology into the space environment. Space-faring countries and commercial interests must acknowledge the inevitability of more numerous collisions and damage. If space debris continues to increase, the threat to space-based technology increases exponentially. Approval of space debris mitigation guidelines is a positive contribution to debris mitigation and prevention. In the short term, there is a need to clarify space terminology, define transfer-of-ownership guidelines, and create a registration timeframe to enhance the current body of space law.

HARMS: SPACE EXPLORATION ALREADY BEING HURT

**THE VAST AMOUNT OF SPACE DEBRIS IS ALREADY HINDERING AMERICAN SPACE EFFORTS-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

This orbital junkyard is already hindering our utilization of outer space. In recent years, the vast amount of space debris has affected space launch schedules and caused in-space collision avoidance

maneuvering. On March 12, 2009, the near collision of space debris with the International Space Station (ISS) caused the ISS crew to temporarily evacuate into a Russian escape capsule

docked with the station.28 This was the second time in less than a year that space debris threatened the ISS,29 and it highlighted a list of nine 2009 space debris collision-avoidance maneuvers by satellites under NASA’’s control.30 Since February 2009, over thirty-two collision-avoidance maneuvers have been reported, including one by China.31 Concerns with space debris also threatened a space shuttle launch in fall 2008, as NASA warned that the risk of a catastrophic

collision between space debris and the shuttle exceeded the norm.32 Earlier that year, in order to ensure that an Atlas V rocket carrying a secret payload into space did not collide with space debris, the United States was forced to delay the rocket’’s launch for two weeks.33 Additionally, in 2005, a spacecraft that is a major part of NASA’’s Earth Observing System successfully performed a small collision avoidance maneuver to ensure that it did not collide with space debris.

**SPACE DEBRIS ACCOUNTS FOR HALF OF THE CATASTROPHIC RISK ON ANY SPACE FLIGHT-Kelly ‘05**

[John; Debris is Shuttle’s Biggest Threat; Space.com; 05 Mar 2005; <http://www.space.com/792-debris-shuttle-biggest-threat.html;> retrieved 16 Jun 2011]

Tiny rocks, paint flecks and other fragments of junk whizzing around the Earth pose the greatest threat to the shuttles and the astronauts on board, according to the preliminary results of a new NASA risk study.

Engineers and scientists long have known the stuff pounding the shuttle as it flies through space can do catastrophic damage. Until now, few put space debris on the same level as the dangers seen during the shuttle's treacherous launch or its fiery plunge back through the atmosphere to land.

The internal risk assessment, still under review by the agency's experts, says space debris hitting different parts of the orbiter accounts for 11 of the 20 problems most likely to cause the loss of another shuttle and crew. Overall, space debris accounts for half of the catastrophic risk on any flight.

**SPACE DEBRIS POSED A CRITICAL THREAT TO THE SAFETY OF THE SHUTTLE-Kelly ‘05**

[John; Debris is Shuttle’s Biggest Threat; Space.com; 05 Mar 2005; [http://www.space.com/792-debris-shuttle-biggest-threat.html;](http://www.google.com/url?q=http%3A%2F%2Fwww.space.com%2F792-debris-shuttle-biggest-threat.html%3B&sa=D&sntz=1&usg=AFQjCNGA_9-kIZGrUvzNwipXSM6w2_4DaA) retrieved 16 Jun 2011]

The 2003 shuttle risk assessment is the first to incorporate the threat from orbital debris. The results: the likelihood of space junk bringing down the shuttle is far greater than widely feared failures of the powerful main engines, explosive solid rocket boosters or brittle heat-shield components.The new assessment indicates about half of the risk of disaster on any given shuttle mission involves space debris hitting the orbiter and, consequently, damaging some component needed to keep the crew alive in space or safely return them to the Earth.

Past risk assessments attributed most risk to thousands of possible mishaps during the first nine minutes of a flight: the fraction of time it takes to go from a standstill on the launch pad to the 20,000-plus mph necessary to escape the grip of Earth's gravity.

This study says space debris hits on different spots on the wing flaps are the two most likely catastrophic failures. Damage could render an elevon, or wing flap, unable to steer and slow the orbiter as it plummets through the atmosphere. Without them, the orbiter could burn up, rip apart or veer far off the planned landing course. Ten other space debris failure modes involve space junk damaging the heat shield.

**ORBITAL DEBRIS POSES A BIGGER THREAT TO SPACE SAFETY THAN LIFTOFF OR LANDING-Michaels ‘09**

[Daniel; staff writer; A Cosmic Question: How to Get Rid Of All That Orbiting Space Junk; Wall Street Journal; 11 March 2009; <http://online.wsj.com/article/SB123672891900989069.html;> retrieved 16 Jun 2011]

In the 1980s, Jim Hollopeter helped design rockets that shot into orbit. Today, some of those launchers are still cluttering up space, and he wants to wash them away with a rocket-powered water gun.

Like many aerospace engineers, Mr. Hollopeter is worried about thousands of pieces of useless equipment circling Earth. Bits of spent rocket boosters, old exploded satellites and tools dropped by space-walking astronauts are just some of the trash racing along in the near-vacuum of space.

The volume of man-made space debris has grown so large that scientists say garbage now poses a bigger safety threat to the U.S. space shuttle than an accident on liftoff or landing. The International Space Station occasionally fires thrusters to dodge junk.

**DEBRIS COULD MAKE SPACE TO DANGEROUS TO FLY IN-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk With Lasers; Wired; 15 Mar 2011; <http://www.wired.com/wiredscience/2011/03/lasering-space-junk/#more-54167;> retrieved 16 Jun 2011]

The growing cloud of space junk surrounding the Earth is a hazard to spaceflight, and will only get worse as large pieces of debris collide and fragment. NASA space scientists have hit on a new way to manage the mess: Use mid-powered lasers to nudge space junk off collision courses.

The U.S. military currently tracks about 20,000 pieces of junk in low-Earth orbit, most of which are discarded bits of spacecraft or debris from collisions in orbit.

The atmosphere naturally drags a portion of this refuse down to Earth every year. But in 1978, NASA astronomer Don Kessler predicted a doomsday scenario: As collisions drive up the debris, we’ll hit a point where the amount of trash is growing faster than it can fall out of the sky. The Earth will end up with a permanent junk belt that could make space too dangerous to fly in, a situation now called “Kessler syndrome.”

**EVEN THE TINIEST FRAGMENTS OF SPACE DEBRIS CAN BE LETHAL-Kelly ‘05**

[John; Debris is Shuttle’s Biggest Threat; Space.com; 05 Mar 2005;<http://www.space.com/792-debris-shuttle-biggest-threat.html;> retrieved 16 Jun 2011]

The U.S. military tracks about 9,000 big pieces of debris orbiting the Earth. Small pieces, such as micrometeorites or paint specks chipped off old rocket segments or satellites, can't be seen. The shuttle and the debris are zipping around the Earth as fast as six miles per second, making collisions with even the tiniest fragments potentially lethal.

The Air Force warns Houston's mission control if something big is headed at the orbiter. That gives a shuttle commander time to maneuver out of the way.

Smaller debris regularly hits the orbiter. Something half the size of what the military tracks can punch a hole in the hull or the heat shield. Pieces far smaller -- say, the size of a dime -- can chip or crack windows or, worse, rip through a spacewalking astronaut's spacesuit.

**THE KESSLER SYNDROME IS ALREADY IN EFFECT IN CERTAIN ORBITS-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

The threat of catastrophic or debilitating collisions between active spacecraft and orbital debris is gaining increased attention as prescient predictions of population evolution are confirmed. Early satellite environment distribution models showed the potential for a runaway Kessler

syndrome" of cascading collisions, where the rate of debris creation through debris-debris collisions would exceed the ambient decay rate and would lead to the formation of debris belts (Kessler & Cour-Palais, 1978). Recorded collisions events (including the January 2009 Iridium 33/Cosmos 2251 collision) and additional environmental modeling have rearmed the instability in the LEO debris population. The latter has found that the Kessler syndrome is probably already in effect in certain orbits, even when the models use the extremely conservative assumption of no new launches (Liou & Johnson, 2008, 2009).

**HIGH SPEED OF DEBRIS MEANS IT CAN DISABLE SATELLITES AND SPACECRAFT-Lovegren ‘06**

[Stefan; Space Junk Cleanup Needed, NASA Experts Warn; National Geographic; 19 Jan 2006;

[http://news.nationalgeographic.com/news/2006/01/0119\_060119\_space\_junk.html;](http://www.google.com/url?q=http%3A%2F%2Fnews.nationalgeographic.com%2Fnews%2F2006%2F01%2F0119_060119_space_junk.html%3B&sa=D&sntz=1&usg=AFQjCNHoS6_Y6HhdN_c7WQkbsNwfuwokbg) retrieved 11 Jun 2011]

In addition, there are hundreds of thousands of smaller objects in space. These include everything from pieces of plastic to flecks of paint.

Much of this smaller junk has come from exploding rocket stages. Stages are sections of a rocket that have their own fuel or engines.

These objects travel at speeds over 22,000 miles an hour (35,000 kilometers an hour). At such high velocity, even small junk can rip holes in a spacecraft or disable a satellite by causing electrical shorts that result from clouds of superheated gas.

Three accidental collisions between catalogued space-junk objects larger than four inches (ten centimeters) have been documented from late 1991 to early 2005.

HARMS: LONG-TERM USE OF SPACE

**TO PRESERVE THE LONG-TERM USE OF SPACE, IT’S CRITICAL TO CONTROL THE DEBRIS PROBLEM-Wright ‘07**

[David; PhD; co-director of the Global Security Program; Space debris from antisatellite weapons; Bulletin of the Atomic Scientists; 01 Oct 2007; [http://www.thebulletin.org/web-edition/features/space-debris-antisatellite-weapons;](http://www.google.com/url?q=http%3A%2F%2Fwww.thebulletin.org%2Fweb-edition%2Ffeatures%2Fspace-debris-antisatellite-weapons%3B&sa=D&sntz=1&usg=AFQjCNG2FfWLPrnSOJs9TBkM-CK8ylYUlg) retrieved 16 Jun 2011]

To preserve the long-term use of space, it's particularly important to address how to control the production of orbital debris. Due to their high speed in orbit, even small pieces of orbiting debris can damage or destroy a satellite. Since debris at high altitude can remain in orbit for decades or longer, it accumulates as more is produced, expanding the risk of collisions with satellites. If the amount of debris at some altitudes becomes large enough, it could become difficult to use those regions for satellites. Currently, there isn't an effective way to remove large amounts of debris from orbit; as a result, controlling the production of debris is essential for preserving the long-term use of space.

There are two main sources of orbital debris: (1) The accidental breakup of objects placed in orbit by routine activity; and (2) the creation of debris by the testing or use of destructive antisatellite (ASAT) weapons.

The international community is addressing the first issue by developing debris mitigation guidelines. The United States wrote and released its own guidelines in 1997, which call for measures such as designing satellites and rocket stages to limit the release of debris when placing satellites in orbit and depleting propellant from nonoperational satellites or stages to reduce the risk of explosions. By calling for spent stages and satellites to be removed from orbit, the guidelines also attempt to control the number of large objects in space that could break up due to collisions.

**FAILURE TO CONTROL DEBRIS PROBLEM WILL MAKE SPACE TOO TRASHED FOR ANY MORE LAUNCHES-Williams ‘10**

[Lynda; Physics Instructor, Santa Rosa Junior College;Irrational Dreams of Space Colonization; Peace Review, A Journal of Social Justice; Spring 2010]

Since the space race began 50 years ago with the launch of Sputnik, the space environment around Earth has become overcrowded with satellites and space debris, so much so, that circumterrestrial space has become a dangerous place with an increasing risk of collision and destruction. Thousands of pieces of space junk created from launches orbit the Earth in the same orbit as satellites, putting them at risk of collision. Every time a rocket is launched, debris from the rocket stages are put into orbital space. In 2009 there was a disastrous collision between an Iridium satellite and a piece of space junk that destroyed the satellite. In 2007 China blew up one of its defunct satellites to demonstrate its antiballistic missile capabilities, increasing the debris field by 15%. There are no

international laws prohibiting anti-satellite actions. Every year, since the mid 1980s, a treaty has been introduced into the UN for a Prevention of an Arms Race in Outer Space (PAROS), with all parties including Russia and China voting for it except for the US.

