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## 1AC

**CONTENTION ONE – THE STATUS QUO IS FAILING**

**FIRST, NASA WILL NOT MEET ITS 2020 ASTEROID DETECTION GOALS NOW – STATUS QUO IS FAILING TO PROVIDE ENOUGH RESOURCES FOR THE PROGRAMS**

**Mason, 2009** (Betsy, masters degree in geology from Stanford, science editor for wired.com“NASA Falling Short of Asteroid Detection Goals” 2009, Conde Nast Digital, <http://www.wired.com/wiredscience/2009/08/neoreport/>) Max /Justin/Chris

Without more funding, NASA will not meet its goal of tracking 90 percent of all deadly asteroids by 2020, according to a report released today by the National Academy of Sciences. The agency is on track to soon be able to spot 90 percent of the potentially dangerous objects that are at least a kilometer (.6 miles) wide, a goal previously mandated by Congress. Asteroids of this size are estimated to [strike Earth](http://http:/bit.ly/jFNfl) once every 500,000 years on average and could be capable of causing a global catastrophe if they hit Earth. In 2008, NASA’s [Near Earth Object Program](http://neo.jpl.nasa.gov/index.html) spotted a total of [11,323 objects](http://neo.jpl.nasa.gov/stats/) of all sizes. But without more money in the budget, NASA won’t be able to keep up with a 2005 directive to track 90 percent of objects bigger than 460 feet across. An impact from an asteroid of this size could cause significant damage and be very deadly, particularly if it were to strike near a populated area. Meeting that goal “may require the building of one or more additional observatories, possibly including a space-based observatory,” according to [the report](http://www.nap.edu/catalog.php?record_id=12738#toc). The committee that investigated the issue noted that the United States is getting little help from the rest of the world on this front, and isn’t likely to any time soon. Another report is planned for release by the end of the year that will review [what NASA plans to do](http://neo.jpl.nasa.gov/neo/pdc_paper.html) if we spot a life-threatening asteroid headed our direction.

**AND, NO NATION IS CURRENTLY DEPLOYING A SPACE-BASED OBSERVATORY NOW TO DETECT NEAR-EARTH OBJECTS**

**National Academy of Science, 10.** (National Academy of Science is comprised of the top scientists based on their individual work and achievements, no date, 2010, “Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies,” pdf document, CALLAHAN)

No nation has had or currently operates a space-based observatory dedicated to the discovery and/or characterization of NEOs. Space-based observatories are, however, planned for launch that will help to discover and/or characterize NEOs, especially because of the sensitivity of the observatories’ telescopes to infrared light, as explained below. Asteroids in orbits that bring them close to Earth are especially menacing if they are dark and have evaded detection by ground-based surveys in visible light. Also, since the assumed albedo might not be representative of a dark object, the calculated diameter could be misrepresented as smaller than the object’s true diameter. But dark objects are especially detectable in infrared light. The bias against lower-albedo (darker) asteroids is reduced through the use of infrared observations in space: At the temperatures and albedos that dominate the solar system inside the orbit of Mars, the diameters computed from infrared signals are more accurate than those derived from visible-light reflections from asteroids and comets. Thus, the detections of potentially hazardous NEOs by an infrared telescope (one sensitive to infrared light) will result in a more accurate size-frequency distribution for these objects. Additionally, the background from other astronomical sources is about 100 times lower at infrared wavelengths of 10 microns (a micron is one-millionth of a meter) than at visible wavelengths, since most stars emit far less infrared light than visible light. This difference reduces the chance for interference from other strong astronomical sources. Combined with visible-light data, the albedos of NEOs detected in the infrared can also be derived. This derivation of albedos offers insight into composition and surface properties. The Wide-field Infrared Survey Explorer for Near-Earth Objects (NEOWISE), a U.S. mission (see below), will leverage this infrared advantage. Canada and Germany are both building spacecraft (see below) that could contribute to the discovery of NEOs, especially those whose orbits are partially or fully inside Earth’s orbit. These NEOs are less able to be observed by ground-based telescopes because they are so close to the Sun, as seen from Earth. Searching for NEOs from orbits in which spacecraft can be positioned to observe objects while the spacecraft is not pointed toward the Sun is an advantage for observing NEOs with orbits largely inside Earth’s orbit. Neither mission, however, will detect fainter or smaller objects than those detected by ground-based telescopes.

## 1AC

**PLAN: THE UNITED STATES FEDERAL GOVERNMENT SHOULD SUBSTANTIALLY INCREASE ITS EFFORTS TO SURVEY AND TRACT NEAR EARTH OBJECTS, INCLUDING SPACE-BASED MEASURES.**

## 1AC

**ADVANTAGE I – LARGE ASTEROID ARMAGGEDON**

**It is not a question of if, but when an asteroid will collide with the Earth – a collision will make the devastation of a nuclear weapon seem minimal – the Affirmative prevents a tidal wave of environmental catastrophes that would kill billions – impact of an asteroid collision trumps any of your spending arguments**

**Sagan and Ostro 94** (Carl, Editor “Issues in Science and Technology”, and Steven, Editor, “Issues in Science and Technology” “Long-range consequences of interplanetary collisions.” 6/22/94http://elibrary.bigchalk.com/elibweb/elib/do/document?set=search&dictionaryClick=&secondaryNav=&groupid=1&requestid=lib\_standard&resultid=1&edition=&ts=5F4EDF6D6382539965B2AA9E564E5FF2\_1310419971306&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B28902300) Steven Canova

As Comet Shoemaker-Levy 9 races toward its mid-July **collision** with the planet Jupiter, considerable public attention is being focused on catastrophic impacts with the Earth--in the past and in the future. In recent years calls have been made to develop technologies that could deflect any asteroid or comet found to be on a **collision** course with Earth. But before devoting resources to this scheme, careful consideration must be given to the nature and time scale of the risk and to the cost-effectiveness and possible booby traps in the suggested means of mitigation. Comets have been associated with catastrophes in almost all cultures and since remotest antiquity. The first such argument with a modern scientific flavor was offered by Edmund Halley in 1688. He wondered if the Noachic flood could have been caused by tidal effects from a grazing **collision** (or an actual impact) of a comet with the Earth and proposed in effect a comet-induced tsunami. Since then the impact danger of small worlds has been a common motif in popular culture. Scientists have, until recently, generally responded with reassurances about the improbability of perilous **collisions**. This summer's impact with Jupiter reminds us that improbable is not impossible. We now know that the Earth orbits the Sun amid a swarm of small bodies. Some 200 Earth-orbit-crossing asteroids (ECAs) and a much smaller number of Earth-orbit-crossing comets have been discovered, almost entirely by a handful of observers using small telescopes. These limited searches, in tandem with analyses of the lunar and terrestrial cratering records, have established that the ECA population awaiting **detection** is enormous. There are thought to be some 2,000 objects as large as 1 kilometer in diameter, 320,000 as large as 100 meters, and 150,000,000 as large as 10 meters. It is a straightforward consequence of orbital mechanics and probability theory that, through its long history, the Earth will be struck, at typical velocities of 20 kilometers per second, many times by these objects. **Collisions** with the larger members of this population are catastrophic. The greatest danger is from impacts energetic enough to inject so much pulverized soil and rock into the stratosphere as to darken and cool most of the Earth, regardless of the impact location. Unlike most familiar hazards, the impact threat works on many different time scales, all much longer than a human lifetime. On average, every millennium there will be a **collision** event as energetic as the highest-yield nuclear weapon ever detonated (the result of an impact of an object a few tens of meters in diameter); every 10,000 years, one that may have global climatic effects (the result of an impact of an object 200 meters in diameter); and every million years, an impact event tens of times more energetic than the aggregate yield of the world's current nuclear arsenal (the result of an impact of an object 2.5 kilometers in diameter)--enough to cause a global catastrophe and kill a significant fraction of the human species. The evolution of life on Earth seems to have been profoundly altered by **collisions** with such bodies. The best-attested such event, and the single-most important reason that interplanetary **collision** hazards are being taken seriously today, is the Cretaceous-Tertiary (K-T) catastrophe of about 66 million years ago, in which all the dinosaurs and about 75 percent of the other species of life on Earth were rendered extinct. The events attendant to that impact are thought to include a global immolation of land plant life, widespread tsunamis, chaotic ocean mixing, a decline in light levels toward and below the compensation point of photosynthesis (below which plants burn more chemical energy than they store), short-term average global temperature declines of 10 [degrees] C or more, global acid rain, significant depletion of the protective ozone layer, and prolonged carbon-dioxide-induced global warming. The relative hazards provided by each of these factors is unknown, but it seems likely that a quick succession of environmental catastrophes is nonlinearly more dangerous, because organisms immune to or only weakened by one assault may be finished off by the next. Even an impact much less severe than the K-T event would pose a serious threat to our global civilization. A conservative rough threshold for the diameter of a colliding asteroid that would cause a global catastrophe (and not just local devastation) is set at about 1.5 kilometers. Such a **collision** would release an energy equivalent to 100,000 megatons of TNT, disrupt the ecosphere, terminate agriculture, and likely kill more than a billion people. Refining current assessments of the impact hazard is therefore well worth doing, especially because, compared with many other activities of our civilization, it is so cheap.

## 1AC

**A COLLISION FROM A LARGE ASTEROID MAKES THE GLOBE UNINHABITABLE – ECONOMIES WILL COLLAPSE, ANARCHY WILL ENSUE, ROCKS WILL RAIN FROM THE SKY, GRAVITATIONAL TIDAL WAVES WILL KILL BILLIONS – ANY SURVIVORS WILL BE KILLED BY THE RUNAWAY GLOBAL WARMING THAT WILL FOLLOW**

**Paine, 99** (Michael, writer for the Planetary Society, “How an Asteroid Impact Causes Extinction” Space.com, 5/11/99, <http://idisk.mac.com/mpaineau-Public/rocks_from_space/asteroid_extinction.pdf>) [JHegyi14]

NASA scientists announce they have detected a 10-mile-wide asteroid on a collision course with the Earth. They calculate it will hit Southeast Asia in two weeks. There is no chance of Bruce Willis being sent on a beefed-up space shuttle to blow up the asteroid. Earthlings will have to ride out the impact. The world economy grinds to a halt as people take to the hills. Anarchy sets in, civilization breaks down. Accusations fly over the lack of warning -where was Spaceguard, the proposed international search effort for large asteroids? People in Brazil feel less vulnerable than most of the world's population. They are on the opposite side of the Earth from the predicted impact point. But one hour after the impact Brazilians notice some brilliant meteors. Then more meteors. Soon the sky gets brighter and hotter from the overwhelming number of meteors. Within a few minutes trees ignite from the fierce radiant heat. Millions of fragments of rock, ejected into space by the blast, are making a fiery return all over the planet. Only people hiding underground survive the deadly fireworks display. Within three hours, however, massive shock waves from the impact travel through the Earth's crust and converge on Brazil at the same time. The ground shakes so violently that the ground fractures and molten rock spews from deep underground. Maybe Brazil wasn't the best place to be after all. The survivors of the firestorms, tsunami and massive earthquakes emerge to a devastated landscape. Within a few days the Sun vanishes behind a dark thick cloud -- a combination of soot from the firestorms, dust thrown up by the impact and a toxic smog from chemical reactions. Photosynthesis in plants and algae ceases and temperatures plummet. A long, sunless Arctic winter seems mild compared to the new conditions on most of the planet. After a year or so the dust settles and sunlight begins to filter through the clouds. The Earth's surface starts warming up. But the elevated carbon dioxide levels created by the fires (and, by chance, vaporization of huge quantities of limestone at the impact site) results in a runway greenhouse effect. Those creatures that managed to survive the deep freeze now have to cope with being cooked. Many species of plants and animals vanish. The few hundred thousand human survivors find themselves reverting to a Stone Age existence. Is it fiction? Computer modeling of asteroid impacts and climatic effects suggest that this devastating sequence of events could happen.

**AND, WE WILL OUTWEIGH YOUR NUCLEAR WAR SCENARIO 15 BILLION TIMES OVER – AN ASTEROID COLLISION FAR OUTWEIGHS THE IMPACT FROM A NUCLEAR EXPLOSION – WE CONTROL THE ONLY EXTINCTION SCENARIO IN THE ROUND**

**Hawkes, no date.** (Bob is a member of the Meteorites and Impacts Advisory Commission, an advisory group to the Canadian Space Agency, no date given, “A comet or asteroid impact with the earth – how real is the threat?” <http://miac.uqac.ca/MIAC/impactearth.htm>, CALLAHAN)

There is now widespread acceptance that the dinosaurs and more than 70% of all species suffered mass extinctions about 65 million years ago as the result of an impact of a comet or asteroid. The remnants of this collision remain in the Yucatan Peninsula of Mexico. About 140 major impact craters on Earth (and countless craters throughout the solar system) prove that planets are regularly battered by huge meteorites. In July 1994 Comet Shoemaker-Levy 9 impacted the planet Jupiter. Recently scientists have found evidence in Chad (in Africa) for a similar impact on planet Earth (but with much smaller comet fragments). The entrance speeds (11 to 74 km/s) of comets and asteroids are so high that these objects possess more kinetic energy per mass than the chemical energy per mass represented by explosives such as TNT. A 10 km diameter asteroid entering at 30 km/s would have the energy equivalent to 15 billion times that of the Hiroshima nuclear bomb. The effects from a major (about10 km in size) impact include: shock waves in the crust of the earth, tsunamis (tidal waves), firestorms over large portions of a continent, destruction of the ozone layer, atmosphere alteration (due to the huge amount of material ejected into the upper atmosphere), etc. and range in time scales from hours to thousands of years. While we would, on average, expect one such dramatic impact every ten million years, our state of ignorance of the population of near earth objects (NEOs) is such that we have no guarantee that it will not happen during our lifetime. Also, we would expect that a 50 to 100 m sized object, still capable of generating dangerous tsunamis, would strike Earth every century or so (the last such event occurred in June, 1908 in Tunguska in Siberia). A land impact of a more modest object can also cause severe destruction, through earth shocks and firestorms. One can estimate the approximate area of devastation from such objects by using the relationship area of devastation (in square km) =3D 400 x (kinetic energy in terms of megatons of TNT)2/3. A 500 m object would be expected to devastate an area comparable to Ontario plus Quebec. The probability of a comet impact is probably less than that posed by near earth asteroids, although it is also much more difficult to defend against (e.g. Comet Hyakutake, which passed very close to the Earth in late March this year, had only been discovered two months prior). The relative speed of impact for comets is, on average, much higher so that a smaller object can pose a greater threat. Can our society protect itself from a catastrophic impact? The answer is probably yes, if we choose to make the effort. A relatively minor (~ 0.1 m/s) push on a typical NEO when it is nearest the sun (at perihelion) will result in its orbit being changed sufficiently to safely miss the Earth. We need to better estimate the hazard posed (and identify the specific consequences with more precision), through better models of the atmospheric effects of major impacts. It would be irresponsible to spend huge sums of money in a search for NEOs, if the effects were in fact not those currently expected. The precise effects depend on the degree of atmospheric fragmentation of the impactor, and the fragmentation of large meteoroids is being actively researched in Atlantic Canada. Next we need to better estimate the populations of dangerous objects, and determine the orbits of dangerous objects. The first earth-intersecting orbit asteroid was found only in 1932, and half of all known objects have been found since 1990. However, even at the current rate of detection it is estimated that it will require several centuries to have detected 99% of the dangerous objects. Finally, we need to develop techniques for diverting potential impactors to prevent catastrophic collisions. The most likely technique involves explosion of a nuclear weapon at (or above) the surface of the NEO (chemical explosives do not possess enough energy per mass), although other techniques (such as "solar sails") are also possible.

## 1AC

**AND, OUR IMPACT IS MORE PROBABLE THAN YOURS – A PERSON HAS A HIGHER CHANCE OF BEING KILLED BY AN ASTEROID COLLISION THAN A PLANE CRASH**

**Rees, 2000, (**Professor Sir Martin, Professor of Cosmology and Astrophysics at the University of Cambridge “The risk is real”, September 22, 2000, LexisNexis Academic) [Max Waxman]

A British Government task force this week said a defence centre to identify and track asteroids should be set up. Astronomer PROFESSOR SIR MARTIN REES in London writes that our planet faces real dangers from space. A GIANT lump of cosmic rock hurtling ever closer to our fragile planet, threatening nuclear winters, kilometre-high tidal waves and global infernos, is a beloved scenario of Hollywood directors, but it has more basis in fact than fiction, something we have been slow to recognise. The astonishing truth is that the average person is at greater risk of being killed by an asteroid - a large lump of rock from outer space - than dying in a plane crash. Indeed, in western Europe and North America, you are more likely to die from an asteroid striking Earth than from any other form of natural disaster. Just as we need to understand and prepare for natural disasters here on Earth, it is only right that we should be aware of the genuine dangers the planet faces from outer space.. That is why we should welcome, rather than ridicule, this week's recommendation by the British Government-appointed task force for the establishment of an asteroid defence centre. The task force is made up of eminent scientists who had been charged with assessing the potential hazards of "near-Earth objects" colliding with our planet. Space is littered with a range of dangerous debris - comets, asteroids, rocks of all sizes and vast tracts of dust - which are the "builders' rubble" left over from the formation of the planets. These objects move at enormous speeds - up to 100 times faster than a bullet. Very small particles hit the Earth in vast numbers regularly but they generally burn up in the atmosphere, giving rise to what we call "shooting stars". A swarm of tiny asteroids led to the spectacular Leonid display or "meteor storm" that illuminated skies in many parts of the world last November. But objects hurtling between the planets aren't all small and harmless. Asteroids can be many kilometres in diameter and can have some devastating consequences.

**AND, POLICYMAKERS HAVE A RESPONSIBILITY TO UTILIZE THE PRECAUTIONARY PRINCIPLE WHEN MAKING A DECISION ABOUT ASTEROID POLICY – ONE MUST ERR ON THE SIZE OF MAGNITUDE EVEN IF THE PROBABILITY IS PROVEN SMALL – DEFAULT TO WORST-CASE PREDICTIONS**

**Seamone 04** (Evan R., J.D., University of Iowa College of Law; M.P.P. and B.A., University of California, Los Angeles. Evan Seamone is an attorney and a Judge Advocate in the U.S. Army stationed at Fort Polk, Louisiana, “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, Vol. 17, Iss. 1; pg. 1, 23 pgs, Fall 2004, <https://litigation-essentials.lexisnexis.com/webcd/app?action=DocumentDisplay&crawlid=1&doctype=cite&docid=17>+

Geo.+Int'l+Envtl.+L.+Rev.+1&srctype=smi&srcid=3B15&key=a2a4327cc80f04b8f9c09805718305b8) [Iuliano]

The precautionary principle governs responses to unknown types of harm. In many international agreements and other bodies of rules, the principle obligates governments to institute measures to prevent potential harm from a source, even if it is not certain if, when, or where, the harm will occur. n22 The current policy of [\*7] the United States requiring agencies to prevent terrorist attacks before they occur rests squarely within this principle. Mitigation measures contained in this policy depend on preventive and anticipatory action: "the greater the threat, the greater the risk of inaction -- and the more compelling the case for taking anticipatory action to defend ourselves, **even if uncertainty remains as to time and place of the enemy's attack***."* n23 In the context of planetary defense, the same principle applies because some natural impact threats can strike without notice (*e.g*., long-period comets). Likewise, in hypothesized situations where asteroids are spotted with some advance notice, response times may require so much preparation that delaying action will preclude effective intervention. In line with the precautionary principle, lawmakers and planners should be cautious of adopting different alternatives to deal with asteroid and comet threats that are projected to occur within different timeframes. n24 While some priorities must change over time, such as evacuating people in impact zones closer to the time of impact, governments must be capable of responding to threats of the greatest magnitude at all times. Planning for a "worst case scenario" is common in disaster relief circles. Whether the harm is an earthquake, flood, or other natural disaster, the government's goal must be to withstand maximum harm; not only harm that is considered "normal." n25 The logic underlying this practice recognizes that there may only be one chance to avert significant harm. Multiple [\*8] plans for every imaginable scenario could lead to mass confusion. n26 The consequence of the precautionary principle on policy is the adoption of "effectiveness as international law" in measures to mitigate a potential threat. n27 This means that governments have an obligation to respond to crisis with the most effective measures warranted by the circumstances, *i.e.,* measures that will preserve the greatest number of lives and protect the most property. n28 This simple proposition provides governments with necessary guidance where other well-intentioned policies and principles cannot. Most importantly, it requires prompt action and not merely proclamations of good will that have little force.