How can we hope to pursue a peaceful and environmentally sound route of space exploration without international laws in place that protect space and Earth environments and guarantee that the space race to the moon and beyond does not foster a war over space resources? Indeed, if the space debris problem continues to grow unfettered or if there is war in space, space will become too trashed for launches to take place without risk of destruction.

HARMS: FAILURE TO ACT NOW WILL LEAD TO CASCADE

**FAILURE TO CONTROL SPACE DEBRIS IN THE NEXT DECADE WILL LEAD TO CASCADE-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

If space debris is not immediately countered by preventative and removal measures, the cascade effect could occur in little more than a decade.57 In February 2008, Dr. Geoffrey Forden, a Massachusetts Institute of Technology physicist and space programs expert, stated that the United States is ““in danger of a runaway escalation of space debris.””58 He argued that the danger of a cascade effect is a greater threat to U.S. space assets than the threat of anti-satellite (ASAT) weapons.

**FAILURE TO CONTROL THE DEBRIS PROBLEM WILL MAKE THE CASCADE EFFECT INEVITABLE, THREATENING SPACE EXPLORATION AND SATELLITES-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

The drastic additions to the space debris environment caused Nicholas Johnson, one of the two NASA scientists involved in the 2006 modeling, to predict the inevitability of the cascade effect.146

Other scientific experts agree with Johnson and say that the cascade effect will start sooner than predicted in the 2006 modeling.147 In short, scientists currently say that the space debris issue is now ““a very big problem.””148 A report to the United Nations in October 2008——before the 2009 satellite collision——added to the ominous feeling, stating that the unhindered increase in space debris will,

within ten to fifty years, create a cascade of collisions threatening sustainable space access.

If the cascade effect actually occurs, it will put ““billions of dollars’’ worth of advanced satellites at risk and eventually threaten to limit humanity’s reach for the stars.””150 But is the cascade actually

inevitable? Can this cascading effect be prevented, or at least mitigated by an international agreement? The United States’’ national security may depend on such efforts.

**DESPITE LOW NUMBER OF COLLISIONS SO FAR, THE THREAT OF A CASCADE IS GROWING-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Although the probability of catastrophic collisions caused by space debris has increased over the years, it remains relatively low and there have been only four known collisions between objects larger than ten centimeters (Wright 2009, 6). Nevertheless, the real concern is the predicted runaway growth of space debris over the coming decades. Such uncontrolled growth would prohibit the ability of satellites to provide their services, many of which are now widely used by the global community. Indeed, in a testimony to Congress for a hearing on “Keeping the Space Environment Safe for Civil and Commercial Uses,” the Director of the Space Policy Institute at George Washington University, Dr. Scott Pace, stated that,

...space systems such as satellite communications, environmental monitoring, and global navigation satellite systems are crucial to the productivity of many types of national and international infrastructures such as air, sea, and highway transportation, oil and gas pipelines, financial networks, and global communica­tions (Pace 2009).

**WE MUST ENSURE THAT THE COLLISIONS IN SPACE STOP TO PREVENT THE CHAIN REACTION-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk With Lasers; Wired; 15 Mar 2011; [http://www.wired.com/wiredscience/2011/03/lasering-space-junk/#more-54167;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fwiredscience%2F2011%2F03%2Flasering-space-junk%2F%23more-54167%3B&sa=D&sntz=1&usg=AFQjCNEkApiiB7vJmrApyGGMvCZgdTCD-g) retrieved 16 Jun 2011]

In a paper submitted to *Advances in Space Research* and posted to the preprint server arXiv.org, a team led by NASA space scientist James Mason suggests a novel way to cope: Instead of dragging space junk down to Earth, just make sure the collisions stop.

“If you stop that cascade, the beauty of that is that natural atmospheric drag can take its natural course and start taking things down,” said William Marshall, a space scientist at NASA and coauthor of the new study. “It gives the environment an opportunity to clean itself up.”

Simply keeping new fragments from forming can make a big difference for orbital safety, Levit said. Because objects with more surface area feel more drag, the atmosphere pulls down the lightest, flattest fragments of space junk first. When big pieces of debris break up into smaller ones, the pieces become harder and harder to remove.

Worse, the pieces left behind are often the most dangerous: small, dense things like bolts.

“If one collides with a satellite or another piece of debris at the not-unreasonable relative velocity of, say 5 miles per second, it will blow it to smithereens,” Levit said.

In the new study, the researchers suggest focusing a mid-powered laser through a telescope to shine on pieces of orbital debris that look like they’re on a collision course. Each photon of laser light carries a tiny amount of momentum. Together, all the photons in the beam can nudge an object in space and slow it down by about .04 inches per second.

Shining the laser on bits of space litter for an hour or two a day should be enough to move the whole object by about 650 feet per day, the researchers show. That might not be enough to pull the object out of orbit altogether, but preliminary simulations suggest it could be enough to avoid more than half of all debris collisions.

**THE CHAIN REACTION FROM SPACE DEBRIS WILL LAST FOR CENTURIES-Broad ‘07**

[William; Orbiting Junk, Once a Nuisance, Is Now a Threat; New York Times; 6 February 2007; <http://www.nytimes.com/2007/02/06/science/space/06orbi.html>; retrieved 9 August 2011]

For decades, space experts have worried that a speeding bit of orbital debris might one day smash a large spacecraft into hundreds of pieces and start a chain reaction, a slow cascade of collisions that would expand for centuries, spreading chaos through the heavens.

In the last decade or so, as scientists came to agree that the number of objects in orbit had surpassed a critical mass — or, in their terms, the critical spatial density, the point at which a chain reaction becomes inevitable — they grew more anxious.

Early this year, after a half-century of growth, the federal list of detectable objects (four inches wide or larger) reached 10,000, including dead satellites, spent rocket stages, a camera, a hand tool and junkyards of whirling debris left over from chance explosions and destructive tests.

Now, experts say, China’s test on Jan. 11 of an antisatellite rocket that shattered an old satellite into hundreds of large fragments means the chain reaction will most likely start sooner. If their predictions are right, the cascade could put billions of dollars’ worth of advanced satellites at risk and eventually threaten to limit humanity’s reach for the stars.

HARMS: TIPPING POINT FOR KESSLER EFFECT NOW

**WE ARE AT THE TIPPING POINT FOR SPACE DEBRIS-Bates ‘11**

[Daniel; staff writer; Nasa to shoot lasers at space junk around Earth to prevent collisions with satellites; Daily Mail; 16 Mar 2011; [http://www.dailymail.co.uk/sciencetech/article-1366838/Nasa-use-lasers-shoot-space-junk-Earth.html;](http://www.google.com/url?q=http%3A%2F%2Fwww.dailymail.co.uk%2Fsciencetech%2Farticle-1366838%2FNasa-use-lasers-shoot-space-junk-Earth.html%3B&sa=D&sntz=1&usg=AFQjCNHJ4nr_q4VAxVGZTpUNrE_cET-yMA) retrieved 16 Jun 2011]

Some 20,000 pieces of rubbish are currently being monitored in low-Earth orbit, the majority of which are discarded bits of spacecraft or debris from collisions.

Serious accidents in recent years included the 2009 smash between the Iridium 33 satellite and the Kosmos 2251 satellite.

The communications vessels collided at more than 3,000m per second - the first major smash between two operational satellites in Earth orbit.

Nasa engineer Creon Levit said it was imperative that something was done about space junk.

‘There’s not a lot of argument that this is going to screw us if we don’t do something’ he told Wired.

‘Right now it’s at the tipping point … and it just keeps getting worse.’

**RIGHT NOW WE ARE AT THE TIPPING POINT FOR THE KESSLER SYNDROME-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk With Lasers; Wired; 15 Mar 2011; [http://www.wired.com/wiredscience/2011/03/lasering-space-junk/#more-54167;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fwiredscience%2F2011%2F03%2Flasering-space-junk%2F%23more-54167%3B&sa=D&sntz=1&usg=AFQjCNEkApiiB7vJmrApyGGMvCZgdTCD-g) retrieved 16 Jun 2011]

Low-Earth orbit has already seen some scary smashes and near-misses, including the collision of two communications satellites in 2009. Fragments from that collision nearly hit the International Space Station a few months later. Some models found that the runaway Kessler syndrome is probably already underway at certain orbit elevations.

“There’s not a lot of argument that this is going to screw us if we don’t do something,” said NASA engineer Creon Levit. “Right now it’s at the tipping point … and it just keeps getting worse.”

**NASA AND THE PENTAGON WORRY THAT WE HAVE REACHED—OR SOON WILL—THE TIPPING POINT FOR THE KESSLER EFFECT-The Economist ‘10**

[Scientists are Increasingly Worried About the Amount of Debris Orbiting the Earth; The Economist; 19 Aug 2010; <http://www.economist.com/node/16843825?story_id=16843825&fsrc=rss;> retrieved 27 Jul 2011]

Such low-Earth orbits, or LEOs, are among the most desirable for artificial satellites. They are easy for launch rockets to get to, they allow the planet’s surface to be scanned in great detail for both military and civilian purposes, and they are close enough that even the weak signals of equipment such as satellite phones can be detected. Losing the ability to place satellites safely into LEOs would thus be a bad thing. And that is exactly what these two incidents threatened. At orbital velocity, some eight kilometres a second, even an object a centimetre across could knock a satellite out. The more bits of junk there are out there, the more likely this is to happen. And junk begets junk, as each collision creates more fragments—a phenomenon known as the Kessler syndrome, after Donald Kessler, an American physicist who postulated it in the 1970s.

According to the European Space Agency (ESA) the number of collision alerts has doubled in the past decade. Nicholas Johnson, the chief scientist for orbital debris at ESA’s American equivalent, NASA, says modelling of the behaviour of space debris “most definitely confirms the effect commonly referred to as the Kessler syndrome”. Even the National Security Space Office at the Pentagon is worrying about whether a tipping-point has been reached, or soon will be.

**DEBRIS IS ALREADY A PROBLEM, BUT WE’RE ON THE VERGE OF A RUNAWAY ESCALATION OF DEBRIS-Johnson ‘08**

[John; staff writer; Scientists Cite Growing Peril of Space Junk; Los Angeles Times; 16 April 2008; <http://articles.latimes.com/2008/apr/16/science/sci-spacejunk16;> retrieved 16 Jun 2011]

"Debris in space is already a problem," said David Wright, a senior scientist with the Union of Concerned Scientists in Cambridge, Mass. "But it's potentially a very big problem."

Geoffrey Forden, an MIT physicist and expert on the Chinese space program, said the danger from space debris was actually more of a worry than the threat that the Chinese, or some other country, could intentionally cripple American space assets with antisatellite weapons.

Forden argued that America's redundancy in space satellite systems made it almost invulnerable to that kind of attack, and that it would be relatively easy to spot the Chinese readying a launch.

On the other hand, he said, "We are in danger of a runaway escalation of space debris.

**SCIENTISTS WARN THAT WE ARE RAPIDLY APPROACHING THE THRESHOLD FOR THE KESSLER EFFECT-Cooper ‘07**

[Sean; staff writer; Houston, We Have A Trash Problem; Wired; 24 April 2007; <http://www.wired.com/wired/archive/15.05/st_houston.html;> retrieved 16 Jun 2011]

Outer space is becoming a garbage heap. Some 15,000 pieces of debris, ranging from fingernail-sized paint flecks to 10-ton rocket stages, are hurtling through Earth's orbit at 5 miles per second — about 10 times as fast as a speeding bullet. And the junk is multiplying, *Asteroids*-like, as large objects break apart into smaller ones. (China's recent anti-satellite test has hastened the process.) Scientists warn of an approaching Kessler syndrome: the point at which flotsam from collisions makes future space ventures dangerous. How can we clean up the mess? The trick is to either grab shrapnel or coax it toward the planet, where it will burn up in the atmosphere. Several methods of trash collection have been floated. Some are cleverly low tech; others seem like fodder for the Sci Fi Channel.

**ENOUGH SPACE JUNK EXISTS NOW FOR THE KESSLER EFFECT-Stenger ‘02**

[Richard; Scientist: Space weapons pose debris threat; CNN.com; 3 May 2002; <http://articles.cnn.com/2002-05-03/tech/orbit.debris_1_low-earth-orbits-space-junk-international-space-station?_s=PM:TECH>; retrieved 9 August 2011]

Kessler conducted groundbreaking research in the 1970s on the threat of orbital debris to satellites. His mathematical predictions that collisions would cascade into more and more collisions became known as the Kessler effect.

He was one of the first people to sound the alarm about space junk. In fact, Kessler and others think there is enough junk now to pose significant risks to spacecraft in low-Earth orbits, a contention supported by returning space shuttles, which often have dings and window cracks.

Other space dignitaries lend support to Primack, a Stanford University-trained particle physicist who helped develop the theory that dark matter helps structure the universe.

Sydney Van Den Bergh, a physicist with the National Research Council of Canada, said he raised similar concerns years ago at an international conference on space law.

And in April, astronaut Sally Ride, the first U.S. woman in space, gave a speech in which she said that anti-satellite weapons would be "disastrous."

She said debris created by their use could damage satellites traveling in low-Earth orbits, a particularly popular zone of real estate between 150 and 400 miles high that includes the space shuttle, the international space station and reconnaissance satellites.

SOLVENCY: LASERS WORK

**THE PROPOSED LASER FACILITY COULD REMOVE ALL CRITICAL DEBRIS IN THREE YEARS-The Economist ‘10**

[Scientists are Increasingly Worried About the Amount of Debris Orbiting the Earth; The Economist; 19 Aug 2010; <http://www.economist.com/node/16843825?story_id=16843825&fsrc=rss;> retrieved 27 Jul 2011]

But even this would not be enough. What is needed is a way to clean up the junk so that it is no longer a problem. Ideas for doing this are growing almost as fast as space debris. One proposal, originally made a decade ago by the American armed forces, would be to use ground-based lasers to change the orbits of pieces between 1cm and 10cm across by vaporising parts of their surfaces. This would produce enough thrust to cause the debris to re-enter the atmosphere. The proposal suggested a single laser facility would be enough to remove all junk of this size in three years.

**A MODERATELY SIZED LASER COULD MOVE DEBRIS OUT OF DANGEROUS AREAS-Boyle ‘11**

[Rebecca; staff writer; Polar-Mounted Laser Could Zap Space Junk, Protecting Satellites and the Space Station; Popular Science; 14 Mar 2011; <http://www.popsci.com/technology/article/2011-03/polar-based-laser-could-zap-space-junk-harmless-orbits-protecting-satellites-and-space-station;> retrieved 26 Jul 2011]

Space debris could be nudged out of the way using a moderately sized Earth-based laser, a team of NASA researchers suggests in a new paper. The laser wouldn’t blast the debris to smithereens, but combined with a ground-based telescope, it could be used to move space junk into a different orbit so it would not collide with other debris or important spacecraft.

Space debris has already threatened the International Space Station, and satellites are in harm’s way all the time. But most of the time, the station or satellite in question can be moved out of the way, letting the space junk continue on its orbital path. It’s easier to fire a couple thrusters than to throw out a giant space net, tether or solar sail.

**THE LASERS COULD NUDGE DEBRIS OUT OF ORBIT OR INTO THE ATMOSPHERE TO BURN UP-Boyle ‘11**

[Rebecca; staff writer; Polar-Mounted Laser Could Zap Space Junk, Protecting Satellites and the Space Station; Popular Science; 14 Mar 2011; <http://www.popsci.com/technology/article/2011-03/polar-based-laser-could-zap-space-junk-harmless-orbits-protecting-satellites-and-space-station;> retrieved 26 Jul 2011]

The laser system would take the opposite tack, nudging space junk and letting satellites stay put. It would ideally be based near one of the Earth’s poles, and would use photon pressure to disturb an object’s orbit, according to James Mason and colleagues at NASA’s Ames Research Center. Photons would target the debris every time it passed over the laser, and with enough pressure, it could nudge an object out of orbit enough to avoid a future collision.

It could even be used to de-orbit the space junk entirely, perhaps by moving it low enough that atmospheric drag causes it to re-enter the atmosphere — so long as it's small enough to burn up, so there would be no laser-propelled garbage raining down on Earth.

**GROUND –BASED LASERS CAN DE-ORBIT OR VAPORIZE SMALL OBJECTS-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

Ground-based lasers (GBL) have been proposed as a solution to remove small debris (1-10 cm) in LEO. There are two main components to any laser removal system: a targeting system and the actual directed-energy device. With radar based tracking or high-sensitivity optics, debris of 1 cm diameter or greater can be detected and targeted. Once the debris has been located and targeted, it is hit with short pulses from a laser. The pulses vaporize or ablate a micro-thin layer of the object, causing plasma blow-off. The result is a dramatic change in the object’s orbit, lowering its perigee, reducing its orbital lifespan and allowing it to burn up in the earth’s atmosphere.

**ADVANCES IN TECHNOLOGY MAKE USING LASERS MORE FEASIBLE-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

The Orion study suggested that a near term system could remove small debris at altitudes of up to 800 km. This capability would be sufficient to protect the International Space Station from debris 1-10 cm in diameter. At present, this debris cannot be tracked and the ISS lacks shielding against it in any case. Many remote sensing satellites are also found within this altitude and would benefit from removal of space debris up to this height. A longer term solution would entail a GBL system capable of removing debris up to 1500 km.

A more recent examination of the Orion laser concept found that recent advances in picosecond (one trillionth of a second) laser systems make the Orion concept more feasible in that shorter pulses allow a laser with the same energy to exert more power on an object. The ability to use a lower energy laser also allows components to cool much faster and the laser can be fired much more frequently than a laser of similar power with longer pulses.

**LASER TECHNOLOGY GIVES THE ENVIRONMENT A BOOST TO CLEAN ITSELF-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk with Lasers; Wired (UK); 16 Mar 2011; <http://www.wired.co.uk/news/archive/2011-03/16/space-junk-lasers?page=all;> retrieved 27 Jul]

In a paper submitted to *Advances in Space Research* and posted to the preprint server arXiv.org, a team led by Nasa space scientist James Mason suggests a novel way to cope: instead of dragging space junk down to Earth, just make sure the collisions stop.

"If you stop that cascade, the beauty of that is that natural atmospheric drag can take its natural course and start taking things down," said William Marshall, a space scientist at Nasa and co-author of the new study. "It gives the environment an opportunity to clean itself up."

**LASER TECHNOLOGY OFFERS A COST-EFFECTIVE, ELEGANT SOLUTION TO DEBRIS-Campbell ‘00**

[Jonathan; Colonel, US Air Force; Using Lasers in Space Laser Orbital Debris Removal and Asteroid Deflection; 2000; <http://www.au.af.mil/au/awc/awcgate/cst/csat20.pdf;> retrieved 25 Jul 2011]

An elegant, cost effective, and feasible approach is to use laser technology to solve this problem. It is estimated that a single. Ground- based laser facility that costs about $100 million and that operated near the equator could remove all orbital debris up to an altitude of 800 km in two years Since satellites typically cost several hundred million and given the half billion price tags on shuttle and Titan launchers, this investment is relatively small given the potential losses of rockets. Furthermore, the development of this technology will stimulate other approaches, including laser power beaming, deflecting asteroids, meteoroids, and comets, and propulsion for interstellar missions. In closing, this study addressed a problem that the international community must resolve if we are to reduce the risk to spaceflight, and hence to economic progress, that is caused by orbital debris.

**PRESENT TECHNOLOGY COULD ALLOW LASERS TO WORK-Campbell ‘00**

[Jonathan; Colonel, US Air Force; Using Lasers in Space Laser Orbital Debris Removal and Asteroid Deflection; 2000; <http://www.au.af.mil/au/awc/awcgate/cst/csat20.pdf;> retrieved 25 Jul 2011]

The lasers that would he used in Project Orion have demonstrated sufficient capability for orbital debris removal for objects in the size range from 1-10 cm diameter. Ground based experimental data, using a 20 kW pulsed laser, show that the impulse imparted to aluminum targets due to the ejected plasma cloud gives an average surface pressure p = 6.5 x 10-4 N/cm2, or equivalently, an acceleration, a = l.25x 10-6 m/s2 With present technology, a laser phased array can be aimed at the asteroid with sufficient power to ablate its surface. Assuming that a laser array can be scaled up to operate on a 1 km diameter iron asteroid, this would require a 200 GW power grid. Several alternate potential power sources are available, including nuclear or electric generation and solar power arrays.

**SMALL, FOCUSED LASERS COULD BUMP DEBRIS OUT OF DANGEROUS ORBITS-Bates ‘11**

[Daniel; staff writer; Nasa to shoot lasers at space junk around Earth to prevent collisions with satellites; Daily Mail; 16 Mar 2011;<http://www.dailymail.co.uk/sciencetech/article-1366838/Nasa-use-lasers-shoot-space-junk-Earth.html;> retrieved 16 Jun 2011]

Now a team led by Nasa space scientist James Mason have claimed that gently moving junk off course could be the answer.

The theory is that the photons in laser beams carry a tiny amount of momentum in them which, under the right circumstances, could nudge an object in space and slow it down by 0.04 inches per second.

By firing a laser at a piece of junk for a few hours it should be possible to alter it’s course by 650ft per day.

While that won’t be enough to knock it out of orbit, it could be sufficient to avoid a collision with a space station or satellite.

The theory marks a change in approach from previous research which looked into using expensive military Star Wars-style lasers to destroy space junk.

The new project uses equipment that is available for just $800,000 (£500,000) with the final bill coming to just tens of millions of dollars.

Existing telescopes could even be modified, bringing the cost down further.

**THE LASER BROOM IS ONE OF THE MOST COST-EFFECTIVE WAYS TO DEAL WITH SPACE DEBRIS-Cartwright ‘11**

[Jon; staff writer; Lasers Could Nudge Orbiting Space Debris Aside; Scientific American; 15 Mar 2011; retrieved 16 Jun 2011; [http://www.scientificamerican.com/article.cfm?id=lasers-nudge-orbiting-space-debris-aside]](http://www.scientificamerican.com/article.cfm?id=lasers-nudge-orbiting-space-debris-aside%5d)

Scientists at NASA have considered using a ground-based laser to mitigate debris collisions before. However, in their 'laser broom' concept, a powerful, megawatt-class laser would vaporize the surface of a piece of debris that is heading for another, causing the debris to recoil out of harm's way. But critics argued that the laser could be used as a weapon, as it could easily damage an enemy's active satellites. Indeed, both the United States and China have in the past 15 years been accused of testing the ability of ground-based lasers to 'dazzle' satellites and render them inoperable.

Now, James Mason, a NASA contractor at the Universities Space Research Association in Moffett Field, California, and his colleagues have come up with a variation on the laser broom concept that they claim is unlikely to be useful as a weapon. In a paper uploaded to the arXiv preprint server, Mason and colleagues suggest using a medium-powered laser of 5-10 kilowatts to illuminate debris with light a few times more intense than sunlight, imparting just enough momentum to nudge the debris off course. "We think this scheme is potentially one of the least-threatening ways to solve a problem that has to be addressed," says Mason.