## 1AC

**AND, PREFER OUR IMPACTS – AN INTERVENING ACTOR CANNOT PREVENT A NATURAL DISASTER THAT GOES UNDETECTED – THEIR IMPACTS OF NUCLEAR WAR AND TERRORISM ALWAYS HAS AN INHERENT CHECK OF AN INTERVENING ACTOR**

Seamone 03 (Evan R., J.D., University of Iowa College of Law; M.P.P. and B.A., University of California, Los Angeles. Evan Seamone is an attorney and a Judge Advocate in the U.S. Army stationed at Fort Polk, Louisiana, “The Duty to ‘Expect the Unexpected’: Mitigating Extreme Natural Threats to the Global Commons Such as Asteroid and Comet Impacts with the Earth,” Columbia Journal of Transnational Law, 2003, Lexis [Iuliano]

This Article addresses "extreme" n7 natural threats that endanger multiple countries simultaneously, in particular the threat of "natural impact" - i.e., the threat of asteroids or comets striking the Earth. These threats are particularly dangerous because they are not preceded by the many indicators that enable law enforcement agencies to prevent acts of terrorism, such as "chatter," the transfer of large sums of money, and odd travel patterns. n8 Often, natural threats cannot be prevented, which means that equal, if not greater, emphasis must be placed on post-disaster response. n9 Consequently, the prototype for identifying the duties of governments to plan for and act in the face of massive harm cannot be the traditional, isolated natural disaster, such as the tornado, earthquake, or typhoon, which does not necessarily involve an international response. While the date of the next asteroid or comet disaster remains unknown, the potential for serious harm from these objects cannot be denied. n10 Although the much glamorized "global killer" (perhaps as large as ten kilometers in diameter n11), which would potentially [\*739] eliminate most life on Earth, might only occur after many millions of years, n12 our planet is bombarded daily with countless smaller objects. n13 At least three events, in Tunguska, the Amazon, and Central Asia, within the last 100 years alone would have killed "thousands and perhaps hundreds of thousands," had they occurred in more populated areas. n14 While most objects end up in the Earth's oceans, the closeness in time of these recorded smaller-scale events on land suggests that nations will probably have to deal with some level of harm from the sky within the next century. n15 Regarding threats of the highest magnitude, the results of the bombardment of Jupiter by the Shoemaker Levy-9 comet n16 basically confirm the statement of U.S. Representative George E. Brown, Jr.: If some day in the future we discover well in advance that an asteroid that is big enough to cause a mass extinction is going to hit the Earth, and then we alter the course of that asteroid so that it does not hit us, it will be one of the most important accomplishments in [\*740] all of human history. n17 Many characteristics of natural impact threats are common to all natural threats that endanger the global commons, as well as to harms originating from humans. Understanding applicable governmental duties requires an analysis of domestic and international law, historical precedents, and various aspects of risk analysis.

## 1AC

**ADVANTAGE 2 – SMALL ASTEROIDS**

THE THREAT FROM NEOs ARE REAL AND IMMEDIATE – A SMALL NEO ATTACK COULD LEAD TO MISCALCULATON AND A NUCLEAR RESPONSE

Norris, 04. (Guy Norris is the award-winning West Coast editor for Flight International, cites an international group of scientists and engineers. March 30, 2004, “Deep impact; How serious a threat do near Earth objects pose, and what is being done to prevent the devastation that a collision would inevitably cause?” lexis, CALLAHAN)

On 18 March a mysterious object raced across the evening sky over the South Atlantic. Large enough to destroy a city, a 30m (100ft)-plus diameter rock with an energy equivalent to a 0.5 megaton bomb brushed past the Earth and hurtled onwards through space. Only two months earlier, the NASA-funded Spaceguard telescope spotted a massive asteroid on an apparent collision course with the planet. With around 24h to go before the estimated impact in the northern hemisphere, astronomers recalculated the near Earth object's (NEO) trajectory and discovered that it would clearly miss the planet. Although this all sounds familiar as the fodder for science fiction writers and "doomsday" movie scripts, the threat to Earth from NEOs is real and immediate, says an international group of scientists and engineers. They hope that news of these two recent incidents, plus revelations of the frequency of other near misses, will be a wake-up call to the international community. "The public has to learn we are living in a shooting gallery," says a delegate at the first American Institute of Aeronautics and Astronautics planetary defence conference held recently in California. With input from the conference, the group is drawing up a "white paper" to help guide what it hopes will be a blueprint for the first organised global defence against asteroids and comets. How real is the threat? Some NEOs -- like the 10km (6.2 miles)-diameter Cretaceous-Tertiary asteroid judged to have possibly led to the extinction of the dinosaurs -- are large enough to destroy the human species, while many smaller ones have the potential to wreak nuclear weapon-like havoc.   Previous collisions Large NEOs are known to have hit the planet more than 139 times and evidence exists of more than 93 craters between 5km and 200km in diameter. In 2002 three NEOs came close to the Earth, two of which were not discovered until after they had passed. As recently as 13 January a large NEO, now estimated to be around 500m in diameter, was discovered approaching the planet. Then there are the smaller NEOs, such as the one that grazed the atmosphere on 18 March, which have the potential to cause disaster if they are misinterpreted by a tense nation as a nuclear attack. Outgoing US Air Force Space Command development and transformation director Brig Gen Pete Worden describes one such incident on 6 June 2002 when a "small NEO impact" of around 10 megaton equivalent size lit up the night sky as it exploded in the atmosphere over the Mediterranean. "We were in the middle of a crisis situation as Pakistan and India were at loggerheads with each other. What would have happened if that had gone off over New Delhi or Islamabad? Neither country has the ability to clearly define what has happened. This is the kind of NEO issue we need to deal with -- it's not just about dinosaur bones." A recommendation of the conference will call for the funding of a next-generation Spaceguard survey effort (originally set up with NASA funding in 1998) to detect and catalogue potentially hazardous NEOs larger than 140m, a move embraced within a bill introduced in the US Congress on 11 February. Similar actions are under way in Europe with plans to support NEO surveys from advanced 3m-class telescopes in the Canary Islands. The US Department of Defense will be asked to speed up the release of data on NEOs and meteorites, particularly over areas where unexpected high-altitude detonations could be misinterpreted.   Tracking the threat Thanks largely to NASA's Spaceguard survey conducted through the MIT-Lincoln Lab military telescope in New Mexico, and mostly amateur astronomers, more than 680 NEOs with diameters greater than 1km have been discovered and tracked. Between 300 and 500 NEOs in this class are estimated to exist, but remain undetected, says NASA. An estimated 200,000 of the smaller NEOs in the 100m diameter range also await discovery and tracking. One of the expected recommendations from the conference is the need to establish a globally recognised authority or "home" for the planetary defence initiative, as well as the setting up of a chain-of-command structure to handle detection, threat verification, countermeasures and alerting. The paper is also expected to recommend the launch of low-cost mini/microsatellites to rendezvous with NEOs. The missions would help characterise the nature of different NEO types and could also be used to "tag" them with transponders.

**Small asteroids explode when they hit the atmosphere, mimicking nuclear explosions and inevitably causing miscalculation and nuclear war**

Munro, 02. (Margaret Munro is an award-winning science correspondent for the National Post, a Canadian newspaper. November 22, 2002, “How small asteroids could trigger nuclear war,” lexis, CALLAHAN)

A leading space scientist is warning that small asteroids from space that detonate like bombs as they crash into Earth's atmosphere might accidentally set off a nuclear war. "They mimic nuclear explosions when they hit the atmosphere," said Professor Peter Brown, of the University of Western Ontario, who led a report in the journal Nature yesterday on asteroids that slam almost weekly into Earth's upper atmosphere and explode as fireballs. If one of the bigger rocks was to explode over a country such as Iraq or India when tensions are high, Brown said there is a danger it might be mistaken for a nuclear detonation and provoke retaliation. "By misinterpretation it might trigger a nuclear war." For the study, he and his colleagues were privy to classified information from U.S. military satellites on explosions caused by 300 space rocks, measuring between one and 10 metres in diameter, that have crashed into the upper atmosphere in the last eight and a half years. The United States is the only country with an ability to distinguish between explosions from small asteroids and those caused by nuclear weapons. Brown said he would like to see more effort made to track small asteroids and to share the information. "You'd get a heads up," he said, "and less potential for misinterpretation.” Scientists have long worried about kilometres-wide asteroids, like the one that is believed to have wiped out the dinosaurs 65 million years ago. Brown said smaller space rocks are almost as worrisome because they are much more common. A rock between 30 and 50 metres across exploded over Siberia in 1908 with the force of a 10-megatonne bomb. The resulting shock wave flattened trees in area measuring almost 2,000 square kilometres. If a similar event were to take place over a densely populated region of the world today, scientists say the death toll could be in the millions. To understand the threat posed by space rocks, Brown and his colleagues at U.S. Space Command, and Los Alamos and Sandia National Labs in the United States, looked at data collected by the U.S. military satellites that monitor nuclear explosions and "other objects of military interest on or above Earth's surface." The satellites picked up explosions generated when 300 space rocks hit the upper reaches of the atmosphere from February, 1994, to September, 2002. The satellite readings on the brightness of the explosions were used to calculate the size of the rocks, which researchers say measured between one and 10 metres across. The biggest explosion occurred over the South Pacific in February, 1994, releasing between 30 and 70 kilotonnes of energy, more than the bomb dropped on Hiroshima in 1945.

## 1AC

**Nuclear-armed nations don’t have the capability to distinguish between asteroid explosions and nuclear attacks, which causes miscalc and nuclear war**

Recer, 02. (Paul is the science writer for the Associated Press. October 4, 2002, “War danger seen from asteroids;

Air Force general says blasts could be mistaken for a nuclear attack,” lexis, CALLAHAN)

WASHINGTON - Asteroids regularly explode over the Earth with the intensity of a nuclear bomb and there is a chance the explosions could be mistaken for a nuclear attack, possibly triggering an atomic war, an Air Force general said Thursday. At least 30 times a year, a space rock measuring a few yards across slashes into the atmosphere and explodes, releasing energy equal to that of an atomic bomb, Air Force Brig. Gen. Simon P. Worden told members of a House Science subcommittee. Worden, deputy director for operations of the U.S. Strategic Command, said the United States has satellite instruments that determine within a minute if the explosion is a nuclear weapon or a natural explosion from an asteroid. But no one else has such technology, he said, and without it, some countries could conclude the explosions came from a nuclear bomb and could launch an atomic attack against an enemy. For instance, Worden said Pakistan and India, both of which have the atomic bomb, were at full alert in August, poised for war. Not far away, a few weeks before, Worden said, U.S. satellites detected over the Mediterranean an atmospheric flash that indicated "an energy release comparable to the Hiroshima burst." Air Force instruments quickly determined it was caused by an asteroid 15 feet to 30 feet wide. "Had you been situated on a vessel directly underneath, the intensely bright flash would have been followed by a shock wave that would have rattled the entire ship, and possibly caused minor damage," Worden said in his testimony. The explosion received little or no notice, the general said, but it possibly could have caused a major human conflict had it occurred over India or Pakistan while those countries were on high alert. "The resulting panic in the nuclear-armed and hair-triggered opposing forces could have been the spark that ignited a nuclear horror we have avoided for over a half-century," he said. Worden said the Air Force's early warning satellites in 1996 detected an asteroid burst over Greenland that released energy equal to about 100,000 tons of explosives. He said similar events are thought to have occurred in 1908 over Siberia, in the 1940s over Central Asia and over the Amazon basin in the 1930s. "Had any of these struck over a populated area, thousands and perhaps hundreds of thousands might have perished," he said. Worden said the current generation of early warning satellites do a good job of detecting asteroid bursts in the atmosphere and that new equipment will be even better. He said the Air Force is working on an asteroid alert program that would quickly send information from the satellites to interested nations. He said the Air Force is studying the establishment of what he called a Natural Impact Warning Clearinghouse that would be part of the North American Aerospace Defense Command communications center in Cheyenne Mountain near Colorado Springs, Colo. NASA is in the midst of a 10-year program to find and assess every asteroid one kilometer (0.6 miles) or more in size that could pass close to the Earth and might pose a danger to the planet. Such asteroids or comets are called near earth objects. If an asteroid 1 kilometer in size struck the planet it could wipe out whole countries. An asteroid 1 mile across could snuff out civilizations, while one that is 3 miles across could cause human extinction, experts say. Edward Weiler, head of NASA's office of space science, told the House committee that his agency has detected 619 near earth objects and is finding about 100 new ones each year. None poses a danger to the Earth. One kilometer asteroids are relatively rare, but Worden and others said that smaller asteroids also can be destructive. For instance, if an asteroid the size of a cruise ship smashed into the ocean it could cause huge waves, called tsunamis, capable of drowning coastal cities on two continents. Worden called for a system of instruments and telescopes on land and in space that could scan the sky to find asteroids down to the size of 300 feet. He said telescopes and instruments weighing less than 150 pounds could easily be launched to establish an observing network.

**AND, WE RISK THIS IMPACT OVER THIRTY TIMES EACH YEAR**

**Hobart Mercury, 2002,** (Hobart Mercury, Australia, "Warning asteroid may trigger war”, October 5, 2002, LexisNexis Academic) [Max Waxman]

ASTEROIDS are regularly exploding over the Earth with the intensity of a nuclear bomb, says a US general who fears the blasts could be mistaken for a nuclear attack and trigger an atomic war. At least 30 times a year, a space rock measuring a few metres across slashes into the atmosphere and explodes, releasing energy equal to that of an atomic bomb, Air Force General Simon P. Worden told members of the US Congress. Worden, deputy director for operations of the US Strategic Command, said the US has satellite instruments that determined within a minute if the explosion was a nuclear weapon or a natural explosion from an asteroid. But no one else had such technology, he said, and without it, some countries could conclude the explosions came from a nuclear bomb and could launch an atomic attack against an enemy. For instance, Worden said Pakistan and India, both of which had the atomic bomb, were at full alert in August, poised for war. Not far away, a few weeks before, Worden said, US satellites detected an atmospheric flash over the Mediterranean that indicated "an energy release comparable to the Hiroshima burst". Air Force instruments quickly determined it was caused by an asteroid between 4.5 and 9m wide. "Had you been situated on a vessel directly underneath, the intensely bright flash would have been followed by a shock wave that would have rattled the entire ship and possibly caused minor damage," Worden said. The explosion was barely noticed, he said, but it could have caused a war had it occurred over India or Pakistan while those countries were on high alert.

## 1AC

**Indepdendently, a small asteroid collision will devastate global crop yields – would lead to mass starvation of most of the world’s population**

Johnson 95 (Lindley, NASA’s executive for both the Discovery Program of Solar System exploration missions, and the Near Earth Object Observations Program,“Preparing for Planetary Defense: Detection and Interception of Asteroids on Collision Course with Earth”, A Spacecast 2020 White Paper for the Air War College, 1995, http://csat.au.af.mil/2020/papers/app-r.pdf) [Iuliano]

But it doesn't take a "planet buster" of 10 kilometers diameter to wreak global havoc. Scientists estimate that the effect from an impact by an asteroid even as small as 0.5 km could cause climate changes sufficient to dramatically reduce crop yields for one or more years due to killing frosts in the mid-latitudes in the middle of summer. Impacts by objects 1 to 2 km in size could therefore cause a significant increase in the death toll due to mass starvation by a significant portion of the world's population as few countries store as much as even one year's required amount of food. The death toll from direct impact effects, blast and firestorm, as well as the climatic effects could approach 25 percent of the world's human population (figure 5). Even though it may be a rare event, happening only every few hundred thousand years, the average annual fatalities from such an event could still exceed most natural disaster more familiar to us (figure 6).

**AND, Food shortages are the biggest threat global collapse --- terrorism, disease**

Brown 09 (Lester R., American agricultural economist and writer. He is also the founder and president of the Worldwatch Institute. A strong advocate of sustainable agriculture, Brown has overseen numerous publications and has written as many on his own, “Could Food Shortages Bring Down Civilization?”, Scientific American, 4/22/09, <http://www.sovrn.com/PDF/articles_Could-Food-Shortages-Bring-Down-Civilization_.pdf>) [Iuliano]

The biggest threat to global stability is the potential for food crises in poor countries to cause government collapse. One of the toughest things for people to do is to anticipate sudden change. Typically we project the future by extrapolating from trends in the past. Much of the time this approach works well. But sometimes it fails spectacularly, and people are simply blindsided by events such as today’s economic crisis. For most of us, the idea that civilization itself could disintegrate probably seems preposterous. Who would not find it hard to think seriously about such a complete departure from what we expect of ordinary life? What evidence could make us heed a warning so dire—and how would we go about responding to it? We are so inured to a long list of highly unlikely catastrophes that we are virtually programmed to dismiss them all with a wave of the hand: Sure, our civilization might devolve into chaos—and Earth might collide with an asteroid, too! For many years I have studied global agricultural, population, environmental and economic trends and their interactions. The combined effects of those trends and the political tensions they generate point to the breakdown of governments and societies. Yet I, too, have resisted the idea that food shortages could bring down not only individual governments but also our global civilization. I can no longer ignore that risk. Our continuing failure to deal with the environmental declines that are undermining the world food economy— most important, falling water tables, eroding soils and rising temperatures—forces me to conclude that such a collapse is possible. The Problem of Failed States Even a cursory look at the vital signs of our current world order lends unwelcome support to my conclusion. And those of us in the environmental field are well into our third de--cade of charting trends of environmental decline without seeing any significant effort to reverse a single one. In six of the past nine years world grain production has fallen short of consumption, forcing a steady drawdown in stocks. When the 2008 harvest began, world carryover stocks of grain (the amount in the bin when the new harvest begins) were at 62 days of consumption, a near record low. In response, world grain prices in the spring and summer of last year climbed to the highest level ever. As demand for food rises faster than supplies are growing, the resulting food-price inflation puts severe stress on the governments of countries already teetering on the edge of chaos. Unable to buy grain or grow their own, hungry people take to the streets. Indeed, even before the steep climb in grain prices in 2008, the number of failing states was expanding. Many of their problems stem from a failure to slow the growth of their populations. But if the food situation continues to deteriorate, entire nations will break down at an ever increasing rate. We have entered a new era in geopolitics. In the 20th century the main threat to international security was superpower conflict; today it is failing states. It is not the concentration of power but its absence that puts us at risk. States fail when national governments can no longer provide personal security, food security and basic social services such as education and health care. They often lose control of part or all of their territory. When governments lose their monopoly on power, law and order begin to disintegrate. After a point, countries can become so dangerous that food relief workers are no longer safe and their programs are halted; in Somalia and Afghanistan, deteriorating conditions have already put such programs in jeopardy. Failing states are of international concern because they are a source of terrorists, drugs, weapons and refugees, threatening political stability everywhere. Somalia, number one on the 2008 list of failing states, has become a base for piracy. Iraq, number five, is a hotbed for terrorist training. Afghanistan, number seven, is the world’s leading supplier of heroin. Following the massive genocide of 1994 in Rwanda, refugees from that troubled state, thousands of armed soldiers among them, helped to destabilize neighboring Democratic Republic of the Congo (number six). Our global civilization depends on a functioning network of politically healthy nation-states to control the spread of infectious disease, to manage the international monetary system, to control international terrorism and to reach scores of other common goals. If the system for controlling infectious diseases—such as polio, SARS or avian flu—breaks down, humanity will be in trouble. Once states fail, no one assumes responsibility for their debt to outside lenders. If enough states disintegrate, their fall will threaten the stability of global civilization itself.