**ONE LASER FACILITY COULD AVOID THE KESSLER SYNDROME-Cartwright ‘11**

[Jon; staff writer; Lasers Could Nudge Orbiting Space Debris Aside; Scientific American; 15 Mar 2011; retrieved 16 Jun 2011; [http://www.scientificamerican.com/article.cfm?id=lasers-nudge-orbiting-space-debris-aside]](http://www.scientificamerican.com/article.cfm?id=lasers-nudge-orbiting-space-debris-aside%5d)

With just one laser facility, Mason's group says, the number of debris collisions could be almost halved. What's more, by mitigating the number of collisions, the amount of debris would lessen as it slowly burns up in Earth's atmosphere. And that would avoid the onset of Kessler syndrome, the researchers say.

**USING SMALL LASERS WILL BE SUFFICIENT TO AVOID OVER HALF OF COLLISIONS-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk with Lasers; Wired (UK); 16 Mar 2011; <http://www.wired.co.uk/news/archive/2011-03/16/space-junk-lasers?page=all;> retrieved 27 Jul]

In the new study, the researchers suggest focusing a mid-powered laser through a telescope to shine on pieces of orbital debris that look like they're on a collision course. Each photon of laser light carries a tiny amount of momentum. Together, all the photons in the beam can nudge an object in space and slow it down by about 1mm per second.

Shining the laser on bits of space litter for an hour or two a day should be enough to move the whole object by about 200 metres per day, the researchers show. That might not be enough to pull the object out of orbit altogether, but preliminary simulations suggest it could be enough to avoid more than half of all debris collisions.

**THE LASER SYSTEM COULD OPERATE FOR A FEW MILLION DOLLARS/YEAR-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk with Lasers; Wired (UK); 16 Mar 2011; <http://www.wired.co.uk/news/archive/2011-03/16/space-junk-lasers?page=all;> retrieved 27 Jul]

Nasa scientists have suggested shooting space junk with lasers before. But earlier plans relied on military-class lasers that would either destroy an object altogether, or vaporize part of its surface and create little plasma plumes that would rocket the piece of litter away. Those lasers would be prohibitively expensive, the team says, not to mention make other space-faring nations nervous about what exactly that military-grade laser is pointing at.

The laser to be used in the new system is the kind used for welding and cutting in car factories and other industrial processes. They're commercially available for about $800,000 (£600,000). The rest of the system could cost between a few millions and a few tens of millions of dollars, depending on whether the researchers build it from scratch or modify an existing telescope, perhaps the one at the Air Force Maui Optical Station in Hawaii or at Mt. Stromlo in Australia.

**GROUND BASED LASERS CAN SIGNIFICANTLY REDUCE THE LIKELIHOOD OF COLLISIONS-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

It is clear that debris resulting primarily from collision and explosion fragments is most likely to be involved in collisions with large objects in the LEO polar region. The CRASS statistics suggest that it may be possible to shield these high impact objects from a significant proportion of catastrophic collisions with less massive debris by using a ground based medium power laser. If 75% of collisions with high impact objects involve debris and our analysis of 100 random debris objects suggest that 51% can be significantly (>200 m/day) perturbed using our baseline 5kW system, then it may be possible to prevent up to 39% of all collisions involving the high impact population.

**WHILE LASERS NEED MORE STUDY, RESEARCH INDICATES IT CAN REVERSE THE KESSLER SYNDROME AT A LOW COST-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

It is clear that the actual implementation of a laser debris-debris collision avoidance system requires further study. Assumptions regarding the debris objects properties need refinement and a detailed engineering analysis is necessary before a technology demonstration can be considered. However, this early stage feasibility analysis suggests that a near-polar facility with a 5kW laser directed through a 1.5m fast slewing telescope with adaptive optics can provide sufficient photon pressure on many low-Earth sun-synchronous debris fragments to substantially perturb their orbits over a few days. Additionally, the target acquisition and tracking process provides data to reduce the uncertainties of predicted conjunctions. The laser need only engage a given target until the risk has been reduced to an acceptable level through a combination of reduced orbital covariance and actual photon pressure perturbations. Our simulation results suggest that such a system would be able to prevent a significant proportion of debris-debris conjunctions. Simulation of the long term effect of

the system on the debris population is necessary to confirm our suspicion that it can effectively reverse the Kessler syndrome at a lower cost relative to active debris removal (although quite complementary to it). The scheme requires launching nothing into space - except photons - and

requires no on-orbit interaction - except photon pressure. It is thus less likely to create additional debris risk in comparison to most debris removal schemes. Eventually the concept may lead to an operational international system for shielding satellites and large debris objects from a majority of collisions as well as providing high accuracy debris tracking data and propellant-less station keeping for smallsats.

**WEAK LASERS COULD REVERSE THE KESSLER SYNDROME-Boyle ‘11**

[Rebecca; staff writer; Polar-Mounted Laser Could Zap Space Junk, Protecting Satellites and the Space Station; Popular Science; 14 Mar 2011; <http://www.popsci.com/technology/article/2011-03/polar-based-laser-could-zap-space-junk-harmless-orbits-protecting-satellites-and-space-station;> retrieved 26 Jul 2011]

This laser is pretty weak, however, at just 5 kilowatts. Mason and colleagues say it could nudge up to 10 objects a day.

They say it could reverse the “Kessler syndrome,” a phenomenon wherein new debris formation outstrips the pace at which it falls out of orbit and burns up. As Technology Review's arXiv blog explains, it’s named for NASA scientist Donald Kessler, who described the problem in the 1970s. He said colliding space junk could trigger a cascade of collisions that would create ever more space debris in ever more unpredictable orbits. This may already be happening, as evidenced by the collision between the Iridium 33 and Cosmos 2251 satellites in January 2009, as well as China’s destruction of its Fengyun 1C satellite in 2007. Both incidents created ongoing problems.

Mason and colleagues say much more research is needed, but the laser system could be a feasible, fiscally prudent alternative to space debris removal — nothing would be launched into space except photons, so there would be nothing else to add to the junk.

SOLVENCY: REMOVING FEW OBJECTS ENOUGH

**REMOVING JUST FIVE LARGE OBJECTS A YEAR CAN SOLVE-Szoka and Dunstan ‘09**

[Berin, Senior Fellow at The Progress & Freedom Foundation and Jim, practices space and technology law; Beware of Space Junk: Global Warming Isn’t the Only Major Environmental Problem; Space Frontier; 20 Dec 2009; <http://spacefrontier.org/2009/12/20/beware-of-space-junk-global-warming-isnt-the-only-major-environmental-problem/;> retrieved 27 Jul 2011]

But the problem can be solved. Thus far, governments have simply tried to mandate “mitigation” of debris-creation. But just as some warn about “runaway warming,” we know that mitigation alone will not solve the debris problem. The answer lies in “remediation”: removing just five large objects per year could prevent a chain reaction. If governments attempt to clean up this mess themselves, the cost could run into the trillions—rivaling even some proposed climate change solutions.

**ONLY THE REMOVAL OF EXISTING LARGE OBJECTS CA PREVENT CASCADE EFFECT-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

As early as 1978, scientists postulated that the runaway growth of space debris owing to collisional cascading would eventually prohibit the use of Earth’s orbit (Kessler and Cour-Palais 1978). Recent scientific studies have also predicted uncontrolled debris growth in low-Earth’s orbit over the next century. One NASA study used predictive models to show that even if all launches had been halted in 2004, the population of space objects greater than ten centimeters would remain stable only until 2055 (Liou and Johnson 2006). Beyond that, increasing collisions would create debris faster than debris is removed naturally, resulting in annual increases in the overall space object population. The study concluded that, “only the removal of existing large objects from orbit can prevent future problems for research in and commercialization of space” (Liou and Johnson 2006, 340). The European Space Agency (ESA) has come to similar conclusions using its own predictive models (ESA 2009a).

**SIMPLY REMOVING FIVE PIECES OF DEBRIS A YEAR IS ENOUGH-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

If the orbital debris population remained as it is today with no additional space operations, the level of fragmentation in Earth’s orbit would continue to escalate exponentially. Dr. Nicholas Johnson, chief scientist for orbital debris for NASA at the Johnson Space Center, has modeled future orbital debris scenarios based on non-mitigation over a 5, 10, and 20 year period compared to the removal of one to five pieces of debris beginning in the year 2020. This paper, co-authored by J.-C. Liou and titled “A Sensitivity Study of the Effectiveness of Active Debris Removal in LEO,” suggests that the orbital debris population can be effectively addressed by simply removing five objects per year starting in the year 2020.

SOLVENCY: THE US SHOULD LEAD

**THE UNITED STATES SHOULD TAKE THE LEAD ON REMOVING SPACE DEBRIS-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Space debris increasingly threatens the provision of satellite services that have become integrated into the operations of the global economy and U.S. military, such as GPS precision timing and navigation. While studies suggest that annually removing as few as five massive pieces of debris in critical orbits could significantly stabilize the space debris environment, countries have hesitated to develop space debris removal systems due to high costs and classic free rider problems. This paper argues that the United States should take the lead in immediately developing systems to remove space debris with the greatest potential to contribute to future collisions. Although leading by example will entail certain costs and risks, U.S. leadership in preserving the near-Earth space environment will result in not only long-term benefits for the United States, but also the fulfillment of U.S. national space policy and broader U.S. foreign policy objectives.

**ONE COUNTRY SHOULD TAKE THE LEAD BY ESTABLISHING A NATIONAL DEBRIS REMOVAL PROGRAM, SPEEDING INTERNATIONAL AGREEMENT AND TECHNOLOGY-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Space debris removal systems could take decades to develop and deploy through international partnerships due to the many interdisciplinary challenges they face. Given the need to start actively removing space debris sooner rather than later to ensure the continued benefits of satel­lite services, international cooperation may not be the most appropriate mechanism for instigating the first space debris removal system. Instead,one country should take a leadership role by establishing a national space debris removal program. This would accelerate technology development and demonstration, which would, in turn, build-up trust and hasten international participation in space debris removal.

**THE US IS AN IDEAL CANDIDATE TO REMOVE DEBRIS; SIMPLY REMOVING 5 PIECES A YEAR IS ENOUGH-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

As previously discussed, a recent NASA study found that annually removing as little as five massive pieces of debris in critical orbits could significantly stabilize the long-term space debris environment (Liou and Johnson 2007). This suggests that it is feasible for one nation to unilaterally develop and deploy an effective debris removal system. As the United States is respon­sible for creating much of the debris in Earth’s orbit, it is a candidate for taking a leadership role in removing it, along with other heavy polluters of the space environment such as China and Russia.

**IF THE US FAILS TO LEAD INTERNATIONAL EFFORTS TO CLEAN DEBRIS, WE RISK SUSTAINABLE DEVELOPMENT OF THE EARTH’S NEAR-SPACE ENVIRONMENT-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

If the United States and other powerful governments do not take steps now to avert the potentially devastating effects of space debris, the issue risks becoming stalemated in a manner similar to climate change. Given the past hesitation of international forums in addressing the space debris issue, unilateral action is the most appropriate means of instigating space debris removal within the needed timeframe. The United States is well poised for a leadership role in space debris removal.

Going forward, the U.S. government should work closely with the commercial sector in this endeavor, focusing on removing pieces of U.S. debris with the greatest potential to contribute to future collisions. It should also keep its space debris removal system as open and transparent as possible to allow for future international cooperation in this field.

Although leadership in space debris removal will entail certain risks, investing early in preserving the near-Earth space environment is neces­sary to protect the satellite technology that is so vital to the U.S. military and day-to-day operations of the global economy. By instituting global space debris removal measures, a critical opportunity exists to mitigate and minimize the potential damage of space debris and ensure the sustainable development of the near-Earth space environment.