## 1AC

**CONTENTION FOUR: SOLVENCY**

**FIRST, FOCUSING ON EARLY DETECTION IS KEY TO EFFECTIVE DEFLECTION – WE HAVE THE CAPABILITIES TO DEVELOP OBSERVING TECHNOLOGY THAT CAN ALLOW US TO PREVENT AN ASTEROID COLLISION**

**Barbee and Nuth 09,** (Brent, M.S.E and III, Joesph, Ph.D, Aerospace Engineer and Planetary Defense Scientist, Emergent Space Technologies, Inc., Senior Scientist for Primitive Bodies, Solar System Exploration Division, NASA’s Goddard Space Flight Center, “Asteroid Impact Threats: Advancements in Asteroid Science to Enable Rapid and Effective Deflection Missions” Journal of Cosmology, October 31, 2009, <http://journalofcosmology.com/Extinction109.html>) justin

After the deflection spacecraft launches, it will require time to rendezvous with the NEO (green) and position the deflection system appropriately (blue). While advancements in spacecraft propulsion technology can reduce the flight time to rendezvous with the NEO, the natural orbital mechanics (which we cannot change) is often the limiting factor. This is why early detection and characterization are so important. Finally, once the deflection system is positioned and ready it can be deployed on the NEO, imparting a deflection. The effects of the deflection have time to accumulate during the interval between when the deflection is applied and the time of undeflected Earth impact (indigo). Clearly the goal is to maximize this time interval (by pushing all the other events as far backwards along the timeline as possible in order to stretch out the indigo segment by compressing the preceding intervals). This provides the best chance for causing the incoming asteroid to miss the Earth. The final time interval (violet), shown at the end of the timeline, begins at the point in time past which no deflection could possibly avert the impending collision and ends at the time of undeflected Earth impact, when the asteroid would collide with Earth absent any intervention. Advancements in interplanetary orbit determination techniques and improvements to our observing infrastructure (new and better ground–based telescopic and radar survey systems and/or orbiting observatories) can dramatically increase warning time by virtue of detecting asteroids sooner (making the entire timeline longer), and can also dramatically reduce the amount of time required to determine that the probability of collision is high enough to warrant a response by virtue of increased quantity and quality of observations. Advancements in asteroid scientific characterization techniques, such as those proposed in a subsequent section herein, would serve to the reduce the amount of time required to design and construct the deflection system by providing the necessary physical data on the asteroid more rapidly, not requiring a precursor science mission to the asteroid.

**AND, ATTEMPTS TO DEFLECT COMING ASTEROIDS IS INEVITABLE BUT ONLY EARLY WARNING CAN MAKE THAT DEFLECTION SUCCESSFUL**

**National Academy of Science, 10.** (National Academy of Science is comprised of the top scientists based on their individual work and achievements, no date, 2010, “Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies,” pdf document, CALLAHAN)

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. In contrast to other known natural hazards, there has been no significant loss of human life to impacts in historical times, due to the low frequency of major impacts and the higher probability of impact in unpopulated areas (notably the oceans) rather than in populated regions. 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. Given these issues, there are a number of concerns that can be addressed by an NEO detection, characterization, and mitigation program: 1. The statistical risk to human life and property associated with impacts of NEOs is real, but it falls outside the everyday experience of most of humanity. This risk must therefore be communicated effectively to the community at large in the context of other natural disasters, particularly those that the local community is likely to encounter. Scientists must carefully assess and explain the hazard so that appropriate public policy measures, commensurate with the level of risk, can be put into action. 2. There must be an assessment of the statistical risk from NEOs that is reasonable and acceptable to the general public. The mandate of discovery of 90 percent of objects 140 meters in diameter or greater in the George E. Brown, Jr. Near-Earth Object Survey Act of 2005 was based on many assumptions about impact hazards. However, periodic reassessment of the impact threat needs to be performed as the knowledge base on NEO populations, their physical characteristics, and impact-associated processes increases. 3. It is important to assess the length of time that the public is prepared to wait for scientific surveys to reach target goals of detection and characterization and for mitigation technologies to reach the desired maturity. Whereas surveys will never be 100 percent complete given the diversity of the objects, their origins, and their orbits, surveys should be as close as feasible to 100 percent complete in order to assure the public that all reasonable precautions are being taken. 4. An assessment is needed of the levels of expenditure that the public is prepared to accept in order to reach such goals for detection, and similarly for characterization, and mitigation. Although the costs (other than for advanced mitigation strategies) are almost vanishingly small relative to other elements of the federal budget, public support for such activities may be absent lacking demonstration of a clear and present threat.

## 1AC

**AND, SPACE-BASED OBSERVATIONS ARE KEY – GROUND-BASED TELESCOPES CAN’T GIVE US CONTINUOUS MEASUREMENTS DUE TO WEATHER CHANGES AND POOR NIGHT VISION**

**Park et al 05** (Daniel D. Mazanek, Carlos M. Roithmayr, and Jeffrey Antol Langley Research Center, Hampton, Virginia Sang-Young Park, Robert H. Koons, and James C. Bremer Swales Aerospace, Inc., Hampton, Virginia Douglas G. Murphy, James A. Hoffman, Renjith R. Kumar, and Hans Seywald Analytical Mechanics Associates, Inc., Hampton, Virginia Linda Kay-Bunnell and Martin R. Werner Joint Institute for Advancement of Flight Sciences (JIAFS) The George Washington University, Hampton, Virginia Matthew A. Hausman Colorado Center for Astrodynamics Research The University of Colorado, Boulder, Colorado Jana L. Stockum San Diego State University, San Diego, California, “Comet/Asteroid Protection System (CAPS): Preliminary Space-Based System Concept and Study Results” NASA, May 2005, <http://www.nss.org/resources/library/planetarydefense/2005-CometAsteroidProtectionSystem(CAPS)-NASA.pdf)> Rory

While terrestrial-based telescopes can address many aspects of NEO detection, the ability to discover and track faint and/or small comets and asteroids is tremendously enhanced, if not enabled, from space. It is recognized, and appreciated, that the currently funded terrestrial-based detection efforts are a vital and logical first step. Focusing on the detection of large asteroids capable of global destruction is the best expenditure of limited resources; however, various aspects of the impact threat are largely unaddressed by these efforts. Currently there is no specific search for LPCs, small NEAs, or small SPCs. Additionally, coordinated follow-up observations are critical to limit the likelihood of losing a newly discovered NEO and to precisely determine the object’s orbit. One shortcoming of current ground-based efforts is the difficulty in providing these follow-up measurements, which are provided in part by amateur astronomers. Looking for much smaller and fainter targets is likely to exceed the current capabilities of many asteroid and comet “hunters.” Just as the Hubble Space Telescope has expanded our ability to see the universe without the limitations imposed by Earth’s atmosphere, a space-based NEO detection system would allow us to expand the range of observable comets and asteroids and to provide coordinated follow-up observations. A spacebased detection system is capable of making observations on a continuous basis without the various constraints (daylight, weather, etc.) imposed on Earth-based systems, and NEO searches need not be focused on the solar opposition point. If detection systems can be designed to observe faint NEOs that appear to be near the Sun, which is impossible from the ground because the atmosphere scatters sunlight during the daytime, it would be possible to see objects close to the Sun and on the solar far side where solar illumination conditions are favorable. Additionally, it is critical to ascertain, to the greatest extent possible, the composition and physical characteristics of these objects. A space-based approach can solve this aspect of the problem through both remote observations and rendezvous missions with the NEO.

## 1AC

**AND, THE US IS THE BEST ACTOR – WE CAN NOT CEDE CONTROL OF SPACE TO THE INTERNATIONAL COMMUNITY – IT IS KEY TO MAINTAINING OUR TECHNOLOGICAL AND MILITARY LEADERSHIP**

Lt col **Garretson and** Major **Kaupa 07** (peter United States Air Force HQ USAF Future Concepts, the Pentagon, Douglas United States Air Force 445th Flight Test Squadron, “Planetary Defense: Potential Department of Defense Mitigation Roles”, Jan 3, 2007, <http://www.aero.org/conferences/planetarydefense/documents/Potential-DoD-Roles--Garretson.pdf>) rory/stephanie

Some detractors have stated a planetary defense program is too expensive for the US alone and belongs in the international arena. True as this statement seems, several key issues remain. First, for such a critical survival issue, the US should not be 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, there are significant national security reasons why the US should pursue this capability for the defense of others. The US has an interest in preserving our democratic civilization and maintaining international security. The US reaps significant economic benefits by providing international security. We have the most to gain by maintaining security, and the most to lose. By visibly pursuing the capability to defend the planet, we make ourselves increasingly essential to international security. Another reason to pursue defense of others is we will likely have to pay the bill anyway. The humanitarian crisis that could ensue from a 300-meter (900 foot) asteroid could easily dwarf the 2004 Asian Tsunami. The humanitarian supply, airlift, sealift, and rebuilding would be staggering. Economic losses to US investors, the cost to US insurers and a possible recession or depression from a loss of a city or nation would likely ensue. Despite concerns about the expense of developing such a planetary defense system, the positive aspect is that it translates into a competitive advantage for the US, also creating intellectual capital by solving difficult problems and finding innovative solutions. It creates industrial capacity and technical areas of leadership - critical to maintaining our lead in space. The technology needed to protect the planet offers other advantages, not just a contingency plan. Technologies which appear promising for planetary defense are also attractive for civil and defense applications. Such applications include rapid and responsive high-capacity launchers, high-thrust rockets, long-duration power supply and autonomous docking.\

## 1AC

**THE UNDERVIEW -**

**THERE IS ZERO RISK OF INTENTIONAL WAR - NO ESCALATION OF SMALL CONFLICTS**

**MANDELBAUM 1999** [Michael – professor of American Foreign Policy @ Johns Hopkins University and Director of East-West Relations @ Council on Foreign Relations, “Transcript: Is Major War Obsolete?” *Council on Foreign Relations*, February 25,

<http://www.ciaonet.org/conf/cfr10/>]

My argument says, tacitly, that while this point of view, which was widely believed 100 years ago, was not true then, there are reasons to think that it is true now. What is that argument? It is that major war is obsolete. By major war, I mean war waged by the most powerful members of the international system, using all of their resources over a protracted period of time with revolutionary geopolitical consequences. There have been four such wars in the modern period: the wars of the French Revolution, World War I, World War II, and the Cold War. Few though they have been, their consequences have been monumental. They are, by far, the most influential events in modern history. Modern history which can, in fact, be seen as a series of aftershocks to these four earthquakes. So if I am right, then what has been the motor of political history for the last two centuries that has been turned off? This war, I argue, this kind of war, is obsolete; less than impossible, but more than unlikely. What do I mean by obsolete? If I may quote from the article on which this presentation is based, a copy of which you received when coming in, “ Major war is obsolete in a way that styles of dress are obsolete. It is something that is out of fashion and, while it could be revived, there is no present demand for it. Major war is obsolete in the way that slavery, dueling, or foot-binding are obsolete. It is a social practice that was once considered normal, useful, even desirable, but that now seems odious. It is obsolete in the way that the central planning of economic activity is obsolete. It is a practice once regarded as a plausible, indeed a superior, way of achieving a socially desirable goal, but that changing conditions have made ineffective at best, counterproductive at worst.” Why is this so? Most simply, the costs have risen and the benefits of major war have shriveled. The costs of fighting such a war are extremely high because of the advent in the middle of this century of nuclear weapons, but they would have been high even had mankind never split the atom. As for the benefits, these now seem, at least from the point of view of the major powers, modest to non-existent. The traditional motives for warfare are in retreat, if not extinct. War is no longer regarded by anyone, probably not even Saddam Hussein after his unhappy experience, as a paying proposition. And as for the ideas on behalf of which major wars have been waged in the past, these are in steep decline. Here the collapse of communism was an important milestone, for that ideology was inherently bellicose. This is not to say that the world has reached the end of ideology; quite the contrary. But the ideology that is now in the ascendant, our own, liberalism, tends to be pacific. Moreover, I would argue that three post-Cold War developments have made major war even less likely than it was after 1945. One of these is the rise of democracy, for democracies, I believe, tend to be peaceful. Now carried to its most extreme conclusion, this eventuates in an argument made by some prominent political scientists that democracies never go to war with one another. I wouldn’t go that far. I don’t believe that this is a law of history, like a law of nature, because I believe there are no such laws of history. But I do believe there is something in it. I believe there is a peaceful tendency inherent in democracy. Now it’s true that one important cause of war has not changed with the end of the Cold War. That is the structure of the international system, which is anarchic. And realists, to whom Fareed has referred and of whom John Mearsheimer and our guest Ken Waltz are perhaps the two most leading exponents in this country and the world at the moment, argue that that structure determines international activity, for it leads sovereign states to have to prepare to defend themselves, and those preparations sooner or later issue in war. I argue, however, that a post-Cold War innovation counteracts the effects of anarchy. This is what I have called in my 1996 book, The Dawn of Peace in Europe, common security. By common security I mean a regime of negotiated arms limits that reduce the insecurity that anarchy inevitably produces by transparency-every state can know what weapons every other state has and what it is doing with them-and through the principle of defense dominance, the reconfiguration through negotiations of military forces to make them more suitable for defense and less for attack. Some caveats are, indeed, in order where common security is concerned. It’s not universal. It exists only in Europe. And there it is certainly not irreversible. And I should add that what I have called common security is not a cause, but a consequence, of the major forces that have made war less likely. States enter into common security arrangements when they have already, for other reasons, decided that they do not wish to go to war. Well, the third feature of the post-Cold War international system that seems to me to lend itself to warlessness is the novel distinction between the periphery and the core, between the powerful states and the less powerful ones. This was previously a cause of conflict and now is far less important. To quote from the article again, “ While for much of recorded history local conflicts were absorbed into great-power conflicts, in the wake of the Cold War, with the industrial democracies debellicised and Russia and China preoccupied with internal affairs, there is no great-power conflict into which the many local conflicts that have erupted can be absorbed. The great chess game of international politics is finished, or at least suspended. A pawn is now just a pawn, not a sentry standing guard against an attack on a king.”

## 2AC ADD-ON – SPACE LEADERSHIP

**TAKING A LEAD IN PLANETARY DEFENSE IS A VITAL LYNCHPIN IN OUR SPACE LEADERSHIP – ONLY THE US CAN EFFECTIVELY TAKE ON THE ASTEROID THREAT**

Dinerman, 09 (Taylor Dinerman, author of the textbook Space Science for Students and consultant for the US Defense Department, “the new politics of planetary defense,” 7/16/11, <http://www.thespacereview.com/article/1418/1>) Hou

While the US is obviously going to have to take the lead in any effort to detect and possibly deflect any celestial object that might do our planet harm**,** it will have to consult with others, both to keep other nations informed and to help make the choices needed to deal with the threat. Yet in the end, it is likely that the decision, if there is one, will rest with the President of the United States. He or she is the only world leader today with the wherewithal to deal with such a threat. If the US is have any claim to global leadership in the 21st century it will have to unambiguously take the lead in planetary defense. This is why any planning effort that leans to heavily on international institutions may endanger the whole planet**.** The process inside an organization like the UN would simply get bogged down in procedural and political questions. US leaders may find that the system would be paralyzed while, for example, nations argued over deflection or destructions methods or who would control and pay for them. Precious time would be lost while nations would consider their own best interests in supporting one approach or another. [The US] should do so in an open way and be ready to listen to everyone’s concerns and ideas. But if the Earth is to be effectively protected, the ultimate decisions will have to be American. In this case “global governance” could end up setting the stage for a disaster.

**AND, US SPACE LEADERSHIP KEY TO OVERALL US HEGEMONY AND MILITARY READINESS, THE GLOBAL ECONOMY, OUR ABILITY TO RESPOND TO NATURAL DISASTERS, SOLVING ENVIRONMENTAL DESTRUCTION AND MAINTAINING STRONG GLOBAL NON-PROLIFERATION EFFORTS**

**DoD 11** (“National Security Space Strategy” unclassified summary, 2011, <http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf>) rory

During the past 50 years, U.S. leadership in space activities has benefited the global economy, enhanced our national security, strengthened international relationships, advanced scientific discovery, and improved our way of life. Space capabilities provide the United States and our allies unprecedented advantages in national decision-making, military operations, and homeland security. Space systems provide national security decision-makers with unfettered global access and create a decision advantage by enabling a rapid and tailored response to global challenges. Moreover, space systems are vital to monitoring strategic and military developments as well as supporting treaty monitoring and arms control verification. Space systems are also critical in our ability to respond to natural and man-made disasters and monitor long-term environmental trends. Space systems allow people and governments around the world to see with clarity, communicate with certainty, navigate with accuracy, and operate with assurance. Maintaining the benefits afforded to the United States by space is central to our national security, but an evolving strategic environment increasingly challenges U.S. space advantages. Space, a domain that no nation owns but on which all rely, is becoming increasingly congested, contested, and competitive. These challenges, however, also present the United States with opportunities for leadership and partnership. Just as the United States helped promote space security in the 20 th century, we will build on this foundation to embrace the opportunities and address the challenges of this century. The National Security Space Strategy charts a path for the next decade to respond to the current and projected space strategic environment. Leveraging emerging opportunities will strengthen the U.S. national security space posture while maintaining and enhancing the advantages the United States gains from space. Our strategy requires active U.S. leadership enabled by an approach that updates, balances, and integrates all of the tools of U.S. power. The Department of Defense (DoD) and the Intelligence Community (IC), in coordination with other departments and agencies, will implement this strategy by using it to inform planning, programming, acquisition, operations, and analysis. Space is vital to U.S. national security and our ability to understand emerging threats, project power globally, conduct operations, support diplomatic efforts, and enable global economic viability. As more nations and non-state actors recognize these benefits and seek their own space or counterspace capabilities, we are faced with new opportunities and new challenges in the space domain.