**THE US COULD ENSURE THAT OTHER NATIONS JOIN IN LATER OR PAY FOR REMOVAL-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Moreover, current U.S. National Space Policy asserts that the United States will take a “leadership role” in space debris minimization. This could include the development, deployment, and demonstration of an effective space debris removal system to remove U.S. debris as well as that of other nations, upon their request. There could also be international political and economic advantages associated with being the first country to develop this revolutionary technology. However, there is always the danger of other nations simply benefiting from U.S. investment of its resources in this area. Thus, mechanisms should also be created to avoid a classic “free rider” situation. For example, techniques could be employed to ensure other countries either join in the effort later on or pay appropriate fees to the United States for removal services.

**EVEN IF THERE ARE COSTS TO THE UNITED STATES, IT MUST LEAD THIS EFFORT-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Space debris increasingly threatens the provision of satellite services that have become integrated into the operations of the global economy and U.S. military, such as GPS precision timing and navigation. While studies suggest that annually removing as few as five massive pieces of debris in critical orbits could significantly stabilize the space debris environment, countries have hesitated to develop space debris removal systems due to high costs and classic free rider problems. This paper argues that the United States should take the lead in immediately developing systems to remove space debris with the greatest potential to contribute to future collisions. Although leading by example will entail certain costs and risks, U.S. leadership in preserving the near-Earth space environment will result in not only long-term benefits for the United States, but also the fulfillment of U.S. national space policy and broader U.S. foreign policy objectives.

SOLVENCY: TIME TO ACT IS NOW

**POLICYMAKERS MUST TAKE DECISIVE ACTION TO AVOID THE TRAGEDY OF THE COMMONS IN SPACE; THE TIME TO ACT IS NOW-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

The biggest challenge, however, will be simply starting the process of active debris removal. Despite growing consensus within the space debris community that active removal will be needed over the next several decades, the fact that space activities continue today without significant interference causes the larger global community to not see space debris as an issue. Moreover, space suffers from the “tragedy of the commons,” a phenomenon that refers to the overexploitation of a shared resource when there is no clear ownership over it. This, in addition to the abovementioned challenges facing debris removal systems, means that the natural tendency of those in power will likely be to do nothing until they absolutely must. This is reminiscent of responses to climate change, where the failure of governments to take responsibility for their past actions and act preemp­tively is compromising the larger global good. Policy makers must therefore take necessary actions, as recommended in next section of this paper, to prevent what is now happening on Earth from also occurring in space.

**DOUBLING THE AMOUNT OF DEBRIS WE REMOVE CAN GET THE PROBLEM UNDER CONTROL-David ‘10**

[Leonard; Space Columnist; A Real Mess in Orbit: Space Junk to Hang Around Longer Than Expected; Space.com; 03 Aug 2010; retrieved 11 Jul 2011; [http://www.space.com/8875-real-mess-orbit-space-junk-hang-longer-expected.html]](http://www.space.com/8875-real-mess-orbit-space-junk-hang-longer-expected.html%5D)

As the atmospheric density in the thermosphere decreases, however, debris can remain in orbit up to 25 percent longer, said Hugh Lewis, from the university's School of Engineering Sciences.

"The fact that these objects are staying in orbit longer counteracts the positive effects that we would otherwise see with active debris removal," Lewis said.

The research team suggests that international efforts to control the growth of space debris may become much less effective in the future if these atmospheric changes continue.

"Our study shows that if we double the number of debris objects we can remove each year, we can get back on track with reducing the debris population. Achieving this target, however, will be challenging," Lewis said.

**SCIENTISTS AGREE WE MUST ACT NOW- Messier ‘09**

[Doug; Secure World Says: Act Now to Deal with Space Debris; Parabolic Arc; 12 May 2009; <http://www.parabolicarc.com/2009/05/12/secure-world-act-deal-space-debris/>; retrieved 9 August 2011]

Now is the time to reduce the threat to both human spaceflight and satellites from destructive space debris.

That viewpoint emerged from a major gathering of space experts at the International Interdisciplinary Congress on Space Debris, held May 7-9 at the Faculty of Law, McGill University in Montreal, Canada.

The Congress brought together legal, policy, and technical experts from around the globe, including the U.S., Russia, India, China, Canada, and Europe, a unique gathering of officials to thrash out legal, and technical ideas for the next phase of dealing with the space debris issue.

ADVANTAGE 1: DEBRIS BLOCKS SPACE EXPLORATION

**FAILURE TO CONTROL SPACE DEBRIS ENDS HOPES OF SPACE COLONIZATION AND CLEAN ENERGY FROM SOLAR POWER SATELLITES-Szoka and Dunstan ‘09**

[Berin, Senior Fellow at The Progress & Freedom Foundation and Jim, practices space and technology law; Beware of Space Junk: Global Warming Isn’t the Only Major Environmental Problem; Space Frontier; 20 Dec 2009; <http://spacefrontier.org/2009/12/20/beware-of-space-junk-global-warming-isnt-the-only-major-environmental-problem/;> retrieved 27 Jul 2011]

As world leaders meet in Copenhagen to consider drastic carbon emission restrictions that could require large-scale de-industrialization, experts gathered last week just outside Washington, D.C. to discuss another environmental problem: Space junk.[1] Unlike with climate change, there’s no difference of scientific opinion about this problem—orbital debris counts increased 13% in 2009 alone, with the catalog of tracked objects swelling to 20,000, and estimates of over 300,000 objects in total; most too small to see and all racing around the Earth at over 17,500 miles per hour. Those are speeding bullets, some the size of school buses, and all capable of knocking out a satellite or manned vehicle.

At stake are much more than the $200 billion a year satellite and launch industries and jobs that depend on them. Satellites connect the remotest locations in the world; guide us down unfamiliar roads; allow Internet users to view their homes from space; discourage war by making it impossible to hide armies on another country’s borders; are utterly indispensable to American troops in the field; and play a critical role in monitoring climate change and other environmental problems. Orbital debris could block all these benefits for centuries, and prevent us from developing clean energy sources like space solar power satellites, exploring our Solar System and someday making humanity a multi-planetary civilization capable of surviving true climatic catastrophes.

**SPACE DEBRIS THREATENS SATELLITES WHICH ARE THE SOFT UNDERBELLY OF AMERICAN NATIONAL SECURITY-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

Simply put, the United States depends on space-based assets for national security, and those assets are vulnerable to space debris collisions. As Massachusetts Democratic Congressman Edward

Markey stated, ““American satellites are the soft underbelly of our national security.””161 The Rumsfeld Commission set the groundwork for such a conclusion in 2001, when it discussed the vulnerability of U.S. space-based assets and warned of the Space Pearl Harbor.162 Congress also recognized this vulnerability in June 2006, when it held hearings concerning space and its import to U.S. national power and security.163 In his June 2006 Congressional Statement, Lieutenant General C. Robert Kehler, then the Deputy Commander, United States Strategic Command, stated that ““space capabilities are inextricably woven into the fabric of American security.””164 He added that these space capabilities are ““vital to our daily efforts throughout the world in all aspects of modern warfare”” and discussed how integral space capabilities are to ““defeating terrorist threats, defending the homeland in depth, shaping the choices of countries at strategic crossroads and preventing hostile states and actors from acquiring or using WMD.””

**CONTROLLING THE PRODUCTION OF DEBRIS IS CRITICAL TO PRESERVE THE LONG-TERM USE OF SPACE-Wright ‘08**

[David; PhD; co-director of the Global Security Program; Space Debris from Anti-Satellite Weapons; Union of Concerned Scientists Fact Sheet; April 2008; <http://www.ucsusa.org/assets/documents/nwgs/debris-in-brief-factsheet.pdf;> retrieved 11 Jun 2011]

Space debris is any human-made object in orbit that no longer serves a useful purpose. It includes defunct satellites, discarded equipment and rocket stages, and fragments from the breakup of satellites and rocket stages.

Space debris is a concern because—due to its very high speed in orbit—even relatively small pieces can damage or destroy satellites in a collision. Since debris at high altitudes can stay in orbit for decades or longer, it accumulates as more is produced. As the amount grows, the risk of collisions with satellites also grows. If the amount of debris at some altitudes becomes sufficiently large, it could be difficult to use those regions for satellites.

Since there is currently no effective way to remove large amounts of debris from orbit, controlling the production of debris is essential for preserving the long-term use of space.

**FAILURE TO DEAL WITH DEBRIS COULD MAKE SPACE EXPLORATION FINANCIALLY IMPOSSIBLE-Broad ‘07**

[William; staff writer; Orbiting Junk, Once a Nuisance, is Now a Threat; New York Times; 06 Feb 2007; [http://www.nytimes.com/2007/02/06/science/space/06orbi.html;](http://www.google.com/url?q=http%3A%2F%2Fwww.nytimes.com%2F2007%2F02%2F06%2Fscience%2Fspace%2F06orbi.html%3B&sa=D&sntz=1&usg=AFQjCNHllnF-ZmS7sY_UPvEMNwJCjbB4tg) retrieved 16 Jun 2011]

If nothing is done, a kind of orbital crisis might ensue that is known as the Kessler Syndrome, after Mr. Kessler. A staple of science fiction, it holds that the space around Earth becomes so riddled with junk that launchings are almost impossible. Vehicles that entered space would quickly be destroyed.

In an interview, Mr. Kessler called the worst-case scenario an exaggeration. “It’s been overdone,” he said of the syndrome.

Still, he warned of an economic barrier to space exploration that could arise. To fight debris, he said, designers will have to give spacecraft more and more shielding, struggling to protect the craft from destruction and making them heavier and more costly in the process.

At some point, he said, perhaps centuries from now, the costs will outweigh the benefits.

“It gets more and more expensive,” he said. “Sooner or later it gets too expensive to do business in space.”

**FAILURE TO CONTROL DEBRIS WILL INCREASE THE COST OF SPACE MISSIONS OR LEAD TO POLICIES THAT LEAD TO CHEAPER, MORE DEBRIS-PRODUCING CRAFT-Kessler ‘09**

[Donald; PhD, 30 year researcher about orbital debris at NASA; 08 Mar 2009; [http://webpages.charter.net/dkessler/files/KesSym.html;](http://www.google.com/url?q=http%3A%2F%2Fwebpages.charter.net%2Fdkessler%2Ffiles%2FKesSym.html%3B&sa=D&sntz=1&usg=AFQjCNF6jZmFYJBoiqla5QFcdsOX0iorKw) retrieved 16 Jun 2011]

We are entering a new era of debris control….an era that will be dominated by a slowly increasing number of random catastrophic collisions. These collisions will continue in the 800 km to 1000 km altitude regions, but will eventually spread to other regions. The control of future debris requires, at a minimum, that we not leave future payloads and rocket bodies in orbit after their useful life and might require that we plan launches to return some objects already in orbit.

These control measures will significantly increase the cost of debris control measures; but if we do not do them, we will increase the cost of future space activities even more. We might be tempted to put increasing amounts of shielding on all spacecraft to protect them and increase their life, or we might just accept shorter lifetimes for all spacecraft. However, neither option is acceptable: More shielding not only increases cost, but it also increases both the frequency of catastrophic collisions and the amount of debris generated when such a collision occurs. Accepting a shorter lifetime also increases cost, because it means that satellites must be replaced more often….with the failed satellites again increasing the catastrophic collision rate and producing larger amounts of debris.

**SPACE DEBRIS FILLS ORBIT, THREATENING THE ENTIRE SPACE ENTERPRISE-Dickens ‘10**

[Peter; professor @ Universities of Brighton and Cambridge; The Humanization of the Cosmos--To What End?; Monthly Review; November 2010; retrieved 28 Jun 2011

[http://monthlyreview.org/2010/11/01/the-humanization-of-the-cosmos-to-what-end]](http://monthlyreview.org/2010/11/01/the-humanization-of-the-cosmos-to-what-end%5D)

Note, for example, that there are now around fourteen thousand tracked objects circling around the earth, known as “space debris” or “space junk.” Improved tracking systems will increase the number of smaller, observable tracked objects to around thirty thousand, many of these causing potential damage. Even whole satellites may collide. Such collisions are estimated at millions or even billions to one. But on February 10, 2009, such a collision actually happened. A defunct Russian satellite crashed into an American commercial satellite, generating thousands of pieces of orbiting debris. Space junk poses a serious threat to the whole enterprise of space colonization, and plans are now afoot to launch even more satellites, designed to drag older satellites out of orbit in order to avoid collisions.