## 2AC ADD-ON – SPACE LEADERSHIP

**AND, THAT IS KEY TO PREVENTING NUCLEAR WAR**

**KAGAN, 7**  (Robert, senior fellow at the Carnegie Endowment for International Peace (Robert, “End of Dreams, Return of History”, 7/19, http://www.realclearpolitics.com/articles/2007/07/end\_of\_dreams\_return\_of\_histor.html)

This is a good thing, and it should continue to be a primary goal of American foreign policy to perpetuate this relatively benign international configuration of power. The unipolar order with the United States as the predominant power is unavoidably riddled with flaws and contradictions. It inspires fears and jealousies. The United States is not immune to error, like all other nations, and because of its size and importance in the international system those errors are magnified and take on greater significance than the errors of less powerful nations. Compared to the ideal Kantian international order, in which all the world's powers would be peace-loving equals, conducting themselves wisely, prudently, and in strict obeisance to international law, the unipolar system is both dangerous and unjust. Compared to any plausible alternative in the real world, however, it is relatively stable and less likely to produce a major war between great powers. It is also comparatively benevolent, from a liberal perspective, for it is more conducive to the principles of economic and political liberalism that Americans and many others value. American predominance does not stand in the way of progress toward a better world, therefore. It stands in the way of regression toward a more dangerous world. The choice is not between an American-dominated order and a world that looks like the European Union. The future international order will be shaped by those who have the power to shape it. The leaders of a post-American world will not meet in Brussels but in Beijing, Moscow, and Washington. The return of great powers and great games If the world is marked by the persistence of unipolarity, it is nevertheless also being shaped by the reemergence of competitive national ambitions of the kind that have shaped human affairs from time immemorial. During the Cold War, this historical tendency of great powers to jostle with one another for status and influence as well as for wealth and power was largely suppressed by the two superpowers and their rigid bipolar order. Since the end of the Cold War, the United States has not been powerful enough, and probably could never be powerful enough, to suppress by itself the normal ambitions of nations. This does not mean the world has returned to multipolarity, since none of the large powers is in range of competing with the superpower for global influence. Nevertheless, several large powers are now competing for regional predominance, both with the United States and with each other. National ambition drives China's foreign policy today, and although it is tempered by prudence and the desire to appear as unthreatening as possible to the rest of the world, the Chinese are powerfully motivated to return their nation to what they regard as its traditional position as the preeminent power in East Asia. They do not share a European, postmodern view that power is passé; hence their now two-decades-long military buildup and modernization. Like the Americans, they believe power, including military power, is a good thing to have and that it is better to have more of it than less. Perhaps more significant is the Chinese perception, also shared by Americans, that status and honor, and not just wealth and security, are important for a nation. Japan, meanwhile, which in the past could have been counted as an aspiring postmodern power -- with its pacifist constitution and low defense spending -- now appears embarked on a more traditional national course. Partly this is in reaction to the rising power of China and concerns about North Korea 's nuclear weapons. But it is also driven by Japan's own national ambition to be a leader in East Asia or at least not to play second fiddle or "little brother" to China. China and Japan are now in a competitive quest with each trying to augment its own status and power and to prevent the other 's rise to predominance, and this competition has a military and strategic as well as an economic and political component. Their competition is such that a nation like South Korea, with a long unhappy history as a pawn between the two powers, is once again worrying both about a "greater China" and about the return of Japanese nationalism. As Aaron Friedberg commented, the East Asian future looks more like Europe's past than its present. But it also looks like Asia's past. Russian foreign policy, too, looks more like something from the nineteenth century. It is being driven by a typical, and typically Russian, blend of national resentment and ambition. A postmodern Russia simply seeking integration into the new European order, the Russia of Andrei Kozyrev, would not be troubled by the eastward enlargement of the EU and NATO, would not insist on predominant influence over its "near abroad," and would not use its natural resources as means of gaining geopolitical leverage and enhancing Russia 's international status in an attempt to regain the lost glories of the Soviet empire and Peter the Great. But Russia, like China and Japan, is moved by more traditional great-power considerations, including the pursuit of those valuable if intangible national interests: honor and respect. Although Russian leaders complain about threats to their security from NATO and the United States, the Russian sense of insecurity has more to do with resentment and national identity than with plausible external military threats. 16 Russia's complaint today is not with this or that weapons system. It is the entire post-Cold War settlement of the 1990s that Russia resents and wants to revise. But that does not make insecurity less a factor in Russia 's relations with the world; indeed, it makes finding compromise with the Russians all the more difficult. One could add others to this list of great powers with traditional rather than postmodern aspirations. India 's regional ambitions are more muted, or are focused most intently on Pakistan, but it is clearly engaged in competition with China for dominance in the Indian Ocean and sees itself, correctly, as an emerging great power on the world scene. In the Middle East there is Iran, which mingles religious fervor with a historical sense of superiority and leadership in its region. 17 Its nuclear program is as much about the desire for regional hegemony as about defending Iranian territory from attack by the United States. Even the European Union, in its way, expresses a pan-European national ambition to play a significant role in the world, and it has become the vehicle for channeling German, French, and British ambitions in what Europeans regard as a safe supranational direction. Europeans seek honor and respect, too, but of a postmodern variety. The honor they seek is to occupy the moral high ground in the world, to exercise moral authority, to wield political and economic influence as an antidote to militarism, to be the keeper of the global conscience, and to be recognized and admired by others for playing this role. Islam is not a nation, but many Muslims express a kind of religious nationalism, and the leaders of radical Islam, including al Qaeda, do seek to establish a theocratic nation or confederation of nations that would encompass a wide swath of the Middle East and beyond. Like national movements elsewhere, Islamists have a yearning for respect, including self-respect, and a desire for honor. Their national identity has been molded in defiance against stronger and often oppressive outside powers, and also by memories of ancient superiority over those same powers. China had its "century of humiliation." Islamists have more than a century of humiliation to look back on, a humiliation of which Israel has become the living symbol, which is partly why even Muslims who are neither radical nor fundamentalist proffer their sympathy and even their support to violent extremists who can turn the tables on the dominant liberal West, and particularly on a dominant America which implanted and still feeds the Israeli cancer in their midst. Finally, there is the United States itself. As a matter of national policy stretching back across numerous administrations, Democratic and Republican, liberal and conservative, Americans have insisted on preserving regional predominance in East Asia; the Middle East; the Western Hemisphere; until recently, Europe; and now, increasingly, Central Asia. This was its goal after the Second World War, and since the end of the Cold War, beginning with the first Bush administration and continuing through the Clinton years, the United States did not retract but expanded its influence eastward across Europe and into the Middle East, Central Asia, and the Caucasus. Even as it maintains its position as the predominant global power, it is also engaged in hegemonic competitions in these regions with China in East and Central Asia, with Iran in the Middle East and Central Asia, and with Russia in Eastern Europe, Central Asia, and the Caucasus. The United States, too, is more of a traditional than a postmodern power, and though Americans are loath to acknowledge it, they generally prefer their global place as "No. 1" and are equally loath to relinquish it. Once having entered a region, whether for practical or idealistic reasons, they are remarkably slow to withdraw from it until they believe they have substantially transformed it in their own image. They profess indifference to the world and claim they just want to be left alone even as they seek daily to shape the behavior of billions of people around the globe. The jostling for status and influence among these ambitious nations and would-be nations is a second defining feature of the new post-Cold War international system. Nationalism in all its forms is back, if it ever went away, and so is international competition for power, influence, honor, and status. American predominance prevents these rivalries from intensifying -- its regional as well as its global predominance. Were the United States to diminish its influence in the regions where it is currently the strongest power, the other nations would settle disputes as great and lesser powers have done in the past: sometimes through diplomacy and accommodation but often through confrontation and wars of varying scope, intensity, and destructiveness. One novel aspect of such a multipolar world is that most of these powers would possess nuclear weapons. That could make wars between them less likely, or it could simply make them more catastrophic. It is easy but also dangerous to underestimate the role the United States plays in providing a measure of stability in the world even as it also disrupts stability. For instance, the United States is the dominant naval power everywhere, such that other nations cannot compete with it even in their home waters. They either happily or grudgingly allow the United States Navy to be the guarantor of international waterways and trade routes, of international access to markets and raw materials such as oil. Even when the United States engages in a war, it is able to play its role as guardian of the waterways. In a more genuinely multipolar world, however, it would not. Nations would compete for naval dominance at least in their own regions and possibly beyond. Conflict between nations would involve struggles on the oceans as well as on land. Armed embargos, of the kind used in World War i and other major conflicts, would disrupt trade flows in a way that is now impossible. Such order as exists in the world rests not merely on the goodwill of peoples but on a foundation provided by American power. Even the European Union, that great geopolitical miracle, owes its founding to American power, for without it the European nations after World War ii would never have felt secure enough to reintegrate Germany. Most Europeans recoil at the thought, but even today Europe 's stability depends on the guarantee, however distant and one hopes unnecessary, that the United States could step in to check any dangerous development on the continent. In a genuinely multipolar world, that would not be possible without renewing the danger ofworld war**.** People who believe greater equality among nations would be preferable to the present American predominance often succumb to a basic logical fallacy. They believe the order the world enjoys today exists independently of American power. They imagine that in a world where American power was diminished, the aspects of international order that they like would remain in place. But that 's not the way it works. International order does not rest on ideas and institutions. It is shaped by configurations of power. The international order we know today reflects the distribution of power in the world since World War ii, and especially since the end of the Cold War. A different configuration of power, a multipolar world in which the poles were Russia, China, the United States, India, and Europe, would produce its own kind of order, with different rules and norms reflecting the interests of the powerful states that would have a hand in shaping it. Would that international order be an improvement? Perhaps for Beijing and Moscow it would. But it is doubtful that it would suit the tastes of enlightenment liberals in the United States and Europe. The current order, of course, is not only far from perfect but also offers no guarantee against major conflict among the world's great powers. Even under the umbrella of unipolarity, regional conflicts involving the large powers may erupt. War could erupt between China and Taiwan and draw in both the United States and Japan. War could erupt between Russia and Georgia, forcing the United States and its European allies to decide whether to intervene or suffer the consequences of a Russian victory. Conflict between India and Pakistan remains possible, as does conflict between Iran and Israel or other Middle Eastern states. These, too, could draw in other great powers, including the United States. Such conflicts may be unavoidable no matter what policies the United States pursues. But they are more likely to erupt if the United States weakens or withdraws from its positions of regional dominance. This is especially true in East Asia, where most nations agree that a reliable American power has a stabilizing and pacific effect on the region. That is certainly the view of most of China 's neighbors. But even China, which seeks gradually to supplant the United States as the dominant power in the region, faces the dilemma that an American withdrawal could unleash an ambitious, independent, nationalist Japan. In Europe, too, the departure of the United States from the scene -- even if it remained the world's most powerful nation -- could be destabilizing. It could tempt Russia to an even more overbearing and potentially forceful approach to unruly nations on its periphery. Although some realist theorists seem to imagine that the disappearance of the Soviet Union put an end to the possibility of confrontation between Russia and the West, and therefore to the need for a permanent American role in Europe, history suggests that conflicts in Europe involving Russia are possible even without Soviet communism. If the United States withdrew from Europe -- if it adopted what some call a strategy of "offshore balancing" -- this could in time increase the likelihood of conflict involving Russia and its near neighbors, which could in turn draw the United States back in under unfavorable circumstances. It is also optimistic to imagine that a retrenchment of the American position in the Middle East and the assumption of a more passive, "offshore" role would lead to greater stability there. The vital interest the United States has in access to oil and the role it plays in keeping access open to other nations in Europe and Asia make it unlikely that American leaders could or would stand back and hope for the best while the powers in the region battle it out. Nor would a more "even-handed" policy toward Israel, which some see as the magic key to unlocking peace, stability, and comity in the Middle East, obviate the need to come to Israel 's aid if its security became threatened. That commitment, paired with the American commitment to protect strategic oil supplies for most of the world, practically ensures a heavy American military presence in the region, both on the seas and on the ground. The subtraction of American power from any region would not end conflict but would simply change the equation. In the Middle East, competition for influence among powers both inside and outside the region has raged for at least two centuries. The rise of Islamic fundamentalism doesn't change this. It only adds a new and more threatening dimension to the competition, which neither a sudden end to the conflict between Israel and the Palestinians nor an immediate American withdrawal from Iraq would change. The alternative to American predominance in the region is not balance and peace. It is further competition. The region and the states within it remain relatively weak. A diminution of American influence would not be followed by a diminution of other external influences. One could expect deeper involvement by both China and Russia, if only to secure their interests. 18 And one could also expect the more powerful states of the region, particularly Iran, to expand and fill the vacuum. It is doubtful that any American administration would voluntarily take actions that could shift the balance of power in the Middle East further toward Russia, China, or Iran. The world hasn 't changed that much. An American withdrawal from Iraq will not return things to "normal" or to a new kind of stability in the region. It will produce a new instability, one likely to draw the United States back in again. The alternative to American regional predominance in the Middle East and elsewhere is not a new regional stability. In an era of burgeoning nationalism, the future is likely to be one of intensified competition among nations and nationalist movements. Difficult as it may be to extend American predominance into the future, no one should imagine that a reduction of American power or a retraction of American influence and global involvement will provide an

## 2AC ADD-ON – ASTEROID MINING

**Asteroid detection is the first step to mining**

Space Wealth 11 (“Is Profitable Asteroid Mining a Pragmatic Goal?,” 2/22/11, <http://spacewealth.org/files/Is-P@M-Pragmatic-2011-02-23.pdf>) [Iuliano]

Platinum group metals are abundant in certain types of near-Earth asteroids (NEAs). NEAs that are mineralogically similar to one of the most common types of “observed fall” meteorites (H-type, ordinary chondrites) offer PGM concentrations (4.5 ppm)30 that are comparable to those found in profitable terrestrial mines (3-6 ppm).31 Other meteorites suggest that some asteroids may contain much more valuable metal.32 The PGM value of a 200 m asteroid can exceed $1 billion, or possibly $25 billion.33 Over 7,500 NEAs have been detected.34 Close to a fifth of these are easier to reach than the moon; more than a fifth of those are ≥200 m in diameter: 200+ targets.35 President Obama requested, and Congress has authorized, a four-fold increase in detection funding ($5.8 m to $20.4 m/year).36 This could lead to ~10,000 known 200 m NEAs in a decade.37 But **detection is just a start**. The costs to locate, extract, and process asteroid ore are not well understood.38 Before significant private capital is put at risk, we need to learn more.

## 2AC ADD-ON – SPACE COLONIZATION

**PLAN IS KEY TO HUMAN EXPLORATION AND COLONIZATION**

**THE NEW YORKER 2011** [Ted Friend – staff writer, “Vermin of the sky: who will keep the planet safe from asteroids?”, page lexis] ttate

Nine days later, the White House's Office of Science and Technology Policy recommended that NASA be the agency that oversees all research into planetary defense. Significantly, the decision also yoked NEO detection and mitigation to President Obama's plan to send humans to an asteroid by 2025, envisaging deflection activities "as part of the overall mission planning and objectives." At the moment, the number of asteroids judged suitable for a human visit is fewer than nine, and perhaps as few as zero. So there is an obvious need to find more asteroids-and to learn considerably more about what it's like to operate in their neighborhoods. Paul Abell, the lead NEO scientist at NASA's Johnson Space Flight Center, said that, to find the right asteroid for a human mission, "my personal opinion is we need a space-based survey telescope, which could give us up to forty times the number of targets." Within two and a half years, the Venus-orbit telescope touted by the Task Force could find several hundred promising asteroids closer to home, which could cut billions of dollars out of the price of a mission. Yet what would be a small step for a human mission turns out to be a giant leap for planetary defense: NASA has already indicated that it doesn't have the roughly six hundred and fifty million dollars needed to fund the telescope. And a practice grapple with an asteroid may occur, as vaguely promised by the White House, only when the human mission launches, in fourteen years. (If it does launch: in January, an internal NASA study suggested that a human mission to an asteroid would be "too costly.") One senior planetary-defense advocate suggests that should the human mission take precedence the tail would truly be wagging the dog. "Saving millions to billions of people and civilization itself is a more important goal than displaying American plumage and vigor by visiting an asteroid," he said. "But, in order to support three to five guys going to an asteroid, I may finally be able to find money for planetary defense."

**AND, COLONIZATION NECESSARY TO PREVENT INEVITABLE EXTINCTION FROM STAYING ON THE ROCK**

BAUM 2009 [Seth – professor of geography in the Rock Ethics Institute @ Pennsylvania State University, “Cost-Benefit Analysis of Space Exploration: Some Ethical Considerations, *Space Policy,* <http://sethbaum.com/ac/2009_CBA-SpaceExploration.pdf>] ttate

Another non-market benefit of space exploration is reduction in the risk of the extinction of humanity and other Earth-originating life. Without space colonization, the survival of humanity and other Earth-originating life becomes extremely difficult- perhaps impossible- over the very long-term. This is because the Sun, like all stars, changes in its composition and radiative output over time. The Sun is gradually converting hydrogen into helium, thereby getting warmer. In approximately 500 million to one billion years, this warming is projected to render Earth uninhabitable to life as we know it [25–26]. Humanity, if it still exists on Earth then, could conceivably develop technology by then to survive on Earth despite these radical conditions. Such technology may descend from present proposals to “geoengineer” the planet in response to anthropogenic climate change [27–28].3 However, the Sun later- approximately seven billion years later- loses mass that spreads into Earth’s orbit, causing Earth to slow, be pulled into the Sun, and evaporate. The only way life could survive on Earth may be if Earth, by sheer coincidence (the odds are on the order of one in 105 to one in 106 [29]) happens to be pulled out of the solar system by a star system that passes by. This process might enable life to survive on Earth much longer, although the chance of this is quite remote. While space colonization would provide a hedge against these very long-term astrological threats, it would also provide a hedge against the more immediate threats that face humanity and other species. These 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,4 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 [32–33]. 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 [34–35]. 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.

## 2AC ADD-ON – INTERNATIONAL LAW

**FAILURE TO DEVELOP EARLY WARNING ASTEROID DETECTION MEANS WE WILL RELY ON NUCLEAR DETONATION TO DEFLECT THE ASTEROIDS**

**Betts 09 (**Bruce, Director of Projects, Science Editor, The planetary Report, “Final Update From Planetary Defense Conference”, The Planetary Society, April 30, 2009, <http://www.planetary.org/blog/article/00001927/>) rory

Unless we have a warning time of at least a decade (more for a large asteroid), most scientists and engineers agree that, at this point, the only option is nuclear weapons. The usual concept is to detonate a nuclear weapon a few tens or hundreds of meters from the NEO, which will vaporize some of its surface. That vaporized rock act like a rocket jet, moving the NEO in the opposite direction. This concept needs a lot of work, though scientists feel they understand the physics of the nuclear explosion extremely well. What isn't well understood is the upper surface of a NEO: solid, fluffy, rubble-pile. Each surface will have a different effect. Then, there is the challenge of getting the nuclear weapon to the asteroid -- possibly very quickly -- and detonating it at the right place.

**THAT NUCLEAR DETONATION CRUSHES US ADHERENCE TO INTERNATIONAL LAW**

**Gerrard 98** (Micheal, environmental lawyer, “Legal issues in defending against asteroids”, New York Law Journal, march 27, 1998, http://members.tripod.com/~Ray\_Martin/RiskAnal/DefAgAst.html) The basic principles governing international activities in outer space are established by the 1967 Outer Space Treaty. [FN12] It provides that, like the high seas and the Antarctic, outer space is not subject to the sovereign jurisdiction of any nation, but rather may be exploited by all nations. Article IV of the Treaty provides that countries will not place nuclear weapons into orbit around the Earth, or station them in outer space in any other manner. Article IV also provides that no state party may test any type of weapon on any celestial body. This categorical ban would prohibit any signatory from testing any sort of NEO destruction system, even on the smallest, most remote asteroid. Any testing of a nuclear planetary defense system might also violate the multilateral 1963 Partial Test Ban Treaty, [FN13] which prohibits nuclear- weapon test explosions and any other type of nuclear explosion anywhere that is under the "jurisdiction or control" of the party conducting the explosion. The phrase "under its jurisdiction or control" was intended to extend the ban to non-self-governing territories, but not to territories under hostile control. In other words, the Treaty is not intended to prevent explosions in enemy territory during armed hostilities. Arguments could be made either way about whether this Treaty would apply to testing nuclear weapons on asteroids. Neither the Partial Test Ban Treaty nor the Outer Space Treaty prohibits the launch of ballistic missiles carrying nuclear weapons and headed toward an enemy. The Outer Space Treaty does provide that parties shall "conduct exploration of [celestial bodies] so as to avoid their harmful contamination." This provision arguably bans blowing up asteroids or comets, altering their orbits or contaminating them with large amounts of radiation. There is a compelling argument that no international obligation would prevent the launching of a missile with the aim of diverting or destroying a threatening NEO. The launching country should be able to invoke the justification of self- defense, the right to which is codified in the UN Charter. Complexities can arise, however, if scientists disagree over the best tactics to use. A nuclear device could divert a threatening object, but (depending on the composition--some NEOs are mostly rock, some iron and some ice, and all would behave differently in a blast) perhaps an explosion could also fragment it, causing much more harm than good. The 1972 Convention on International Liability for Damage Caused by Space Objects [FN14] provides that a launching state is strictly liable for damage caused on the surface of the Earth or to aircraft in flight caused by objects launched into space. For other types of damage, the launching party is only liable if it is at fault. Debris from exploded comets or asteroids entering the Earth's atmosphere, or failed launches of anti-asteroid weapons, could cause much greater damage than satellites falling back to Earth. Under the Liability Convention, nations might be responsible for any damage caused in other parts of the world as a result of either the testing or the deployment of a planetary defense system.