**UNCHECKED KESSLER SYNDROME WILL END CHANCES OF GOING OUT INTO SPACE-Levi ‘09**

[Ran; B.Sc in Electrical Engineering from the Technion- Israel Institute of Technology; The Orbital Menace-Space Garbage; 2009; retrieved 25 Jul 2011; [http://thefutureofthings.com/column/6513/the-orbital-menace-space-garbage.html]](http://thefutureofthings.com/column/6513/the-orbital-menace-space-garbage.html%5D)

The Kessler Syndrome is a theory raised by the scientist, Donald Kessler. According to Kessler’s calculations, even if we were to stop all launches into space today, all at once, the amount of garbage already accumulated has reached a critical mass. The mechanisms most responsible for the pollution of space are the collisions and explosions – each collision between two objects results in thousands of fragments scattered in space; these will then go on to collide with other objects, creating further collisions. Within a few decades, Kessler hypothesized, the inevitable collision between pieces of garbage already out in space today will fill up space with countless dangerous particles. The particles will form a fatal cloak around the Earth, which will completely obliterate any possibility of going out into space. If this prophecy comes true, we might find ourselves in a situation in which entire generations on Earth will not be able to develop advanced space technology, which will have a serious negative impact on technology in general.

**WITHOUT SPACE DEBRIS MITIGATION, SPACE EXPLORATION AND RESEARCH COULD BECOME IMPOSSIBLE-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

According to forecasts published by the BBC, space industry profits will exceed $250 billion by the year 2010.46 Technologies such as telecommunications, global positioning systems, broadband, and remote sensing are being further developed for use in space. Of utmost priority, however, is the need for heightened space situational awareness and space debris elimination measures. Without space debris elimination measures, the possibility of a crescendo, known as the “Kessler Effect,” occurring at current debris levels remains high. In this scenario, large and small debris continually collide and fragment until the atmosphere at LEO becomes unusable. Space-faring nations would lose the ability for space exploration and technology such as the International Space Station (ISS) and Hubble Space Telescope might be compromised. In fact, the NASA space shuttle could also be rendered inoperable.

ADVANTAGE 2: MILITARY IS DEPENDENT ON SATELLITES

**AMERICAN MILITARY FORCES HAVE BECOME DEPENDENT ON SATELLITES-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

With the modern speed of warfare, it has become difficult to fight conflicts without the timely intelligence and information that space assets provide. Space-based assets and space-controlled assets have created among U.S. military commanders ““a nearly insatiable desire for live video surveillance, especially as provided from remotely piloted vehicles like the Predator and now the Reaper.””157 Moreover, military forces have become so dependent on satellite communications and targeting capabilities that the loss of such a satellite would ““badly damage their ability to respond to a military emergency.””158

In fact, the May 2008 malfunction of a communications satellite demonstrates the fragile nature of the satellite communications system.159 The temporary loss of a single satellite ““effectively pulled the plug on what executives said could [have been] as much as 90 percent of the paging network in the United States.””160 Although this country’’s paging network is perhaps not vital to its national security, the incident demonstrates the possible national security risks created by the simultaneous loss of multiple satellites due to space debris collisions.

**SATELLITE-ENABLED COMMUNICATIONS ARE CRITICAL FOR THE US MILITARY; LOSING ACCESS WILL UNDERMINE AMERICAN MILITARY POWER-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Furthermore, satellite-enabled military capabilities such as GPS precision-guided munitions are critical enablers of current U.S. military strategies and tactics. They allow the United States to not only remain a globally dominant military power, but also wage war in accordance with its political and ethical values by enabling faster, less costly warfighting with minimal collateral damage (Sheldon 2005; Dolman 2006, 163-165). Given the U.S. military’s increasing reliance on satellite-enabled capabilities in recent conflicts, in particular Operation Desert Storm and Operation Iraqi Freedom, some have argued that losing access to space would seriously impede the ability of the United States to be successful in future conflicts (Dolman 2006, 165).

**SATELLITES ARE CRITICAL FOR MUCH OF WHAT THE AMERICAN MILITARY DOES-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

General Kevin P. Chilton, Commander of United States Strategic Command, recently wrote: “Military and civilian entities are heavily reliant on services that satellites provide, and space operations are so pervasive that it is impossible to imagine the U.S. functioning without them.”4 During Operation Desert Storm, commercial satellites provided 45% of all communications between the theater and the continental United States.5 Today, according to General Chilton, “We rely on satellites to verify treaty compliance, monitor threats and provide advance warning of missile attacks. It's important to remember that every soldier, sailor, Marine and airman in Iraq and Afghanistan relies on space technology for crucial advantages in the field.”

ADVANTAGE 2: AMERICAN NATIONAL SECURITY

**PRESERVATION OF SPACE CAPABILITIES IS VITAL TO AMERICAN NATIONAL SECURITY-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

Because so much of the United States’’ security depends on satellites, these integral space-based capabilities would, therefore, be costly to lose. That loss would be felt in more than just the security arena. Due to the steep price tags attached to some of the national space security platforms, the economic loss of a satellite due to space debris would also be significant. For example, a pair of new Global Positioning Satellites (GPS), which provides valuable targeting and battle space awareness to military commanders, costs $1.5 billion.166 Accordingly, if a piece of space debris destroys one of these satellites, $750 million could be lost instantly. Additionally, NASA invests billions of dollars annually in space assets. Congress provided NASA with $18.3 billion to spend on space utilization and exploration for fiscal year 2010, and it provided $17.7 billion for fiscal year 2011.167 Air Force General (retired) Ronald E. Keys, former Commander of Air Combat Command, summed it up best, stating that a great deal ““rides on space-borne satellites.””168 Because these space capabilities are so costly yet so vital to the United States’’ national security and economic well-being, the preservation of these space capabilities should also be vital.

**SPACE DEBRIS IS A CRITICAL THREAT TO AMERICAN NATIONAL SPACE SECURITY AND ASSETS-Hsu ‘11**

[Jeremy; Article: U.S. Worried About Outer Space Security; Space.com; 4 February 2011; <http://www.space.com/10775-national-space-security-strategy-reaction.html>; retrieved 9 August 2011]

A newly unveiled U.S. strategy aims to enlist other countries to help safeguard national space assets against both hostile threats and orbital space debris.

The National Security Space Strategy directs the Department of Defense and the Office of the Director of National Intelligence on how to follow the country's National Space Policy, which was announced by the president last June. It is the first such document co-signed by the secretary of defense and the director of national intelligence, said Gregory Schulte, the deputy secretary of defense for space policy.

"Space becomes critical to everything we do, and that’s why we're worried that the environment is increasingly challenging," Schulte said. "You have more debris in space and you have countries that are developing counterspace capabilities that can be used against us."

The space strategy emphasizes not only the ability to survive and operate in an increasingly dangerous space environment, but also the need to protect that space environment as well as the country's industrial base which supports space launches and operations.

"The National Security Space Strategy represents a significant departure from past practice," said Robert Gates, U.S. secretary of defense. "It is a pragmatic approach to maintain the advantages we derive from space while confronting the new challenges we face."

Both the National Security Space Strategy and the National Space Policy reflect a policy shift in response to a "fundamental change in the nature of space security," according to Brian Weeden, a technical adviser for the Secure World Foundation, an organization dedicated to the sustainable use of space. That change comes from recognizing the dual threat of anti-satellite weapons and the growing cloud of debris surrounding Earth.

ADVANTAGE 3: DEBRIS THREATENS ECONOMY

**THE UNCONTROLLED GROWTH OF SPACE DEBRIS THREATENS SATELLITES AND THE GLOBAL ECONOMY-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

It is likely that space debris will become a significant problem within the next several decades. Predictive studies show that if humans do not take action to control the space debris population, an increasing number of unintentional collisions between orbiting objects will lead to the runaway growth of space debris in Earth’s orbit (Liou and Johnson 2006). This un­controlled growth of space debris threatens the ability of satellites to deliver the services humanity has come to rely on in its day-to-day activities. For example, Global Positioning System (GPS) precision timing and naviga­tion signals are a significant component of the modern global economy; a GPS failure could disrupt emergency response services, cripple global banking systems, and interrupt electric power grids (Logsdon 2001).

**THE USE OF SPACE IS VITAL FOR ECONOMIC AND POLITICAL POWER-Campbell ‘00**

[Jonathan; Colonel, US Air Force; Using Lasers in Space Laser Orbital Debris Removal and Asteroid Deflection; 2000; <http://www.au.af.mil/au/awc/awcgate/cst/csat20.pdf;> retrieved 25 Jul 2011]

The use of space is vital for future economic and political power for many reasons. Since an impact from a meteorite, asteroid, or comet would he an unimaginable catastrophe, we have little choice but to deal with this threat. On a lesser scale, the threat of orbital debris to spacecraft raises important economic questions. While there are many risks with spaceflight, we must decide at what threshold the risks are too high and action s necessary. That threshold must balance the possible impact to the mission, resources available to accomplish that mission, and the technical arid cost feasibility of reducing that risk. In addition, that threshold must balance all of the risks that are associated with a mission. In other words, if there is a practical way to reduce risk, then it is probably prudent to do so. The purpose of this study is to describe one solution for reducing the risk posed by orbital debris.

**THE KESSLER SYNDROME THREATENS FUTURE SPACE MISSIONS AND GLOBAL COMMERCE AND COMMUNICATION-Schwartz ‘10**

[Evan; The Looming Space Junk Crisis: It’s Time to Take Out the Trash; Wired; 24 May 2010; [http://www.wired.com/magazine/tag/kessler-syndrome/;](http://www.google.com/url?q=http%3A%2F%2Fwww.wired.com%2Fmagazine%2Ftag%2Fkessler-syndrome%2F%3B&sa=D&sntz=1&usg=AFQjCNHqg-Ie8ShQPeaPrDBJ3I01msATng) retrieved 16 Jun 2011]

Incidents like these served as clear signs from above that something must finally be done about space junk. Its proliferation threatens not only current and future space missions but also global communications—mobile phone networks, satellite television, radio broadcasts, weather tracking, and military surveillance, even the dashboard GPS devices that keep us from getting lost. The number of manufactured objects cluttering the sky is now expected to double every few years as large objects weaken and split apart and new collisions create more Kesslerian debris, leading to yet more collisions.

NASA’s Bacon puts it bluntly: “The Kessler syndrome is in effect. We’re in a runaway environment, and we won’t be able to use space in the future if we don’t start dealing with this now.”

ADVANTAGE 3: ECONOMY IMPACT

**SPACE DEBRIS COULD DESTROY OUR ABILITY TO USE SATELLITES, SENDING THE GLOBAL ECONOMY BACK TO THE 1950S, LEADING TO RESOURCE WARS AND MASSIVE STARVATION-Moore ‘08**

Mike; former editor of Bulletin of the Atomic Scientists; Twilight War: The Folly of U.S. Space Dominance; 10 Jun 2008; <http://www.carnegiecouncil.org/resources/transcripts/0048.html;> retrieved 22 Jul 2011]

Now, in a battlefield there is always debris left over, and it has to be cleaned up, and so on and so forth. But when you have debris in space it stays there. It can stay there for years, for decades, for centuries, or even forever, depending on how high above the earth it is.

If we clutter up orbital space with a conflict, with so many hundreds of thousands of pieces of debris—and I don't kid you about that—the debris problem is huge, and it wouldn't take much to make it beyond home. I've talked to physicists who believe if some country smashed, say, a dozen of our big satellites, or maybe two dozen of our big satellites, we might make space unusable, just plain unusable. And satellites that are undamaged would wear out and we couldn't replace them.