## 2AC ADD-ON/DA THUMPER – MILITARY SATELLITES

**Meteor storms from NEOs knock out satellites**

Worden, 02. (Brigadier General Simon P.’s testimony in front of the Senate. “Threat of Near-Earth Asteroids,” lexis, CALLAHAN)

A few years ago those of us charged with protecting this Nation's vital space systems, such as the Global Positioning System, became aware of another aspect of the NEO problem. This was the Leonid meteor storm. This particular storm occurs every 33 years. It is caused by the debris from a different type of NEO-a comet. When the earth passes through the path of a comet, it can encounter the dust thrown off by that comet through its progressive passes by the sun. This dust is visible on the earth as a spectacular meteor storm. But our satellites in space can experience the storm as a series of intensely damaging micrometeorite strikes. We know about many of these storms and we have figured out their parent comet sources. But there are some storms arising from comets that are too dim for us to see that can produce "surprise" events. One of these meteor storms has the potential of knocking out some or even most of our earth-orbiting systems. If just one random satellite failure in a pager communications satellite a few years ago seriously disrupted our lives, imagine what losing dozens of satellites could do.

**Satellites key to US military communication and readiness – turns the disad**

Kaiser, 11. (Dustin is a Senior Space Analyst at Futron, where he works with commercial and government clients addressing a range of international space markets from military communications to remote sensing and the commercial spaceflight industry, including spaceports, launch vehicles, and astronaut training. Mr. Kaiser has a B.S. in Aeronautics and is currently completing an M.S. in Space Studies from the University of North Dakota. January 2011 edition of MilSat Magazine. “Military Communications a Key Target for Satellite Services.” http://www.milsatmagazine.com/cgi-bin/display\_article.cgi?number=1620673149, CALLAHAN)

The strongest trends impacting military demand for commercial satellite capacity over the next decade include growing use of satellite capacity to support new types of warfighting, which are increasingly dependent on broadband communications. Key among these are the expanded global troop deployments, primarily by U.S. defense forces, as well as use of satellites to support Intelligence, Surveillance and Reconnaissance (ISR) activities, in particular those carried out using a variety of Unmanned Aerial Vehicles (UAVs) or Remotely Piloted Aircraft (RPAs). KaiserFig1.jpg While commercial satellites have increasingly been used to meet these requirements, there is still a bias in the military for specialized, proprietary capabilities, using military satellites. Given the range of uncertainty regarding development and deployment of new technologies, new regulations, and new market solutions, Futron’s forecasting includes projection of a series of possible future states, not just a single demand scenario, with the key variables summarized below. Futron’s assessment of demand for commercial military satellite communications suggests that the market is significantly larger than generally perceived, due to sizable demand for classified operations and agencies, as well as a rapidly increasing international customer base. Futron estimates the 2009 market size for the military segment at 390 TPEs for C-, Ku-, and Ka-bands, with a baseline forecast for the addition of almost 300 units through 2019, or 5.6 percent annual growth over ten years. Comtech\_ad\_MSM0111.jpg Futron’s forecast includes a full alternate view representing conversion of demand into Mbps, with military demand in 2009 estimated at almost 16 Gbps, growing to over 28Gbps in 2019. While the United States military and security forces represent the largest buyer, demand from international security forces is anticipated to grow in aggregate terms as well as an overall percentage of demand. Fast followers, such as NATO allies and Israel, will continue to require increased supply of commercial capacity. Other governments in the Middle East, Japan, Australia, and India will also likely require international commercial capacity. The geographic demand requirements will include in-theater operations as military communications are pushed lower into the warfighter ranks, as well as “home country” demand tied to training, backhaul, and redistribution of data.

## INHERENCY EXTS – LIMITED RESOURCES

**STATUS QUO IS NOT EFFECTIVE AT DETECTION – ASTEROIDS ARE GETTING THROUGH – MORE RESOURCES NEEDED**

**O’neill, 2008 (**Jen,B.A. from St. Mary’s College, NYC department of education, findingDulcinea, “Surprise Asteroid Underlines Need for Early Detection System” Dulcinea Media Inc., 12-29-2008**,** <http://www.findingdulcinea.com/news/science/2008/December/Surprise-Asteroid-Underlines-Need-for-Early-Detection-System.html>) [Max Waxman]/steven

In October, [a small asteroid collided with the Earth’s atmosphere](http://www.news.com.au/heraldsun/story/0,,24482099-5012751,00.html) over Africa, surprising astronomers who never saw it coming. Although it caused no damage, had the piece of space debris been larger, it could have been “catastrophic for the planet,” wrote Australian paper Herald Sun. Space scientists believe the celestial commotion indicates that there is a need for funding geared toward surveying the skies to predict asteroid patterns, and to learn if any are headed toward the Earth. The asteroid measured two meters across, and was between one and five meters wide—about the “size of a bus,” claims Gareth Williams, associate director of the Minor Planet Center, confirming “something that small would not survive passage through the atmosphere intact.” Williams warned that had the asteroid been larger, however—such as 30 meters across—an entire city could have been taken out. An asteroid as large 300 meters across “could have ended all life on planet Earth.” According to astronomers, a 300-meter-wide asteroid, named Apophis, has a slim [chance of hitting the Earth](http://www.findingdulcinea.com/news/science/Potentially-Devastating-Asteroid-approaching-Earth.html) in 2036. The odds of a collision are 1/6250 according to astronomers, and although that’s only a min

**NASA UNDERFUNDED NOW FOR NEO DETECTION PROGRAMS**

**ASEB** 20**10** (Aeronautics and Space Engineering Board, National Research Council, ([Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies](http://www.nap.edu/catalog.php?record_id=12842)”, The National Academies Press, 2010, <http://www.nap.edu/catalog.php?record_id=12842>) rory

**Finding: 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.**

**NASA’S NEO DETECTION PROGRAMS ARE UNDERFUNDED AND PIECEMEAL – STATUS QUO FAILING TO PROVIDE COMPREHENSIVE EARLY WARNING DETECTION**

**Easterbrook 08** (Gregg, senior editor of The New Republic, “The Sky Is Falling,” The Atlantic, June 2008, http://www.lsst.org/files/docs/TheSkyisFalling-AtlanticMonthly.pdf) [JHegyi14]

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. 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.

## COLLISION ADV– NEOs ARE COMING

**NEOs ARE COMING – WE ARE LIVING IN A SHOOTING GALLERY AND ARE ON THE WRONG SIDE OF THE FIRING LINE – COLLISION IMMINENT**

Spotts, 09. (Peter Spotts is a staff writer for the Christian Science Monitor who cites scientists and reports from the Jet Propulsion Laboratory. July 21, 2009, “Jupiter collision a warning call to Earth,” lexis, CALLAHAN)

When an object smacked into Jupiter over the weekend, giving astronomers their best cosmic-collision show since the comet Shoemaker-Levy 9 in 1994, the giant gas ball of a planet took the poke like the Pillsbury Dough Boy. For all its scientific interest, however, the collision also serves as a stark reminder that the solar system remains a shooting gallery - with Earth, as well as Jupiter, on the wrong side of the firing line. The object's signature on Jupiter's cloud tops initially was discovered by Australian amateur astronomer Anthony Wesley as he gathered digital images of the giant planet through his 14.5-inch telescope. After alerting other astronomers to what appeared to be a "scar" in the cloud tops similar to those generated by the pieces of Shoemaker-Levy 9, NASA scientists trained a 3-meter (9.8-foot) infrared telescope on the planet and got a good look at the scar. "It could be the impact of a comet," according to Glenn Orton, a scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., in a statement yesterday. "But we don't know for sure yet." When it comes to objects Earthlings should keep an eye on, the catalog scientists have amassed is swelling. Since 1995, astronomers associated with 10 search projects have discovered more than 6,200 near-Earth asteroids of all sizes, according to data from JPL. Some 784 are at least a kilometer (0.62 miles) across or larger. Just over 1,000 of the total have been deemed "potentially hazardous" - those that pass Earth at a distance of less than 4.7 million miles. And while the biggest ones have the potential to inflict the most damage, scientists are gaining a new appreciation of the punch even small ones can deliver. Two and a half years ago, scientists at Sandia National Laboratories in Albuquerque, N.M., conducted advanced supercomputer simulations of the June 1908 event over Siberia that flattened and scorched trees over a region 30 miles across. Estimates put the explosive clout of the air burst from either a meteor or comet fragment at between 10 and 20 megatons. The good news: Calculations on Sandia's supercomputer, in 3-D, push that explosive yield down to between three and five megatons. The bad news: The calculations also indicated that the asteroid or comet fragment was much smaller than previously estimated. There are more small asteroids hurtling around us than large ones. Sometimes they can seem to come out of nowhere. Last October, astronomers detected an asteroid an estimated two to five meters across. Some 21 hours later, it entered the atmosphere over northern Sudan sprinkling the Nubian desert with meteorites. The object's blast was estimated at roughly 1,000 tons of TNT. For asteroid specialists, this was a live-fire test of protocols they'd developed to alert astronomers to monitor the object to refine orbital and impact-location estimates - and to alert national authorities that a direct hit was on the way.

**AN ASTEROID COLLISION IS IMMINENT – WE HAVE BARELY SCRATCHED THE SURFACE IN DETECTING THE THREATS**

Shiga, 09. (David is New Scientist’s physical sciences reporter in Boston. Sep 26, 2009, “It's behind you!; They can strike without warning and devastate the planet, so it's time to get asteroids firmly in our sights, says David Shiga,” lexis, CALLAHAN)

Far-fetched it might seem, but this scenario is all too plausible. Certainly it is realistic enough that the US air force recently brought together scientists, military officers and emergency-response officials for the first time to assess the nation's ability to cope, should it come to pass. They were asked to imagine how their respective organisations would respond to a mythical asteroid called Innoculatus striking the Earth after just three days' warning. The asteroid consisted of two parts: a pile of rubble 270 metres across which was destined to splash down in the Atlantic Ocean off the west coast of Africa, and a 50-metre-wide rock heading, in true Hollywood style, directly for Washington DC. The exercise, which took place in December 2008, exposed the chilling dangers asteroids pose. Not only is there no plan for what to do when an asteroid hits, but our early-warning systems - which could make the difference between life and death - are woefully inadequate. The meeting provided just the wake-up call organiser Peter Garreston had hoped to create. He has long been concerned about the threat of an impact. "As a taxpayer, I would appreciate my air force taking a look at something that would be certainly as bad as nuclear terrorism in a city, and potentially a civilisation-ending event," he says. The latest space rock to put the frighteners on us was 2008 TC3. This car-sized object exploded in the atmosphere over Sudan in October last year. A telescope first spotted it just 20 hours before impact - at a distance of 500,000 kilometres - and astronomers say we were lucky to get any warning at all. Thankfully, 2008 TC3 was far too small to do any damage on the ground, but we are nearly as blind to objects big enough to do serious harm. We have barely begun to track down the millions of skyscraper-sized asteroids zipping around Earth's neighbourhood, any one of which could unleash as much destructive power as a nuclear bomb on impact. Asteroid impacts are not as rare as you might think. It is widely accepted that an asteroid or comet 30 to 50 metres across exploded over Tunguska in Siberia in 1908, flattening trees for dozens of kilometres all around. The chance of a similar impact is about 1 in 500 each year (Nature , vol 453, p 1178). Put another way, that's a 10 per cent chance of an impact in the next 50 years (see "Should we panic?"). "Fifty-metre asteroids scare me to death," says Timothy Spahr, director of the Minor Planet Center in Cambridge, Massachusetts. "I could easily see a 50-metre object hitting in three days causing absolute pandemonium." During the US air force planning exercise, the participating scientists explained that with so little warning there would be no hope of preventing an impact. Even Innoculatus's smaller 50-metre asteroid would weigh hundreds of thousands of tonnes, requiring an enormous push to change its trajectory appreciably - so much so that detonating a nuke near it in space would not provide a sufficient impulse so late in the game to cause a miss. To deflect an asteroid sufficiently, force would need to be applied years in advance (see "Could we nuke it?"). In fact, it could make things worse by breaking the asteroid into pieces, some of which could be large enough to do damage, and even create a blizzard of meteors that would destroy satellites in Earth orbit.

## COLLISION ADV– NEOs ARE COMING

**NEOs are coming and we can’t detect them early enough – MD proves**

**MacKinnon, 11.** (Douglas is a writer for the Orlando Sentinel that cites NASA reports. July 10, 2011, “Plan now to avoid ‘Deep Impact’ later,” <http://articles.orlandosentinel.com/2011-07-10/news/os-ed-asteroids-071011-20110708_1_asteroid-strike-strike-earth-nasa-astronomers>, CALLAHAN)

As President Barack Obama jump-starts his re-election campaign and declared or potential Republican candidates like Michele Bachmann, Tim Pawlenty, Jon Huntsman, Mitt Romney and Rick Perry test-fly various strategies, it's a sure bet that not one of them will be breathlessly warning of an always pending and incalculably lethal threat to our troubled planet. Too bad. They should be. This city, region, nation, or even planet-killing threat — chuckling and shakes of the head anticipated — are the all-but invisible asteroids which whiz by earth on a fairly regular basis. For instance, asteroid 2011 MD. Heard of it? Well, on June 27, this asteroid — which was not discovered until June 22.— just missed the only home we have in the universe by a miniscule 7,500 miles To astronomers, that's a distance so close that the objects may as well be touching. Of course, instantly NASA astronomers basically said, "Nothing to see here. Move on. There is no chance 2011 MD will hit Earth." Even if they had been wrong and the asteroid did enter our atmosphere, they said it "likely wouldn't reach the surface." By their own admission, NASA initially got the calculations on asteroid 2011 MD's closet approach to Earth wrong, so "likely" is not always that comforting. What if they had been even more wrong and it was a certainty that it was about to strike earth? What if, instead of the approximately 100 feet across, it had been 500 or 1,000 feet across? With five days’ notice or less, what could we do to avert a collision that would have the potential to wreck havoc on humanity? Nothing. Absolutely nothing. Laugh, if you will. File this incident and remarkably close call in with the reports of UFOs over the swamp and Sasquatch in the neighbor's backyard. But you do so at all of our peril. In 1908, an asteroid — much smaller than originally believed — exploded over Siberia and flattened more than 800 square miles of forest, killing everything in its path. The truth is that the vast majority of politicians in our country — Republican or Democrat — are loath to discuss this subject out of fear of being labeled eccentric or because they have (rightfully) determined that it's not considered tangible and is not a vote-getter.

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## COLLISION ADV – IMPACT EXTS – EXTINCTION

**FIRST, AN ASTEROID STRIKE IS INEVITABLE AND WILL CAUSE EXTINCTION – DETECTION SYSTEMS ARE KEY – THE GOVERNMENT HAS AN OBLIGATION TO PROTECT ITS PEOPLE FROM A COLLISION**

**Roach, 03.** (John is a contributor to National Geographic News and a member of the National Association of Science Writers, the Northwestern Science Writer’s Association, and the Society of Environmental Journalists, June 19, 2003, “Killer Asteroids: A Real but Remote Risk?” http://news.nationalgeographic.com/news/2003/06/0619\_030619\_killerasteroids.html)

It is almost certain that Earth will be hit by an asteroid large enough to exterminate a large percentage of our planet's life, including possibly over a billion people, according to researchers. But as such cataclysmic collisions occur on average only once in a million years or so, are they really worth worrying about? At some point in the geological future a large chunk of rock and ice will smack into Earth and destroy life as we know it. This is a cold, sober, scientific fact, according to Andrea Milani, a researcher at the University of Pisa in Italy. "A future impact from, say, a 1-kilometer [0.62 mile]-diameter asteroid is, rather than just probable, almost certain over a time span of a million years," he said. Wolf Reimold, a geoscientist at the University of Witwatersrand in Johannesburg, South Africa, said a 1-kilometer-wide asteroid would produce an impact crater of about 12 miles (20 kilometers) in diameter and wipe out an area the size of the United Kingdom. The human toll would depend on where such an impact occurs. "Estimates may range from 500,000 to 1.5 billion casualties," he said. "This latter number certainly smells of global nuclear war. Such an event would in all likelihood not wipe out mankind, but it would cause a global economic crisis." Given the real threat of impact by a so-called near Earth object (NEO) and the consequences for human life, Milani and Reimold are urging the worldwide scientific community, and the agencies that fund their research, to take the field of impact mitigation seriously. In separate papers appearing in the June 20 issue of the journal *Science*, Milani and Reimold outline what is known about the impact threat and how impacts have shaped the geologic and life history of Earth. They agree that the developed world has made great strides over the past few decades in NEO research, but say that more funding is required to raise public awareness of the impact risk and to determine how to thwart an incoming object. "Governments have the responsibility to deal with a lot of problems afflicting humankind. But these same governments must realize that large asteroid or comet impact has the potential to wipe out all other problems, including mankind," said Reimold. Impact Science Impacts of meteorites, asteroids, and comets are frequent events on a geological time scale, said Milani. They have shaped the surface of the Earth and altered the course of life that thrives upon it. For example, 65 million years ago a 6.2-mile (10 kilometer)-diameter asteroid impact resulted in a 100-million-megaton explosion that excavated a 112-mile (180 kilometer)-wide crater on the Yucatán Peninsula in Mexico and brought the dinosaur era to an end. ­­­­­­ Events such as the impact implicated in the dinosaur extinction happen on the order of once every 100 million years. Smaller objects collide with Earth with greater frequency. Asteroids large enough to cause ocean-wide tsunamis, for example, happen once every 63,000 years. In 1998 NASA accepted the responsibility of compiling a catalog of at least 90 percent of NEOs of 1 kilometer (0.62 miles) in diameter or greater and to assess the probability that any of them will impact Earth. Such events are believed to happen on the order of about once every 1 million years. To date the NASA initiative, known as Spaceguard, has identified 585 objects of 1 kilometer or greater. Most of them have no chance of impact and those that do have only a very low probability. Scientists estimate there are about 1,000 NEOs, so NASA is more than halfway to accomplishing its goal. Reimold notes that this initiative and projects such as the British Taskforce on Potentially Hazardous Near Earth Objects and the Intercontinental Scientific Drilling Program into the Chicxulub crater in Mexico have helped scientists understand the risks and consequences of collisions with asteroids and comets. The developing world, he said, is slower to catch on, but a movement by astronomers and geoscientists in South Africa to establish a National Working Group to assess NEO impact risk and mitigation is gaining traction. "On the other hand, the general public in developing countries has a host of other problems than the possibility that a large bolide could wipe out mankind," he said. "If your first concern is to have shelter and food, if HIV/Aids and unemployment are your daily worries, you cannot be expected to be wary of meteorite impact." **More Mitigation Funding?** Writing in *Science*, Milani says that the scientific community should take on the responsibility to investigate all objects that could potentially impact Earth "down to the size compatible with available technology and with the public perception of acceptable risk." According to Milani, a reasonable goal would be to detect within the next ten to 20 years 90 percent of the NEOs over 1,000 feet (300 meters) in diameter and 97 percent of those greater than 1 kilometer in diameter. To accomplish this goal, Milani says that understanding and awareness of the impact risk must be raised amongst the public and the agencies that provide the requisite funding to perform the work. "If [funds] are provided, the scientists would know how to use them efficiently," he said. "If resources dedicated to this task are not provided, the scientists have difficulties in canceling other worthwhile basic research to make resources available for impact risk assessment." Reimold said that more money ought to also be made available for research into known and potential impact sites. Currently, he said, only a few impact sites older than 300 million years are known, but that many more should be out there. "Ongoing detailed geological analysis of known impact structures is a must in order to further improve our knowledge of the impact process and its devastating results," he said. Robert Jedicke, an asteroid expert with the Institute for Astronomy at the University of Hawaii, said that "it would be nice" if asteroid researchers had more money but that current funding for the NEO impact risk assessment programs is sufficiently supported given the available funding for all scientific research. "There's only so much money to go around," he said. "So if the pot gets split there's less stew for the rest of the astronomical/scientific community."

## COLLISION ADV– IMPACT EXTS - EXTINCTION

**WE ARE LEFT UNPROTECTED – AT MOST, WE ARE ONLY DETECTING ½ OF THE NEOs OUT THERE – A COLLISION COULD LEAD TO EXTINCTION**

Greene 11 (Nick, about.com guide “Near Earth Objects, Are We in Danger?” about.com 2011 <http://space.about.com/cs/nasanews/a/neoimpact.htm>) Steven Canova

A recent article on BBC.com says that a small [meteoroid](http://space.about.com/od/meteoroids/a/meteoroidsinfo.htm) (approximately 16 feet wide) flew past the Earth recently. It was the fourth closest pass by an object since we have been monitoring near Earth objects. The article continues by saying the object was too small to cause any actual damage and praising the astronomers who had detected it… 21 hours after its closest approach. Personally, I would be happier if space debris that comes close to Earth were discovered before they posed a threat. Also, according to the BBC, “Half of the top 10 approaches to the [Earth](http://space.about.com/cs/solarsystem/p/earthinfo.htm) by space rocks have been detected in the past two years.” What about the other half? Plus, that is just the top 10. How many of the other approaches were spotted? Half? Would you be satisfied with a bullet-proof vest if it only stopped half the bullets shot at you? I am not condemning the people who are working so hard to discover these Near Earth Objects (NEOs). I know they truly do a remarkable job, and the BBS was right to commend Arianna Glearson and Tom Gehrels, who spotted 2003 SW130, observing with the Spacewatch 1.8-metre telescope in Arizona. The fact that they were able to spot such a small object is amazing. However, considering the possible results if Earth were to be struck by a large object, we really need to work harder to find them. Earlier this year, a group of Americans got together to send a request to Congress. These concerned citizens are “convinced that the time has come for our nation to address comprehensively the impact threat from asteroids and comets." This letter goes on to say, "A growing body of scientific evidence shows that some of these celestial bodies, also known as Near Earth Objects (NEOs), pose a potentially devastating threat of collision with Earth, capable of causing widespread destruction and loss of life. The largest such impacts can not only threaten the survival of our nation, but even that of civilization itself."

**EVEN A SMALL ASTEROID COLLISION WILL LEAD TO EXTINCTION THROUGH RAPID CLIMATE CHANGE – WE HAVE HAD RECENT NEAR MISSES**

**Shaffer et al., 1996** (William Shaffer - Capture Manager at Northrop Grumman Information Systems, which is a public company in the Space & Defense Industry, Martin McHugh, Dexter Wang, “Space-Based Asteroid Detection and Monitoring System,” Report to Secretary of Navy, accessed 7/11/11, http://adsabs.harvard.edu/abs/1994padn.reptQ....S) Hou

The earth is continually bombarded by asteroids and comets, most of which are harmlessly burned in the atmosphere. However, a fraction of these objects do impact the earth’s surface, as evidenced by the many craters found around the glove. Such collisions of planetary bodies with the earth have played an important role in the geological, biological and climatologically development of the earth. Asteroid collisions may have had a significant impact on biological evolution as a result of mass extinctions brought on by global climate change. The destructive power of asteroid collisions has also been demonstrated in modern times. The 1908 Tunguska meteorite, the 1947 Sikhote-Alin meteorite and the 1945 meteor explosion over the Pacific Ocean all released energies equivalent to small thermonuclear devices. A near hit of an asteroid with the earth in 1991 underscores the vulnerability of our planet to sudden devastation. Over 200 Near Earth Asteroids (NEAs) have been discovered. The Aten and Apollo class asteroids have earth intersecting orbits. While NEAs are usually smaller than 5 kilometers in diameter, asteroids as small as 50 meters in diameter pose a potential threat for significant destruction should one collide with the earth. NEAs are believed to arise from the decay of cometary nuclei or from ejection from the main asteroid belt.

## COLLISION ADV – IMPACT EXTS – EXTINCTION

**A LARGE ASTEROID COLLISION WILL LEAD TO EXTINCTION – IT WILL PLUNGE THE EARTH INTO DARKNESS AND COLD – WIDESPREAD STARVATION WILL ENSUE**

**INTERNATIONAL SPACEGUARD FOUNDATION 1999** (International Spaceguard Foundation, “Spaceguard UK Proposal”, no date, <http://star.arm.ac.uk/impact-hazard/Spacegd95-2.PDF>) rory

So, what is going to do the killing after a major impact? Immediate effects will include the obvious explosive effects at ground zero and local firestorms raised by the superheated air from the impact. A crater, about 20 times the diameter of the impacting body, will be excavated in a matter of seconds, and debris will be ejected into sub orbital trajectories. This debris will later re-enter the atmosphere – the meteor shower from hell - possibly all over the globe raising massive fires that destroy a significant proportion of the biomass. Intense acid rain would result from the ionisation of the air as the impactor entered the atmosphere, as would the production of pyrotoxins. The ozone layer would be severely damaged, and major volcanism and seismic activity can be expected as the shock wave of the impact ripples through the planet. All of this will cause a globaenvironmental disaster of extreme severity. In addition to most or all of these effects, an impact at sea will produce a significant "tsunami," capable of travelling considerable distances, and possessing enormous energy. Such surges will pose a substantial threat to low lying and coastal areas. The United Kingdom, with much of its population and economic infrastructure located in precisely such areas, would be at particular risk from an impact anywhere in the Atlantic Ocean. Japanese research indicates that there is a one- percent chance that every major city on the Pacific Rim will receive catastrophic damage from an impact-induced tsunami at some stage during the next hundred years. However, the main killing mechanism will be the vast amount of dust and debris injected into the upper atmosphere, combined with the smoke from the firestorms (witness recent events in Indonesia). These will obscure the Sun and cause a phenomenon similar to, but much more severe than the “nuclear winter” that became such an issue during the Cold War. It is this that is likely to pose greatest threat to the ecosphere on a global scale as food chains collapse and darkness, cold and starvation set in

**Asteroid impact causes extinction --- multiple warrants**

Huggett 90 (Richard J., Senior Lecturer in Geography at the University of Manchester, England. He studied geography at University College London, both as an undergraduate and postgraduate, “The Bombardment of Earth,” Geography, Vol. 75, No. 2, pp. 114-127, pp. 114-127, April 1990, <http://www.jstor.org/stable/40571806>) [Iuliano]

The damage done to ecosystems by an impact is varied. Primary damage is caused by the immediate effects of a planetesimal travelling at hypervelocity through the atmosphere and the impact itself. This damage will occur within minutes or hours of the impact. Secondary damage is caused by processes set in train by the impact which may lead to environmental stress over the next few days, weeks, months, or even years. The extent of primary damage inflicted within the first hours depends on the size of the impactor. The area of damage can be considered as a circle with the point of impact as its centre. For organisms, the circle can be defined by a 'lethal radius\* in which all life is exterminated (apart perhaps from a few lucky individuals who happened to be in caves or deep burrows at the time). Within the lethal radius, a blast wave creates enormous air pressures which at their peak would destroy forests and kill animals. Particularly vulnerable would be the large land vertebrates with a small ratio of strength to weight, a fact which has been used to explain the selective extinction of large dinosaurs at the close of the Cretaceous period. Repopulation of the land by animals adapted to underground habitats and the rapid recolonisation of vegetation by roots and seeds would also be consistent with extinction by a blast wave (Napier and Clube, 1979). A wave of intense heat would also radiate from the site of impact, killing all exposed life forms within the lethal radius. For impacts of bodies 10 km or more in diameter the lethal radius could include areas of continental size. The intense heat would also be likely to trigger wildfires. Secondary effects, which produce a general deterioration of the environment, would result from the very high temperatures and the dispersal of the plume of volatilised, melted and solid rock thrown up by the impact. The great temperatures would lead to the formation of large quantities of the oxides of nitrogen. A very large impact could produce up to 3 χ 1018 of nitric oxide which, in less than a year, would have spread through the atmosphere to give worldwide, atmospheric nitrogen dioxide concentrations of 100 parts per million by volume, a level one thousand times higher than during the worst air pollution episodes in modern cities, and capable of poisoning any animals and plants exposed directly to the atmosphere. The nitric oxide would also destroy the ozone layer, exposing the already decimated flora and fauna to a flood of ultraviolet radiation. Nitrogen oxides would react with water to produce large amounts of nitric acid, which in turn would cause superacid rain with a pH of around 1.0. Rain of that acidity would destroy much of the biosphere. Great quantities of carbon dioxide, and possibly noxious chemicals, would also be released. Impacts on land would produce a plume of vaporised, melted and solid rock. If the impact occurred in an ocean, the plume would also contain shock-heated steam. Initially, the plume would rush, at highly supersonic speeds, into the hole punched in the atmosphere by the bolide, and would catch up with the bow shock-wave to which it would impart extra power. The plume would carry much material into the stratosphere. The extra mass added to the atmosphere by an impact would within hours cause a rise of mean global surface air temperature of about 1 °C, the maximum rise occurring near the impact. Large particles would fall out rapidly, but a cloud of fine dust would be spread around the world. The dust cloud would stay in suspension for months or years, blocking out sunlight. Indeed, it would be so dark that you could literally not see your hand in front of your face. The darkness would lead to a reduction or a collapse of photosynthesis, a breakdown of food chains and a drastic drop in surface temperatures with freezing conditions on continents, especially in continental interiors, and widespread and deep snowfall. The dramatic change in climate might account for the relatively sudden disappearance of large parts of fauna and flora associated with large impacts. The climatic effects produced by an impact are similar to the climatic effects predicted to occur after a major nuclear exchange (Ehrlich et al, 1984). If the impact occurred in an ocean, then the period of intense cold may be followed by a longer-lasting time of much hotter conditions. The ocean water vaporised by the impact would increase the atmospheric moisture content considerably, and this would lead to the washing out of the tropospheric dust within a few weeks or months. After that, the remaining water and cloud in the stratosphere would, in the manner of a very efficient greenhouse, generate a large rise in global temperature which at the surface may exceed 10°C: this temperature anomaly would persist for some months or years, until diffusion and photochemical processes in the stratosphere return the Earth to its steady-state condition. On the other hand, it is possible that a dust cloud created by even a modest impact would start a general cooling of the Earth-atmosphere system, owing to an ice-albedo feedback mechanism. A combination of superfloods and a dusting of the upper atmosphere seems a good recipe for making extensive ice sheets. The ice-albedo feedback mechanism would be refuelled by further impacts during an impact episode, the Earth- atmosphere system remaining in a refrigerated state until the chance absence of impacts led to a global warming (Clube and Napier, 1982).

## COLLISION ADV– IMPACT EXTS – GLOBAL WARMING

Asteroid strikes exacerbates warming

Lloyd, 10.(Robin Lloyd is responsible for editing and assigning articles, and managing Scientific American’s website. She has been a senior editor for LiveScience and Space.com. March 31, 2010, “Competing Catastrophes: What’s the Bigger Menace, an Asteroid Impact or Climate Change?” http://www.scientificamerican.com/article.cfm?id=asteroid-impact-climate-change, CALLAHAN)

If you ask the average person whether in the long run it is climate change or an asteroid/comet impact that's expected to kill more people annually, you'll undoubtedly get some confused replies. Those asteroid movies are scary, but there are no verified instances of an asteroid strike killing any humans, are there? Meanwhile, the science of climate change is currently being overshadowed by a media-driven public debate, mainly in the U.S. In fact, the expected annual fatality rate due to climate change is estimated to be far higher than that due to an asteroid or comet impact—150,000 versus 91, per the World Health Organization (WHO) and Alan Harris of the Space Science Institute, respectively. You won't, however, see that 150,000 figure in the main body of the Washington, D.C.–based National Research Council report on near-Earth object (NEO) surveys and mitigation strategies. (The report was written by a total of 42 scientists.) Instead, in a chart on page 26 of the report on "expected fatalities per year, worldwide, from a variety of causes," asteroids are compared with shark attacks (three to seven deaths), firearms accidents (2,500), earthquakes (36,000), malaria (one million), traffic accidents (1.2 million), air pollution (two million), HIV/AIDS (2.1 million) and tobacco (five million). Meanwhile, climate change is mentioned in a note beneath the chart, regarding one of the authors: "Mark Boslough wanted an additional entry in this table for fatalities due to climate change. The steering committee disagreed with including this entry because it did not think a reliable estimate is available, among other reasons. Dr. Boslough has written a minority opinion as Appendix D." The mysterious "Appendix D" In Appendix D Boslough, a physicist at Sandia National Laboratories in Albuquerque, N.M., wrote that he disagreed with the steering committee's reasons for removing the climate data. The reasons: a debate on climate change could distract from the issue at hand, and the irrelevance of climate-change numbers to the NEO threat. Boslough wrote that it's "inappropriate" to remove data from a report to avoid the potential for political controversy. And as for irrelevance, climate change is actually more relevant than the other causes in the table, he wrote. Asteroid impacts that cause global catastrophe are climate-changing events, and most of the resulting fatalities would be due to that change (which would cause social disruption that is expected to lead to starvation, disease and violence). And asteroids and climate change share some features—both can have abrupt and worldwide consequences that would have nothing to do with one's lifestyle or location on the planet. Contrast that with earthquakes, malaria, tobacco or firearms use.

**AN ASTEROID COLLISION WILL CAUSE MASSIVE ENVIRONMENTAL DESTRUCTION THROUGH GLOBAL CLIMACTIC CHANGES AND WORLDWIDE FAMINES**

**Jones, 08** (Thomas, Veteran Astronaut, Space Scientist and Author, “Asteroid deflection: Planning for the inevitable”, Aerospace America, October 2008, <http://www.aiaa.org/aerospace/images/articleimages/pdf/View%20from%20Here1.pdf>) [JHegyi14]

AS NASA’s Spaceguard Survey searches for the last few dozen undiscovered large NEOs (1 km or larger in diameter, capable of a civilization-ending impact on Earth), more and more small, worrisome NEOs are turning up as by-products of the survey. For example, 2007 VK184, a 130-m-wide asteroid, will pass close to Earth four times between 2048 and 2057; it has a 1-in-29,000 chance of striking the planet. If it does, the impact will release the energy equivalent of 150 megatons of TNT. Such a titanic blast would destroy an area the size of a small state; even an ocean impact could cause hundreds of billions of dollars in tsunami damage. Of course, Earth’s long history has often been punctuated by much larger cosmic collisions. The Eltanin impact in the eastern Pacific 2.5 million years ago inundated the South American coastline with towering waves. Very large collisions, such as the KT event 65 million years ago, have caused mass extinctions and dramatically altered the course of life on Earth. The effects of a 1-km asteroid strike on today’s fragile, interconnected human society would probably cause global climatic disruptions, widespread crop failures, and worldwide famine.

## COLLISION ADV – IMPACT EXTS – ECONOMY

**Asteroid collision would collapse the economy --- stock market**

Bobrowsky and Rickman 7 (Peter T, member of CANQUA and a Geologist, and Hans, Astronomer and Professor of Astronomy at Uppsala University, “The Economic Consequences of Disasters due to Asteroid and Comet Impacts, Small and Large,” Comet/Asteroid Impacts and Human Society, 2/21/07, <http://www.springerlink.com/content/m7736>) ben i

Consider next the loss of New York City. As Table 29.3 shows, it is the 16th largest city in the world, but is ranked first in the US. With its population of 8.1 million, it has a civilian labor force of 4.8 million, and the city’s GDP in 2004 was $ 414.1 billion. Personal per capita income in 2002 dollars was $ 40 680. The September 11 attack led to a 20% decline in the city’s GDP in that quarter, with a severe shock to the financial sector, a 12% decline. Total one-time capital and human loss was estimated at $ 45 billion, and for the fiscal year 2002–03, the total economic loss was estimated to be between $ 45 and $ 60 billion (The City of New York, 2001). However, the financial sector is now recovering. Table 29.3 also gives the population of other large cities in the world. Whereas the loss of life may be of the same order of magnitude, none of the other cities would have as a large a global economic impact as New York City. With the exception of London, Tokyo and New York, all the other cities are in developing countries. It is the economic importance of the city that governs the loss. New York is by far the largest capital market in the world. The market capitalization of the two New York Exchanges (NYSE and Nasdaq) is around $ 17 trillion. The loss of New York City would be a blow to the world economy as well as to the US. This loss could disrupt the global capital market and lead to a stock market crash of 1930s proportions, as stockholders try to move out of equity and into cash, gold or non-US dollar assets. The stock market crash of 1939–42 led to a 40% decline in the Dow Jones Industrial Average (DJIA). But the 1929 stock market crash was even worse: see Figs. 29.2 and 29.3, using DJIA and the S & P 500 respectively. The S & P 500 declined from a peak of 300 in June 1929 to a trough of just 50 in June 1932. Such stock market crashes not only affect the perceived real wealth of stockholders but are also accompanied by large reductions in output and employment. The real hardships of populations in the US after the 1929 crash are well known. The 1939–42 decline of 40% was not unprecedented; a similar decline had occurred between November 21st 1916 and December 19th 1917. History shows that stock markets recovered – eventually. But serious recovery did not take place until the 1950s. Now there is a view, promulgated largely by the US Federal Reserve, that such crashes cannot happen again: look at the 1987 crash (36% decline), from which the Fed was able to engineer a recovery by pumping unlimited liquidity, i.e. credit. But the causes of the 1987 crash were rather technical and not rooted in the goods markets. Although this scenario concentrates on the economic and financial effects, needless to say what was said about the loss of critical public infrastructure (see Scenario 3 above) also applies here, perhaps with added force. The adverse consequences of the loss of New York would also affect cities in the adjacent states of New Jersey, Maryland, etc. A cascading effect can be expected, compounding the problems. A NEO impact will be accompanied not only by a financial crisis, but also by a loss of real assets. It would therefore be instructive to consider the loss of London, on which more data is available. If the city of London were lost, the impact on financial markets would not be as large as that of New York. London has become more specialized; while just under 20 percent of international bank lending is done through London, more than a third (actually 36 percent) of all derivative trades is carried out there. But it has the largest foreign exchange market in the world, with an average daily turnover of $ 504 billion, which is more than all foreign exchange traded in New York and Japan combined. It is also the world’s largest insurance market, covering international trade and ocean tanker traffic. The main global impact of the loss of London would be disruption of the foreign exchange market, international trade and insurance. With global integration, more and more countries are dependent on the smooth flow of international trade and its payment through orderly foreign exchange markets. Its disruption would affect hospitals, water and sanitation and could trigger disease outbreaks that could then spread. There could be secondary or other long term consequences of the large NEO impact, such as the much talked about nuclear winter associated with sunlight becoming blocked for months on end due to particles in the atmosphere (see Chapman, Chap. 25 of this volume). In that case we can also expect large-scale population movements – a flow of refugees further complicating the difficulties.