The global economy depends on these satellites. We're not in the 1980s anymore. Everything we do in terms of the global economy depends in one way or another on satellites in space. If we can't replace satellites, if we lose the use of space, then we are going to have a situation where satellites fail and we are going to drift back to a 1950s-style economy.

In the 1950s—and I grew up then, and I kind of liked it—there were only about 2 billion people in the world. Now there are 6.5 billion people If we lose the kind of global economy we have, which is space-dependent, how is that going to work? There are going to be wars for resources, there is going to be malnutrition, there is going to be mass starvation. It is going to be a very, very terrible thing. We can't go back to the 1950s.

**THE ECONOMY OF THE UNITED STATES IS HEAVILY DEPENDENT ON SPACE ASSETS-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

Commercially, the economy of the United States is heavily dependent on space assets in virtually every industry. Communications, Global Positioning System (GPS) technology, agriculture, weather monitoring, and shipment tracking in the manufacturing sector are all indispensable to workings of the market.7, 8 With international economies interwoven across borders and cultures, damage to a critical satellite might pose serious monetary repercussions throughout multiple countries. For example, nearly a decade ago the failure of the Galaxy IV satellite rendered certain communications useless for two days. “The failure of that one satellite left about 80 (to) 90 percent of the 45 million pager customers in the United States without service…and 5400 of 7700 Chevron gas stations without pay-at-the-pump capability.”

A/T: SPENDING/COST

**SHORT-TERM COSTS OF DEBRIS REMEDIATION ARE OUTWEIGHED BY THE ECONOMIC COSTS OF FAILING TO ACT-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

This type of international treaty would be economically burdensome on the United States in the short term. However, for the reasons previously discussed,332 investment in the removal of space

debris is in the long-term national security interest of the United States. The United States has consistently led the way in space debris mitigation, and it should continue to do so. In 1987, the Department of Defense (DoD) addressed the debris issue for the first time: ““[The] DoD will seek to minimize the impact of space debris on its military operations. Design and operations of DoD space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements.””333 President Ronald Reagan’’s 1988 Presidential Directive on National Space Policy also called for ““all space sectors [to] minimize the creation of space debris . . . consistent with mission requirements and cost effectiveness.””334 President George W. Bush’’s 2006 National Space Policy echoed this directive, 335 as does President Barack Obama’’s 2010 National Space Policy,336 which states,

For the purposes of minimizing debris and preserving the space environment for the responsible, peaceful, and safe use of all users, the United States shall . . . [l]ead the continued development and adoption of international and industry standards and policies to minimize debris, such as the United Nations Space Debris Mitigation Guidelines.

**$500 MILLION WOULD BE ENOUGH FOR GROUND-BASED LASERS TO MOVE THOUSANDS OF BITS OF DEBRIS TOWARDS INCINERATION-Michaels ‘09**

[Daniel; staff writer; A Cosmic Question: How to Get Rid Of All That Orbiting Space Junk; Wall Street Journal; 11 March 2009;<http://online.wsj.com/article/SB123672891900989069.html;> retrieved 16 Jun 2011]

Experts are also taking a fresh look at the National Aeronautics and Space Administration's 1996 Project Orion, a "space broom" concept to fry space trash with ground-based lasers. When Jonathan W. Campbell started leading the effort, he thought the approach would entail futuristic and impossibly costly technologies.

"I thought it would be a Buck Rogers thing," the astrophysicist recalls. Instead, his team concluded that for the price of one space-shuttle launch -- roughly $500 million -- the laser could nudge thousands of bits of garbage toward incineration in the atmosphere within five years. Compared to the cost of losing a satellite or a shuttle to space debris impact, "this looks like a bargain," says Dr. Campbell, who works at NASA's Marshall Space Flight Center in Huntsville, Ala.

A key to his plan is using existing low-power lasers in quick pulses, much like the flashbulb on a camera. The laser would only singe the surface of an object in space, but that tiny burn could still help point it downward, Dr. Campbell says. Project Orion's low-budget approach hits at a conundrum of space debris.

**A GROUND BASED LASER WILL BE MUCH CHEAPER THAN LAUNCHING SATELLITES-Satnews Daily ‘11**

[NASA Laser to Remove Space Debris?; SatNews Daily; 17 Mar 2011; <http://www.satnews.com/cgi-bin/story.cgi?number=1202250009;> retrieved 26 Jul 2011]

The ground-based laser "is almost certainly going to be an order of magnitude cheaper than launching a satellite," study lead author James Mason, a NASA contractor associated with the Universities Space Research Association, told me today.

He and colleagues propose using a 5-kilowatt industrial laser — the same size used for industrial purposes such as cutting and welding in car factories — to nudge pieces debris off collision courses.

They would shine the laser on a piece of debris for the first half of its pass over their line of sight. The photons in the laser have enough collective power to slightly nudge the object.

Halfway through the pass, the team would analyze the piece of debris' orbit. If it needed a further nudge, it would be given on the subsequent pass.

"Engaging during every pass for a few days is typically enough, depending on the target's size and mass," Mason said in an e-mail he sent to me and other reporters. The process can target several pieces of debris a day, provided only one is being illuminated with the laser at a time.

The team suspects that if their system could be deployed today, they should be able to remove more debris than is created each year, addressing the problem identified by NASA scientist Donald Kessler in 1978 that more debris is created each year than de-orbits.

**THE LASER SYSTEM COULD COST AS LITTLE AS $10 MILLION AND BE READY IN A FEW YEARS-Cowen ‘11**

[Ron; staff writer; Laser Proposed To Deflect Space Junk; Science News; 22 March 2011; <http://www.sciencenews.org/view/generic/id/71534/title/Laser_proposed_to_deflect_space_junk_;> retrieved 26 Jul 2011]

It won’t prevent Armageddon, but a simple ground-based laser system could nudge small pieces of space junk away from satellites to prevent collisions, a new study suggests.

The proposed system uses photons generated by a medium-power laser and aimed into space through a 1.5-meter telescope. The photons exert pressure on space debris in low-Earth orbit, gently pushing the objects aside rather than vaporizing them. Researchers have applied the same idea, using the pressure from sunlight, to propel spacecraft (SN: 8/21/99, p. 120).

James Mason of the Universities Space Research Association and NASA’s Ames Research Center in Mountain View, Calif., and his colleagues describe their system online at [arXiv.org](http://arxiv.org/abs/1103.1690) on March 10. The proposed device, which would cost a little over $10 million, could be ready for testing next year and fully operational a few years later.

**THE LASER SYSTEM WILL NOT REQUIRE MUCH ENERGY OR POSE ANY DANGER-Cowen ‘11**

[Ron; staff writer; Laser Proposed To Deflect Space Junk; Science News; 22 March 2011; <http://www.sciencenews.org/view/generic/id/71534/title/Laser_proposed_to_deflect_space_junk_;> retrieved 26 Jul 2011]

Mason’s team suggests that the laser facility be built at a near-polar, high-altitude site, such as the Plateau Observatory in Antarctica, because most debris passes over the polar regions many times a day.

Researchers have suggested using lasers to vaporize space debris for more than two decades, but those systems would require powerful devices that might be mistaken for weapons, notes Mason.

Using a laser to slightly alter the speed of small debris doesn’t take much energy, notes Kessler. And if the medium-power laser missed its target it would be unlikely to do much damage, he adds. Kessler notes, however, that scientists would need precise knowledge of the path of debris in order for the system to be effective.

A/T: INTERNATIONAL ACTION

**AMERICAN SUPPORT FOR AN INTERNATIONAL AGREEMENT TO REMOVE DEBRIS IS CRITICAL FOR NATIONAL SECURITY AND THE ECONOMY-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

To preserve and protect its national security, the United States must therefore pursue and compel a binding international agreement regarding space debris, and the Senate must give its bilateral consent to the ratification of that agreement. Something must be done now or the current costs involved in contributing to the proposed fund will be trivial compared to the costs, both to the United States’’ economy and to its national security, of a space debris cascade. Unless space debris is removed, it will essentially control space and space access.343 If the cascade effect is ““inevitable”” unless space debris is removed——a prognostication made even before the February 2009 satellite

collisions344——supporting an international fund to ensure the removal of space debris should be a ““no brainer.”

**THERE ARE NO BINDING INTERNATIONAL STANDARDS ON SPACE DEBRIS-Wright ‘07**

[David; PhD; co-director of the Global Security Program; Space debris from antisatellite weapons; Bulletin of the Atomic Scientists; 01 Oct 2007;<http://www.thebulletin.org/web-edition/features/space-debris-antisatellite-weapons;> retrieved 16 Jun 2011]

Given its importance and changing nature, space requires international laws, regulations, and operational guidelines governing its use to enhance commercial and scientific uses, avoid and settle conflicts, and limit debris production. Parts of this structure exist, but its development hasn't kept pace with the growing complexity of space activities. Moreover, much of what exists isn't legally binding and doesn't have enforcement mechanisms.

One important piece of space law, the Outer Space Treaty, turns 40 in October. While it establishes the fundamental principles for governing space, these principles need to be articulated in laws and regulations to address contemporary challenges and new technologies. Fortunately, the international community is beginning to discuss important issues such as space traffic management. However, international negotiations on military issues in space haven't taken place since the early 1990s.

**THERE IS NO CLEAR INTERNATIONAL POLICY ON DEBRIS-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

There is also a lack of clear policy on both national and international levels. Space-faring countries and the United Nations have only adopted mitigation guidelines and have not cited the development of active debris removal systems as part of their space policies. Moreover, there has been a lack of discussion about what entity is responsible for financing and operating these systems. This is a complicated issue as some nations have created more debris than others, yet all space-faring nations and users of satellites services would benefit from space debris clean up.

A/T: PRIVATE COUNTERPLAN

**FOLLOWING A NATIONAL PROGRAM, THE US COULD ENGAGE THE COMMERCIAL SECTOR-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

Going forward, the U.S. government should engage the commercial sector in space debris removal. Government contracts with several commercial firms would create a competitive environment, encouraging innovation and cost minimization. Having several companies working on the problem at the same time would also accelerate remediation as several critical orbits could be addressed at once. Furthermore, early investments in a domestic space debris removal industry would give the United States a head start in what may become a critical industry over the coming decades.

**THERE IS LITTLE INCENTIVE FOR A PRIVATE ENTITY TO BUILD SPACE DEBRIS TECHNOLOGY-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

There is little incentive for a commercial entity to build its own space surveillance network. With information currently provided at zero cost, there is no profit potential to reward commercial entrepreneurship. Instead, commercial entities are strongly encouraging governments such as that of the United States to continue publishing orbital element sets. In a statement to Congress, Iridium Satellite, the operator of the largest commercial satellite installation in the world, stated, “We encourage continued funding of the Commercial and Foreign Entities (CFE) pilot program to provide space surveillance data to commercial operators to help promote safe operations in space.”162 Some space operators within the commercial sector believe that the TLEs provided through the CFE program are not good enough. David McGlade, the CEO of Intelsat, has stated, “Although CFE has been advantageous for governments and industry, the accuracy of the data currently provided is not sufficient for precise collision detection/assessments, support of launch operations, end of life/re-entry analyses, nor anomaly resolution.”

**THERE IS NO FINANCIAL BENEFIT REMOVING DEBRIS, SO NO PRIVATE COMPANIES-Michaels ‘09**

[Daniel; staff writer; A Cosmic Question: How to Get Rid Of All That Orbiting Space Junk; Wall Street Journal; 11 March 2009;<http://online.wsj.com/article/SB123672891900989069.html;> retrieved 16 Jun 2011]

Multibillion-dollar budgets have parked people in space, allowed global telecommunications and brought Star Wars military systems within reach. But cleanup missions to pick up all the trash cast off by a launch are prohibitively expensive. "The problem with removing space debris is you don't have any financial benefit from doing it," says Dr. Klinkrad.