**Asteroid impact collapses the economy --- stock market**

Bobrowsky and Rickman 7 (Peter T, member of CANQUA and a Geologist, and Hans, Astronomer and Professor of Astronomy at Uppsala University, “The Economic Consequences of Disasters due to Asteroid and Comet Impacts, Small and Large,” Comet/Asteroid Impacts and Human Society, 2/21/07, http://www.springerlink.com/content/m7736

Suppose the capital market disruption was accompanied by a more serious financial crisis, perhaps because of the destruction of a government along with its Central Bank. Following such an impact a government might be perceived to be financing recovery by issuing more currency. A loss of some minor currency would not be a problem. Even the loss of an internationally traded currency such as the Canadian dollar would not be a problem, as those affected would merely shift to one of the major currencies such as the US dollar, which is now the reserve currency of the world. But if the magnitude of the NEO impact were large enough to destroy confidence in a major world currency, such as the Japanese Yen, the euro or the US dollar, then its consequences could be serious on a global level. Loss of confidence in a major currency can be rapid. The worst decline in a major currency occurred in Germany between January 1921 and December 1923, as shown in Table 29.4. It shows a rapid decline in the external value of the currency, as domestic prices rose in response to the German government printing more and more currency to meet its reparation obligations. This occurred after it lost a large part of its productive capacity after WW I along with the destruction of the state apparatus and its ability to levy taxes. With regard to the social cost of this hyperinflation, it is worth noting that the real quantity of money (after adjusting for inflation) declined by 92 percent, indicating a virtual collapse of monetary exchange and a return to barter (Keynes 1923). After this loss of confidence in the German Mark, the government introduced a new currency, called the Rentenmark, and declared that one unit of the new currency would be equal to 1 trillion (i.e. 1012) old marks! Hungary, Poland and Austria had similar experiences, although the German case was the most spectacular. Thus history shows that a fiat currency can collapse, and collapse most dismally, under the right conditions. A dramatic decline in the external value of the US dollar could occur even if there were not a catastrophic NEO, but some “large” event that shakes the confidence of the international community, especially as the US has now become a debtor country and does not have enough reserves to cover its external debt, as the Table 29.5 shows. The comparison of Reserves of Foreign Exchange and Gold with external debt should be carried out with care. The external debt can be held in government bonds, or it can be held in the form of equity in real investments in corporations in the form of plant, machinery and equipment. The external debt results in an annual flow of dividends and interest payments out of the indebted countries. It is this flow that can be jeopardized when the level of reserves and holdings of foreign currencies is inadequate to meet the flow. A depreciation of the currency (in terms of its external value) can follow. If a NEO impact that interferes with this annual flow could have a serious effect on that particular currency, it could be “dumped” in the market, leading to its precipitous decline. Another set of data that is of relevance is what is called the Net Investment Position: this is in fact the total external debt of the country. That information is given in Table 29.6. The international comparison in Table 29.6 is an indicator of indebtedness and hence of vulnerability. The English speaking countries and Finland show heavy foreign investments into their countries and net indebtedness. The level of indebtedness approaches the debt of some developing countries. Of particular concern is the US debt ratio (–22.2%). Fortunately for the US, its currency is a world reserve currency, but it is all a matter of confidence. As soon as some major player, such as OPEC, prices its oil in euros, the US dollar as a reserve currency can lose ground in a matter of years. The debt service would then become burdensome and a rapid decline would be a real possibility. A NEO impact in the indebted countries would have major implications for the main creditor nations that are Japan and Switzerland, followed by countries in Western Europe. A major catastrophic impact of a NEO in the indebted countries, with destruction of factories or real estate could be viewed as a force majeure, and an act of God. When real capital is wiped out, it is the insurance companies who will have to meet the costs. Of course the insurance companies could declare bankruptcy and default on their payment obligations. Such a financial disaster would have cascading multiplier effects. Its global spread would be rapid. It is important to note that whereas financial disasters could have major consequences, the damage or destruction of real capital assets such as power stations could have enormous consequences, as the world has become more reliant on large power sources such as nuclear power stations and hydroelectric dams. Table 29.7 gives information on the world’s 11 largest hydroelectric dams. The destruction of any one of them could cause massive floods as well as disruption of economic life.

## COLLISION ADV– IMPACT CALCULUS – PRECAUTIONARY PRINCIPLE

**DECISION-MAKERS MUST USE THE PRECAUTIONARY PRINCIPLE WHEN MAKING DECISIONS ABOUT ASTEROID THREATS – MUST ERR AFFIRMATIVE DUE TO THE MAGNITUDE OF IMPACT**

**Wood et al, 06.** (Stephen G. Wood is a Professor of Law, J. Reuben Clark Law School, Brigham Young University, Stephen Q. Wood is an associate with the Los Angeles law firm of Quinn Emanuel Urqhard Oliver & Hedges, L.L.P. J.D., and Rachel A. Wood , third year law student and J.D. candidate at the J. Reuben Clark Law School, Brigham Young University, Fall 2006 issue American Journal of Contemporary Law, “Whither the Precautionary Principle?” http://www.jstor.org/stable/20454554, CALLAHAN)

The precautionary principle permits decisionmakers 1 to avoid or minimize risks whose consequences are uncertain but potentially serious by taking anticipatory action. The “catchphrase” 2 attached to this principle is: better safe than sorry. The precautionary principle consequently comes into play “[w]here risks of serious or irreversible damages are identified but conclusive evidence is not available[.]” 3 Under those circumstances, the appropriateness of a legal framework that demands certainty is called into question. The precautionary principle quite obviously is about decisionmaking. Is it simply about the information required to make decisions at a time when information either is difficult to interpret or unavailable? Or, alternatively, is it about the need to make decisionmaking “more humanistic and community-oriented” at a time when “concepts of deconstructionism and postmodern science and democracy [point to] the need to replace a non-democratic technocracy[?]” 4 The precautionary principle traditionally has been invoked in a variety of contexts, including, in alphabetical order, the following substances, products, or processes: air pollution, climate change, 5 energy development, fisheries, genetically modified organisms (“GMOs”), hazardous waste, marine pollution, ozone layer depletion, pesticides, and water pollution. The precautionary principle also raises international trade issues. More recently, the precautionary principle has been invoked with respect to human rights, 6 planetary defense, 7 terrorist attacks, 8 and tourism 9. One American author indicates that the precautionary principle “enjoys widespread international support” and “has been a staple of regulatory policy for several decades.” 10 This same author posits that the precautionary principle “is worthy of sustained attention for two reasons[:]” First, it provides the foundation for intensely pragmatic debates about danger, fear, and security. Second, the Precautionary Principle raises a host of theoretically fascinating questions about individual and social decision making under conditions of risk and uncertainty. 11 Part I of this article examines the role the precautionary principle plays in American law. The precautionary principle has been subjected to a number of critiques by American authors, and some of those critiques are outlined in Part II. Several American authors have explored alternatives to the precautionary principle, and those alternatives are analyzed in Part III. Part IV contains some concluding observation

## COLLISION ADV – IMPACT CALCULUS – INTERVENING ACTOR

**OUR IMPACT WILL OUTWEIGH YOURS – MOST THREATS CAN BE DEALTH WITH AND PREVENTED BY INTERVENING ACTORS**

**CHICHILNISKY AND EISENBERGER 2010** [Graciela and Peter – professors @ Columbia University, “Asteroids: Assessing Catastrophic Risks”, *Journal of Probability and Statistics,* <http://www.hindawi.com/journals/jps/2010/954750/>] ttate

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 $ 3 0 0 trillion ( = 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 1 0 times what we are now spending which is about US $ 3 0 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.10. ConclusionsWe believe that the above analysis is the beginning of a much more extensive assessment and research about our response to all kinds of catastrophic risks. Recent results provide ways to enhance our subjective judgments about the value of , which is approximated by the marginal utility of avoiding extinction near the catastrophe, see the study by Chichilnisky in [4]. Other methods could include the application of Bayesian analysis involving experts who understand the nature of the threats as well as the correct meaning of low probability events. A Bayesian approach can be helpful to determine both the true risk profile and the most plausible utility function for the use of resources to combat a given threat. Such evaluations identify not only high expected value but also high utility. If there are very expensive things we can do to prevent the risk the the allocations of a large amount of resources may be warranted and the problem becomes more complicated. Our political leaders will need to make the more difficult choices between meeting todays' needs compared with the need to defend against distant catastrophic threats. This is not a new challenge since we and other nations spend a significant part of our resources to defend against the threat of nuclear war or the nuclear winter that would follow it. What is new is that now we recognize that many serious threats like those arising from glaciation, asteroid impact, and biodiversity loss are unlikely to occur within our lifetimes, yet we do not want to wake up one day and find that we are facing the impact of what was an avoidable catastrophic risk. Furthermore the same type of deficiency in our approach also exists for very rare events like tsunamis and earthquakes also leading to a poor allocation of resources, as was likely the case for the 2005 Asian tsunami. This work provides a framework to address these threats in a way that agrees with our intuition. We would like to allocate resources in a way that can be useful in reducing the catastrophic threats we face. In conclusion we offer another perspective that might also be useful for understanding why it is now that we are confronting the dilemmas. An analogy might help. Early on nobody spent a lot of money on personal insurance to protect him/herself. As we gained more knowledge of the risks we face and as we became affluent enough we decided to spend increasing amounts of money on insurance. In a similar way our species only recently has obtained the knowledge of some of the catastrophic risks we face and developed ways to cope with them. For the moment we are seriously underinsured so any way that we can do useful things to reduce our risk we should do so. Someday in the future we may be challenged as we were doing the cold war to decide between present risks and future ones.

## COLLISION ADV – IMPACT CALCULUS – PROBABILITY – INEVITABLE

**THERE ARE LOTS OF NEOs CIRCLING THE EARTH – AN ASTEROID COLLISION IS INEVITABLE**

**Barbee, 9.** (Brent is working as an Aerospace Engineer and Planetary Defense Scientist and teaches Astrodynamics at the University of Maryland. Apr 1, 2009, “Planetary Defense: Near-Earth Object Deflection Strategies,” http://www.airpower.au.af.mil/apjinternational/apj-s/2009/1tri09/barbeeeng.htm, CALLAHAN)

Throughout history our planet has been bombarded by Near-Earth Objects (NEOs), which are asteroids and comets whose orbits around the Sun cause them to pass near Earth. The orbits of these celestial objects gradually change over time, causing some of their orbits to eventually intersect Earth's orbit. An object whose orbit intersects Earth's orbit will collide with Earth, if the timing is right, at the point where the orbital paths intersect. We see evidence of this throughout each year as we witness the wide variety of annual meteor showers caused by Earth passing through debris left in the wake of comets orbiting the Sun. As our ability to detect NEOs has improved we have discovered more and more of them in our celestial neighborhood. Earth's orbital region around the Sun is densely populated with NEOs, as shown in fig. 1, and it is only the vastness of space and the comparatively tiny sizes of celestial bodies that makes collisions infrequent. While collisions are infrequent, they are also inevitable. Our Moon's surface is covered in impact craters and many craters have been discovered and are still being discovered on Earth. The Moon's surface does not experience weathering due to meteorological and geological processes and so the craters are preserved and easy to see. By contrast, Earth is a very meteorologically and geologically active world so the signs of impact craters are often masked over time. Nevertheless, some terrestrial craters are quite obvious, such as the Barringer Crater, shown in fig. 2, located near Winslow Arizona. The crater is 1200 m wide and 170 m deep. It was created approximately 50,000 years ago by a nickel-iron NEO only about 50 m in size whose impact energy was between 20 and 40 Mt, devastating an area with a radius of 10 to 24 km and creating hurricane-force winds out to a radius of 40 km .2 NEO impact events range in consequence from local devastation to extinction-level events. In 1908 a relatively small NEO (perhaps 20 meters in size) exploded over the Tunguska river in Siberia, raining destruction over a 2000 square kilometer area4 (about the size of Washington, DC). Approximately 65 million years ago a relatively large NEO, about 10 km in size, slammed with terrible destructive force into the Yucatan peninsula and is believed to have caused the extinction of more than 70% of the species living at the time, including the dinosaurs .5 More recently, in October of 2008 we were able to just barely predict the collision with Earth of a very small NEO named 2008 TC3 a mere six hours before it entered our atmosphere and disintegrated at high altitude over Sudan. 6 The asteroid disintegrated rather than striking the ground because it was only about 5 meters in size. Perhaps the most unique aspect of these natural disasters is that for the first time in known history humanity may have the technology to anticipate and prevent them by discovering and deflecting incoming NEOs before they collide with Earth. However, to date no NEO deflection systems have been built or tested and no agency has been given the responsibility of defending Earth from hazardous NEOs.

**PROBABILITY OF AN ASTEROID COLLISION HIGH, EVEN IN THE SHORT TERM – WE ARE LIVING IN A SWARM OF ROCKS**

**AMES RESEARCH CENTER 2003** [research facility that has projects ranging from developing small spacecraft to supercomputer management to astrobiology research, “NASA NEO News: Open Letter to Congress on Near Earth Objects”, July 08, <http://www.spaceref.com/news/viewsr.html?pid=9866>] ttate

The latest NEO close approaches are typical of the two dozen such encounters known to have occurred in the 20th Century. These are only a small fraction of the actual number that have occurred; most have gone completely undetected. Such approaches are commonplace in our part of the solar system. The late planetary geologist Eugene Shoemaker put it succinctly: Earth exists in an asteroid swarm**.** We know that since 1937, at least 22 asteroids have approached Earth more closely than did 2001 YB5, which missed by just twice the distance to the Moon. Five of those objects were larger than 100 yards in diameter. According to NASA, there may be as many as 100,000 NEOs with diameters of 100 yards or larger. Of those asteroids larger than 150 yards in diameter, about 250 are today estimated to be potentially hazardous. The United States has very limited capability to detect these smaller NEOs, which can nevertheless inflict substantial damage upon striking Earth. There is a significant probability (20%) of such an object colliding with the Earth during the next century.Although the annual probability of a large NEO impact on Earth is relatively small, the results of such a collision would be catastrophic. The physics of Earth's surface and atmosphere impose natural upper limits on the destructive capacity of natural disasters, such as earthquakes, landslides, and storms. By contrast, the energy released by an NEO impact is limited only by the object's mass and velocity. Given our understanding of the devastating consequences to our planet and its people from such an event, (as well as the smaller-scale but still-damaging effects from smaller NEO impacts), our nation should act comprehensively and aggressively to address this threat. America's efforts to predict, and then to avoid or mitigate such a threat, should be at least commensurate with our national efforts to deal with more familiar terrestrial hazards. If space research has taught us anything, it is the certainty that an asteroid or comet will hit Earth again. Impacts are common events in Earth's history: scientists have found more than 150 large impact craters on our planet's surface. Were it not for Earth's oceans and geological forces such as erosion and plate tectonics, the planet's impact scars would be as plain as those visible on the Moon.

## COLLISION ADV – IMPACT CALCULUS – PROBABILITY – INEVITABLE

**ERR AFFIRMATIVE – ONE SHOULD ALWAYS BE SKEPTICAL OF OPTIMISTIC REPORTS THAT DOWNPLAY THE PROBABILITY OF A MASSIVE IMPACT – YOU SHOULD ERR THAT THEIR OPTIMISM IS NAÏVE AND OVERSTATED**

**Ord et al, 10.** (Toby Ord and Anders Sandberg are with the Future of Humanity Institute at the University of Oxford, and Rafaela Hillerbrand is with the Human Technology Center at RWTH Aachen University, March 2010, “Probing the Improbable: Methodological Challenges for Risks with Low Probabilities and High Stakes,” http://arxiv.org/ftp/arxiv/papers/0810/0810.5515.pdf, CALLAHAN)

Suppose you read a report which examines a potentially catastrophic risk and concludes that the probability of catastrophe is one in a billion. What probability should you assign to the catastrophe occurring? We argue that direct use of the report’s estimate of one in a billion is naïve. This is because the report’s authors are not infallible and their argument might have a hidden flaw. What the report has told us is not the probability of the catastrophe occurring, but the probability of the catastrophe occurring given that the included argument is sound. Even if the argument looks watertight, the chance that it contains a critical flaw may well be much larger than one in a billion. After all, in a sample of a billion apparently watertight arguments you are likely to see many that have hidden flaws. Our best estimate of the probability of catastrophe may thus end up noticeably higher than the report’s estimate. 2 Let us use the following notation: 2 Scientific arguments are also sometimes erroneous due to deliberate fraud, however we shall not address this particular concern in this paper.3 X = the catastrophe occurs, A = the argument is sound. While we are actually interested in P(X), the report provides us only with an estimate of P(X|A), since it can’t take into account the possibility that it is in error. 3 From the axioms of probability theory, we know that P(X ) is related to P(X|A) by the following formula: (1) P(X) = P(X|A) P(A) + P(X|A) P(A) . To use this formula to derive P(X) we would require estimates for the probability that the argument is sound, P(A), and the probability of the catastrophe occurring given that the argument is unsound, P(X|A). We are highly unlikely to be able to acquire accurate values for these probabilities in practice but we shall see that even crude estimates are enough to change the way we look at certain risk calculations. A special case, which occurs quite frequently, is for reports to claim that X is completely impossible. However, this just tells us that X is impossible given that all our current beliefs are correct, i.e. that P(X|A) = 0. By equation (1) we can see that this is entirely consistent with P(X) > 0, as the argument may be flawed. Figure 1 is a simple graphical representation of our main point. The square on the left represents the space of probabilities as described in the scientific report, where the black area represents the catastrophe occurring and the white area represents it not occurring. The normalized vertical axis denotes the probabilities for the event occurring and not occurring. This representation ignores the possibility of the argument being unsound. To accommodate this possibility, we can revise it in the form of the square on the right. The black and white areas have shrunk in proportion to the probability that the argument is sound and a new grey area represents the possibility that the argument is unsound. Now the horizontal axis is also normalized and represents the probability that the argument is sound. 3 An argument can take into account the possibility that a certain sub-argument is in error. For example, it could offer two alternative sub-arguments to prove the same point. We encourage such practice and look at an example in section 4. However, no argument can fully take into account the possibility that it is itself is flawed — this would require an additional higher level argument.4 Figure 1: The left panel depicts a report’s view on the probability of an event occurring. The black area represents the chance of the event occurring, the white area represents it not occurring. The right hand panel is the more accurate picture, taking into account the possibility that the argument is flawed and that we thus face an grey area containing an unknown amount of risk. To continue our example, let us suppose that the argument made in the report looks very solid, and that our best estimate of the probability that it is flawed is one in a thousand, (P(A) = 10 -3 ). The other unknown term in equation (1), P(X|A), is generally even more difficult to evaluate, but lets suppose that in the current example, we think it highly unlikely that the event will occur even if the argument is not sound, and that we also treat this probability as one in a thousand. Equation (1) tells us that the probability of catastrophe would then be just over one in a million — an estimate which is a thousand times higher than that in the report itself. This reflects the fact that if the catastrophe were to actually occur, it is much more likely that this was because there was a flaw in the report’s argument than that a one in a billion event took place. Flawed arguments are not rare. One way to estimate the frequency of major flaws in academic papers is to look at the proportion which are formally retracted after publication. While some retractions are due to misconduct, most are due to unintentional errors. 4 Using the MEDLINE database 5 (Cokol, Iossifov et al. 2007) found a raw retraction rate of 6.3 ! 10 -5 , but used a statistical model to estimate that the retraction rate would actually be between 0.001 and 0.01 if all journals received the same level of scrutiny as those in the top tier. This would suggest that P(A) > 0.001, making our earlier estimate rather optimistic. We must also remember that an argument can easily be flawed without warranting retraction. Retraction is only called for when the underlying flaws are not trivial and are immediately noticeable by the academic community. The retraction rate for a field would thus provide a lower bound for the rate of serious flaws. Of course, we must also keep in mind the possibility that different branches of science may have different retraction rates and different error rates. In particular, the hard sciences may be less prone to error than the more applied sciences.