To rocket scientists, who defy gravity for a living, that's an irresistible challenge. Mr. Hollopeter says he got excited by water-blasting because it's so low-tech. "This is basically the cheapest way I could come up with," says the 61-year-old engineer, who now works for Satellite Communications in Austin, Texas.

Mr. Hollopeter's recent work was sparked by a request last November for space-cleaning ideas from Launchspace Training, a space consulting firm in Bethesda, Md. Launchspace ran the project, which drew more than 100 responses, as a promotion and to tap aging engineers with experience from the U.S.-Soviet space race of the 1960s, says director Robert Russo.

"There's a magnificent pool of knowledge and talent out there, and I think they're just not being asked," says Mr. Russo. He says Mr. Hollopeter's idea was one of the most original, although nuttier concepts were also submitted by "techno-geeks who read science fiction and know nothing about space."

**GOVERNMENTS ARE THE KEY ACTORS TO PREVENT LOSS OF SPACE-Mason, Stupl, et al ‘11**

[James, NASA Ames Research Center and Universities Space Research Association and Jan, Center for International Security and Cooperation, Stanford University; Orbital Debris-Debris Collision Avoidance; http://arxiv.org/PS\_cache/arxiv/pdf/1103/1103.1690v1.pdf; 10 Mar 2011]

While several maneuvers have been required since then, the operational risk is still insufficient to provide incentive for large scale debris remediation effort and this highlights the need for low-cost, technologically mature, solutions to mitigate the growth of the debris population and specifically to mitigate debris-debris collisions which owner/operators can not influence with collision avoidance. Governments remain the key actors needed to prevent this tragedy of the commons that threatens

the use of space by all actors.

A/T: BIG SKY THEORY

**THE BIG SKY THEORY IS WRONG; WE ARE NEAR A TIPPING POINT FOR UNUSABLE ORBITS-Szoka and Dunstan ‘09**

[Berin, Senior Fellow at The Progress & Freedom Foundation and Jim, practices space and technology law; Beware of Space Junk: Global Warming Isn’t the Only Major Environmental Problem; Space Frontier; 20 Dec 2009; <http://spacefrontier.org/2009/12/20/beware-of-space-junk-global-warming-isnt-the-only-major-environmental-problem/;> retrieved 27 Jul 2011]

The engineering wizards who have fueled the Information Revolution through the use of satellites as communications and information-gathering tools also overlooked the pollution they were causing. They operated under the “Big Sky” theory: Space is so vast, you don’t have to worry about cleaning up after yourself. They were wrong. Just last February, two satellites collided for the first time, creating over 1,500 new pieces of junk. Many experts believe we are nearing the “tipping point” where these collisions will cascade, making many orbits unusable.

**THE COLLISION OF TWO SATELLITES IN 2009 DISPROVED THE BIG SKY THEORY-Ansdell ‘10**

[Megan; graduate student, George Washington, International Science and Technology; Active Space Debris Removal: Needs, Implications, and Recommendations for Today’s Geopolitical Environment; Journal of Public and International Affairs; 2010]

The second major space-debris creating event was the accidental collision between an active Iridium satellite and a defunct Russian military satellite on February 10, 2009. The collision created two debris clouds holding more than 200,000 pieces of debris larger than one centimeter at similar altitudes to those of the 2007 Chinese ASAT test (Johnson 2009b). It was the first time two intact satellites accidentally crashed in orbit, challenging the “Big Sky Theory,” which asserts that the vastness of space makes the chances of a collision between two orbiting satellites negligible (Newman et al. 2009).

A/T: PREVENTION IS ENOUGH

**PREVENTION WILL NOT BE SUFFICIENT TO DEAL WITH EXISTING DEBRIS PROBLEM-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

Prevention is the most cost effective way to keep space clean. However, prevention alone will not be enough to secure the future of space assets. The ability to remove space debris actively is imperative and there is no single solution to remove all debris sizes. Current technologies are promising, but further development remains necessary, and no debris elimination technology has yet to be fully demonstrated. Ground-based lasers were found to be the most effective way to remove small debris from LEO. They are much more cost effective than adding shielding to space assets and a demonstration could prove the ability of lasers to remove smaller debris from space. Orbital rendezvous vehicles provide an example of a technology which could be used to remove large debris. The vehicles could be used to move the debris itself or used in conjunction with a drag device such as an electrodynamic tether to de-orbit debris or to place it in a graveyard orbit.

**PREVENTATIVE MEASURES FOR DEBRIS ARE VITAL, BUT INSUFFICIENT-Johnson and Hudson ‘08**

[Lt. Kevin and John, PhD; project supervisors, Global Innovation and Strategy Center; Eliminating Space Debris: Applied Technology and Policy Prescriptions; January 2008; <http://www.slideshare.net/stephaniclark/giscinternpaperspacedebriselimination;> retrieved 27 Jul]

When small debris pieces collide with space assets, the result is not simply a matter of speed, but also of motion. “Because the (low earth orbit) velocities are so high, the kinetic energy is very high. It’s the equivalent of exploding several sticks of dynamite in your spacecraft,” noted a BBC report on the problem.33 Debris fragments as small as one-tenth of one millimeter could potentially puncture the suit of an astronaut.34 The “Kessler effect”35 complicates matters further: as the volume of satellites increases, so does the probability that they will collide with each other.36 Such a chain reaction is “inevitable,” according to Dr. Johnson37 in an interview with The New York Times, “A significant piece of debris will run into an old rocket body, and that will create more debris. It’s a bad situation.” In summary, while preventative measures against debris creation are vital, they will not prevent further growth arising from existing debris.

**THE REAL THREAT IS SATELLITES ALREADY IN SPACE-The Economist ‘10**

[Scientists are Increasingly Worried About the Amount of Debris Orbiting the Earth; The Economist; 19 Aug 2010; <http://www.economist.com/node/16843825?story_id=16843825&fsrc=rss;> retrieved 27 Jul 2011]

The real threat now comes from collisions between things that are already up there—so much so that since the demise of *Iridium 33*, the normally secretive Strategic Command (Stratcom) of America’s Defence Department has become rather helpful. Brian Weeden, an expert on space debris at the Secure World Foundation, a think-tank, says Stratcom now screens every operational satellite, every day, looking for close approaches, and notifies all operators. Even the Chinese? “Everybody,” he says, “the Russians, the Chinese, even the Nigerians.” This means that satellites’ owners have better information with which to decide whether to use a small amount of their precious fuel reserves to avoid a collision.

A/T: LASERS=SPACE WEAPONS

**TURN: THE SUDDEN LOSS OF A SATELLITE DUE TO DEBRIS COULD PROVOKE ESCALATION-Wright ‘07**

[David, PhD, ; Union of Concerned Scientists;Debris in Brief: Space Debris from Anti-Satellite Weapons; December 2007; <http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons/technical_issues/debris-in-brief-space-debris.html;> retrieved 11 Jul 2011]

The Chinese destruction of a relatively small satellite roughly doubled the debris threat to satellites in the most heavily used part of LEO. Fortunately, the debris threat to satellites is still relatively small, but continued testing of destructive ASAT weapons against satellites, or their use against several large satellites in a conflict, could result in a much higher risk.

ASAT weapons could therefore significantly increase the cost of using space, and could hinder using regions of space that today are widely used for a range of purposes. Beyond that, the sudden loss of a satellite due to debris during a crisis could remove important capabilities, or could lead to dangerous reactions and the escalation of the crisis, especially if the adversary was known to have an ASAT capability.

**NASA’S NEW NASA PROPOSAL DOES NOT USE WEAPONIZED, EXPENSIVE LASERS-Grossman ‘11**

[Lisa; staff writer; NASA Considers Shooting Space Junk With Lasers; Wired; 15 Mar 2011;<http://www.wired.com/wiredscience/2011/03/lasering-space-junk/#more-54167;> retrieved 16 Jun 2011]

NASA scientists have suggested shooting space junk with lasers before. But earlier plans relied on military-class lasers that would either destroy an object altogether, or vaporize part of its surface and create little plasma plumes that would rocket the piece of litter away. Those lasers would be prohibitively expensive, the team says, not to mention make other space-faring nations nervous about what exactly that military-grade laser is pointing at.

The laser to be used in the new system is the kind used for welding and cutting in car factories and other industrial processes. They’re commercially available for about $0.8 million. The rest of the system could cost between a few and a few tens of millions of dollars, depending on whether the researchers build it from scratch or modify an existing telescope, perhaps a telescope at the Air Force Maui Optical Station in Hawaii or at Mt. Stromlo in Australia.

“This system solves technological problems, makes them cheaper, and makes it less of a threat that these will be used for nefarious things,” said space security expert Brian Weeden, a technical adviser for the Secure World Foundation who was not involved in the new study. “It’s certainly very interesting.”

**THE LASER IS INTENTIONALLY DESIGNED NOT TO RAISE FEARS OF WEAPONS IN SPACE-Satnews Daily ‘11**

[NASA Laser to Remove Space Debris?; SatNews Daily; 17 Mar 2011; <http://www.satnews.com/cgi-bin/story.cgi?number=1202250009;> retrieved 26 Jul 2011]

The idea of using an industrial-strength laser — not something more powerful — is meant to help assuage fears that the technology would be used for nefarious purposes, such as blasting another nation's satellite.

"We are intentionally trying to make the system non-threatening ... this is, in general, not enough intensity to mechanically damage a satellite," he said. Brian Weeden, a technical adviser for the Secure World Foundation, told Wired.com the concept is less of a threat than other proposed systems, but "I don't think it is a long term solution. I might be useful to buy some time, but I don't think it would replace the need to remove debris, or stop creating new junk."

A/T: LIABILITY CONVENTION

**THE LIABILITY CONVENTION DOES NOTHING TO REGULATE DEBRIS CREATION-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

More importantly, even if the terms of the Liability Convention do encompass space debris, it does nothing to deter debris creation, because the Liability Convention requires fault before liability can be assessed. Article III of the Liability Convention states that when a launching state causes damage in space to a space object or to persons on board that space object, the state causing the damage

““shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.””226 Accordingly, absent fault, which can be difficult to prove in the space environment, no liability attaches when space debris unintentionally causes damage in space. Therefore, from a liability cost––benefit analysis, the Liability Convention provides little motivation for space-faring nations to minimize space debris or to clean up the debris currently in existence.

**THE LIABILITY CONVENTION IS A LIMITED DETERRENT TO DEBRIS AT BESTImburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

Moreover, the ““Liability Convention speaks only of damage to persons or property, but not for damage caused to the outer space environment.””227 Article I(a) defines ““damage”” to mean ““loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations.””228 Nothing in the Liability Convention mandates the prevention of space debris that does not cause physical damage to other objects or persons.229 Therefore, the Liability Convention does nothing to force nations to remove the existing space debris that fails to cause physical damage, even though it causes launch delays or collision-avoidance maneuvers. Instead, the Liability Convention serves ““only as a limited deterrent to States’’ generation of space debris.””230

**THE LIABILITY CONVENTION CANNOT BE USEFUL TO CONTROL DEBRIS-Imburgia ‘11**

[Lt. Colonel Joseph; Judge Advocate, US Air Force; Space Debris and Its Threat to

National Security: A Proposal for a Binding International Agreement to Clean Up the Junk; Vanderbilt Journal of Transnational Law; Volume 44:589, 2011]

Finally, the Liability Convention fails to ““provide any specific mechanism for establishing the identity of space objects launched into outer space, or the associated debris that might”” be created.231 Instead, the Liability Convention operates under the assumption that the launching state of any given space object will be easily identifiable.232 With space debris, however, ““[t]his is quite clearly not the case.””233 Accordingly, even if the Liability Convention did apply to space debris, ““[l]iability for damage caused by space debris [would be] difficult to establish, as it [would be] difficult to determine the specific source of a piece of debris, particularly when it is a small piece that has not been cataloged.””234 The Liability Convention therefore leaves ““too many gaps to be very useful regarding the problem of [space] debris.