**A DOOMSDAY ROCK IS INEVITABLE AND WE COULD BE FACING IT SOON – ITS COLLISION WILL BLOCK OUT ALL SUNLIGHT, ENDING AGRICULTURE – FEW WOULD SURVIVE**

**BROAD 1991** (William J. – author and senior writer at NYT/25 years as a science correspondent, “Asteroids, a Menace to Early Life, Could Still Destroy Earth; There's a 'Doomsday Rock,' But When Will It Strike?”, NEW YORK TIMES, June 18, 1991, LexisNexis Academic) [Max Waxman]

SOMEWHERE in space at this moment, hurtling toward Earth at roughly 16 miles a second, is the doomsday rock. The question of growing interest to scientists and engineers is exactly when it will approach the planet and whether anything can be done to avoid a catastrophic collision, such as nudging the rock off course with a nuclear blast or two. The doomsday rock is an asteroid large enough to severely disrupt life on Earth upon impact, lofting pulverized rock and dust that blocks most sunlight. Agriculture would virtually end, and civilization could wither and die, just as the dinosaurs and many other forms of life are thought by some to have been wiped out by a massive object from outer space 65 million years ago. So far, no astronomer has located the killer asteroid, which by definition would be a mile wide or larger, would have an orbit that crossed Earth's, and would do so at exactly the wrong moment. But, given enough time, it is inevitable that one will appear. And the odds are that the moment could be relatively soon, in celestial terms. Experts, extrapolating from craters observed on the Moon and from a partial survey of Earth-crossing asteroids, calculate that "a big one" slams into the planet once every 300,000 to one million years. More graphically, that means there is between one chance in 6,000 and one chance in 20,000 of a cataclysmic impact in the next 50 years. "Eventually it will hit and be catastrophic," said Dr. Tom Gehrels, a professor of lunar and planetary science at the University of Arizona who heads a team that searches the sky for killer asteroids. "The largest near-Earth one we know of is 10 kilometers in diameter," or about 6.2 miles. "If a thing like that hit, the explosion would be a billion times bigger than Hiroshima.

## COLLISION ADV – IMPACT CALCULUS – PROBABILITY – INEVITABLE

**AN ASTEROID COLLISION IS INEVITABLE – WE MUST INCREASE OUR DETECTION CAPABILITIES OF NEOs IN ORDER TO DEFLECT THEM**

Addrisi 11(Amity, reporter at FOX40 News, reporter/Weather Anchor at KBAK/KBFX TV, KERN 1410 Radio at Kern News Radio, Bakersfeildnow.com, “25 years from extinction? NASA separates fact from fiction,” 5/24/11 <http://www.bakersfieldnow.com/news/investigations/122477149.html>,) ben

From the silver screen to science fiction novels, the idea of how the world will meet its end has long fascinated the human race. One particular doomsday theory is anything but crazy, and it has NASA scientists putting money into research that might just save out lives. Right now, astronomers are keeping a close eye on an object flying towards earth. Eyewitness News went to NASA's Jet Propulsion Laboratory in Pasadena and learned that if space really is the final frontier, we may someday have to move off our little blue dot in the universe. On April 13, 2029, an asteroid is set to come very close to earth. On that day, the asteroid Apophis, which is the size of two football fields, will fly by the blue planet. Scientists believe that the asteroid could be affected by earth's gravitational pull, eventually spinning Apophis into our orbit. If all the conditions are right, Apophis could return seven years later and actually hit the planet. Scientists calculate that to happen on April 13, 2036, which happens to be Easter Sunday. At JPL, Don Yeomans is the leading astronomer for NASA's Near Earth Objects, or NEO, program. Yeomans said the asteroid would create, "Substantial regional devastation. We're not talking a city or a county. We're talking a state-sized devastation area." NASA's NEO program monitors comets and asteroids heading towards earth. Right now, scientists are keeping track of approximately 380 such objects at JPL. As they get closer to earth, scientists reassess them and determine if they are a threat of earth impact. Eyewitness News asked NASA if they are confident that they could save the world. "We do have the technology to deal with them if we find them early enough," Yeomans said. "I like to say that the three criteria for near earth objects is we have to find them early, we have to find them early and we have to find them early." So, let’s say scientists found an asteroid bound for earth? What then?  "You can run into it, you can with a space craft slow it down so it misses the earth in 10 years time, you could send a nuclear explosive device to either blow it up or slow it down," Yeomans said, listing the options.  It's not necessarily the impact of the asteroid that would devastate our planet. If a large enough meteor hit our planet it could create a worldwide dust cloud. That cloud would block out the sun and kill the plants that sustain all life on earth. At this point, NASA has identified 90 percent of the largest asteroids coming towards earth, including Apophis. Yeomans said almost none of them represent a threat for the next 100 years. However, he says that although the threat of asteroids is not immediate, he stresses we should look beyond earth for a new home. "We have two choices, we can either expand our place in the universe or we can die, because we are going to get hit sooner or later," Yeomans said.

**AN ASTEROID COLLISION IS INEVITABLE – EVEN IF THE NEGATIVE WINS THAT THERE IS A LOW RISK OF THAT SOON, THE MAGNITUDE AND THE INEVITABILITY OF THE IMPACT CONTROLS THE RISK ASSESSMENT OF THE DEBATE**

Kunich, 97 (Lieutenant Colonel John C. Kunich (B.S., M.S., University of Illinois; J.D., Harvard Law School; LL.M., George Washington University School of Law) is the Staff Judge Advocate, 50th Space Wing, Falcon Air Force Base, Colorado. He is a member of the Illinois State Bar., “Planetary Defense: The Legality of Global Survival,” Air Force Law Review, 7/13/11, <http://heinonline.org/HOL/Page?handle=hein.journals/airfor41&div=6&g_sent=1&collection=journals#130>) Hou

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 **[\*126]** 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. n32 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 disaster; 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. n33 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.

## COLLISION ADV – IMPACT CALCULUS – PREFER MAGNITUDE OVER PROBABILITY

**The probability and timeframe of an asteroid impact is irrelevant- the sheer magnitude means that preparing for it is a priority**

**Easterbrook 08** (Gregg, senior editor of The New Republic, “The Sky Is Falling,” The Atlantic, June 2008, http://www.lsst.org/files/docs/TheSkyisFalling-AtlanticMonthly.pdf) [JHegyi14]

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.”

**THE HIGH MAGNITUDE OF AN ASTEROID COLLISION MAKES THE PROBABILITY QUESTION NOT AS RELEVANT-WITH AN IMPACT OF HIGH STAKES, LARGE MAGNITUDES TRUMP PROBABILITY CLAIMS**

**Ord et al, 10.** (Toby Ord and Anders Sandberg are with the Future of Humanity Institute at the University of Oxford, and Rafaela Hillerbrand is with the Human Technology Center at RWTH Aachen University, March 2010, “Probing the Improbable: Methodological Challenges for Risks with Low Probabilities and High Stakes,” http://arxiv.org/ftp/arxiv/papers/0810/0810.5515.pdf, CALLAHAN)

Large asteroid impacts are highly unlikely events. 1 Nonetheless, governments spend large sums on assessing the associated risks. It is the high stakes that make these otherwise rare events worth examining. Assessing a risk involves consideration of both the stakes involved and the likelihood of the hazard occurring. If a risk threatens the lives of a great many people it is not only rational but morally imperative to examine the risk in some detail and to see what we can do to reduce it. This paper focuses on low-probability high-stakes risks. In section 2, we show that the probability estimates in scientific analysis cannot be equated with the likelihood of these events occurring. Instead of the probability of the event occurring, scientific analysis gives the event’s probability conditioned on the given argument being sound. Though this is the case in all probability estimates, we show how it becomes crucial when the estimated probabilities are smaller than a certain threshold. To proceed, we need to know something about the reliability of the argument. To do so, risk analysis commonly falls back on the distinction between model and parameter uncertainty. We argue that this dichotomy is not well suited for incorporating information about the reliability of the theories involved in the risk assessment. Furthermore the distinction does not account for mistakes made unknowingly. In section 3, we therefore propose a three-fold distinction between an argument’s theory, its model, and its calculations. While explaining this distinction in more detail, we illustrate it with historic examples of errors in each of the three areas. We indicate how specific risk assessment can make use of the proposed theory-model-calculation distinction in order to evaluate the reliability of the given argument and thus improve the reliability of their probability estimate for rare events. Recently concerns have been raised that high-energy experiments in particle physics, such as the RHIC (Relativistic Heavy Ion Collider) at Brookhaven National Laboratory or the LHC (Large Hadron Collider) at CERN, Geneva, may threaten humanity. If these fears are justified, these experiments pose a risk to humanity that can be avoided by simply not turning on the experiment. In section 4, we use the methods of this paper to address the current debate on the safety of experiments within particle physics. We evaluate current reports in the light of our findings and give suggestions for future research. The final section brings the debate back to the general issue of assessing low probability risk. We stress that the findings in this paper are not to be interpreted as an argument for anti-intellectualism, but rather as arguments for making the noisy and fallible nature of scientific and technical research subject to intellectual reasoning, especially in situations where the probabilities are very low and the stakes very high.

## COLLISION ADV – IMPACT CALCULUS – PREFER MAGNITUDE OVER PROBABILITY

**AN ASTEROID COLLISION WILL DESTROY ALL LIFE ON EARTH – MAGNITUDE OVERWHELMS PROBABILITY**

**GARSHNKET ET.AL. 2000** [Victoria – researcher @ Global Human Futures Research Associates, David Morrison – researcher @ NASA Ames Research Center, Frederick Burkle – doctor in Division of Emergency Medicine in Department of Surgery @ John A. Burns School of Medicine, “The mitigation, management, and survivability of asteroid/comet impact with Earth”, *Space Policy* 16 (2000), pages 213-222] ttate

As far as we know, impacts are randomly distributed in time**.** Of the roughly 1500 (in number) kilometer-scale NEOs currently in Earth crossing orbits, some 30% have been found. Although we feel confident that Earth will not be struck in the foreseeable future by any of the known objects, we cannot say anything about the 70% that are not yet discovered**.** A comprehensive search has not yet been carried out and we must often speak in terms of probabilities. The chances of one of the undetected NEOs with a diameter of 1 km or more colliding with Earth in the next 50 years is about 1 in 20,000 [32]. The consequences would be catastrophic and global: there would be an impact winter, a collapse of agriculture and, **possibly,** the end of our civilization. However, chance is not really at work here**.** There either is or is not a NEO aimed to hit Earth in the next year or in the next century. There are those who believe that there is no escape from a large asteroid impact that would have global effects. A large object filling the atmosphere with dust, blotting sunlight, causing extreme cold and killing plants presents a complex emergency of unprecedented proportions. The disaster response problem can be immense. Smaller objects could cause continent wide destruction necessitating evacuation plans, which can be the ultimate logistic and public health nightmare. Staying in the projected area of devastation and being comfortable to the end does not "t with the human innate instinct to survive and most likely would not be the popular course of action. Hoping not to know about the impact coming is also not a solution. Other thoughts may center on hoping it does not hit in our lifetime \* let it be a problem for future generations to deal with. All of these viewpoints are missing the key issue: is human civilization worth saving? Is everything we have been a part of in our lifetime and historically evolved from worth preserving? It is the collapse of civilization \* the loss of thousands of years of the fruits of the arts, religion, and the sciences \* that we should fear the most. In his opening statement to the Congressional hearings on the NEO threat on 24 March 1993 [32], the late US Congressman George E. Brown Jr. stated: `If some day an asteroid does strike the Earth, killing not only the human race but millions of other species as well, and we could have prevented it but did not because of indecision, unbalanced priorities, imprecise risk definition and incomplete planning, then it will be the greatest abdication in all of human history not to use our gift of rational intellect and conscience to shepherd our own survival, and that of all life on Earth.

## COLLISION ADV – IMPACT CALCULUS – MAGNITUDE – COMPARATIVE

**ASTEROID EXTINCTION IS CATEGORICALLY DIFFERENT FROM EVERY OTHER IMPACT – IT IS US PLUS ALL OTHER DESCENDENTS**

MATHENY 2007 [Jason – professor of health policy and management @ Bloomberg School of Public Health @ Johns Hopkins University, “Reducing the Risk of Human Extinction”, *Risk Analysis,*  <http://jgmatheny.org/matheny_extinction_risk.htm>] ttate

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 isthus a discontinuity between risks that threaten 99% of humanity and those that threaten 100%.

**AN ASTEROID COLLISION WILL OUTWEIGH YOUR DA IMPACTS – WE OUTWEIGH NUCLEAR PROLIFERATION, TERRORISM, DISEASE, AND GLOBAL WARMING**

**Lawler 7** (Andrew, Owner andrewlalwler, “What To Do Before the Asteroid Strikes”, <http://www.andrewlawler.com/discover/item/53-what-to-do-before-the-asteroid-strikes.html>)

But a group of astronauts, led by Schweickart, also wants their respective countries and the United Nations to prepare for avoiding a hit. “We’re living in a shooting gallery,” he warns. “We’ve evolved to the point where we can do something about this threat. We can either close our eyes as we cross the street and not know what we’ve dodged, or we can open our eyes and act accordingly. Amid fears about global warming, terrorism, disease, and nuclear proliferation, the threat of rocks from space may seem more the province of bad Hollywood movies than front-page news. Even professional astronomers have long dismissed asteroids as undistinguished flotsam and jetsam, would-be planets that circle the sun endlessly in a belt between Mars and Jupiter. Their derision left the field of asteroid hunting largely to amateurs and eccentrics. Only recently have researchers glimpsed the dangers lurking in our deceptively quiet neighborhood. “Impacts are a fact of life in the universe, but when we look up, it’s not what we see,” says Carolyn Shoemaker, who, together with her late husband, Gene, pioneered ways of spotting asteroids and comets. It was geologists who first noticed the evidence of huge impact craters on Earth that had formed long after the solar system settled into its present form, prompting biologists to speculate on whether those collisions dramatically altered life’s evolution. Later, using new technologies on the ground as well as robotic spacecraft, scientists like Shoemaker started to track, catalog, and closely examine the objects. With each new sighting, asteroids turn out to be far more varied, unruly, and bizarre than astronomers dreamed. Many have companions. Some are rubble heaps held together only loosely by their own gravity. Others are extremely dense nickel-iron objects. Their colors can range from a deep dark chocolate to a glinty white. Even the old distinction between comets (dirty snowballs) and asteroids (hard rocks) has become blurred. Some comets eventually turn into asteroids as they burn off their ice and lose their tails while traveling through the warm inner solar system. And comets—which mostly reside in the solar system’s far fringes—pop up occasionally in the asteroid belt. They may even be directly responsible for life on Earth. Donald Yeomans, who calculates the orbits for near-Earth objects at NASA’s Jet Propulsion Laboratory, says that comets flung out from that belt pummeled our planet shortly after its formation and could have left behind water, possibly creating the conditions that allowed Earth to become a cradle for life. The vast bulk of asteroids—millions of individual objects ranging from 560-mile-wide Ceres to pea-size pieces of space shrapnel—reside in a broad zone between the orbits of Mars and Jupiter, the legendary asteroid belt. If pulled together, all this material would form a mass smaller than Earth’s moon, but the immense gravitational force of Jupiter prevents the bits from coalescing into a solid planet. When the rocks approach Jupiter, the occasional asteroid can find itself pushed out of the procession and into deep space; some spin out beyond Pluto’s orbit, while others fall toward the sun, each with its own unique orbit. Some even find a home around other planets. Mars’s two moons, Phobos and Deimos—along with several of Jupiter’s and Saturn’s satellites—may be captured asteroids.

## COLLISION ADV– IMPACT CALCULUS – MAGNITUDE - OUTWEIGHS NUCLEAR WAR

**Err aff – asteroid strike outweighs nuclear war**

Cox and Chestek, 98. (Donald Cox is a prolific author who has published over 100 articles and 13 books. James H Chestek is an author and space expert. 1998, “Doomsday Asteroid: Can We Survive?” pgs 39-40, CALLAHAN)

The Shoemaker science team, organized by NASA, concluded that, unless some new program to search for asteroids was undertaken, only 25 percent of the estimated 2,000 threats would be found in the next decade, and that finding 90 percent of these would not occur until the middle of the twenty-first century." The definition of threat, in this case, is an aster- oid one kilometer (0.62 mile) or larger. Such an object would, if it hit Earth. be expected to cause billions of human casualties, and probably end civilization. However, if the Shoemaker committee recommendations were implemented, they believe that 80 percent to 90 percent of these Objects could be discovered in the next decade. As such a planetoid slams into the Earth at sixteen miles per second, it could explode with the force of over a million H-bombs, lofting enough Pulverized rock and dust to block out the sun. The result would be a naturally produced (rather than human-generated) nuclear winter' that could Wipe out humankind . . . and most of the other natural species as well. Agriculture would be crippled and a billion or more people would die from starvation. Outside critics, according to a New York Times dispatch, were quick no denounce the report as "pie-in-the-sky" busy-work for both astronomers and weapons-makers eager to combat a new threat after the Cold War officially ended. But the primary authors of the report insisted that a wealth of new evidence compiled by biologists, astronomers, and geologists over the past decade makes such a study feasible. The skeptics disagreed and belittled NASA with assertions that the asteroid threat is so small that NASA is "paranoid," or worse yet, con- spiring to guarantee astronomers a lifetime of entitlements to keep them busy, and also provide research money to "star warriors" who wish to concoct new nukes for the cosmos. Dr. David Morrison, the cochairman of the study team from NASA's Ames Research Center in California, rebutted that criticism with the conclusion that "the risk is real!" In an April 1992 editorial in the Washington Times, one of the skep- tics envisioned a plot by a group of astronomers who offered to save the Earth from disaster with a few new powerful telescopes. That paper scorned NASNS plan as a "scam to make away with the taxpayers' money. 'There is no evidence that anyone in all human history has ever been killed by an asteroid!""

**EVEN A SMALL ASTEROID COLLISION WILL OUTWEIGH YOUR NUCLEAR WAR – EXTINCTION BY KILLER TSUNAMIS AND DUST CLOUDS**

Campbell 00 (Johnathan, USAFR Colonel, “Using Lasers in Space,” Air University, 7/11/11, <http://www.au.af.mil/au/awc/awcgate/cst/csat20.pdf>) Hou

Astronomical telescopes and deep space radar systems have observed the existence of at least 2000 Near Earth Objects (NEO), such as asteroids and comets, which potentially could destroy most life on Earth. An asteroid with a diameter of 0.2 km would strike the Earth with a power rivaling the strength of a multiple warhead attack with the most powerful hydrogen bombs. This strike would throw up a cloud of dust rivaling the most powerful volcanic explosion, which would seriously affect climate on the scale of two to three years. A strike by a larger asteroid, say 1 km, (especially in the ocean) would create a gigantic tsunami that would flood and obliterate coastal regions. More significantly it would eject a massive dust cloud that would alter cur biosphere to the point that life as we know it would cease to exist with no chance of recovery within the near term.

**THREAT OF AN ASTEROID COLLISION MAKES YOUR NUCLEAR WAR THREAT AN EPIC FAIL – THE DEVASTATION CAUSED BY AN ASTEROID FAR EXCEEDS A NUCLEAR WINTER**

Kunich, 97 (Lieutenant Colonel John C. Kunich (B.S., M.S., University of Illinois; J.D., Harvard Law School; LL.M., George Washington University School of Law) is the Staff Judge Advocate, 50th Space Wing, Falcon Air Force Base, Colorado. He is a member of the Illinois State Bar., “Planetary Defense: The Legality of Global Survival,” Air Force Law Review, 7/13/11, <http://heinonline.org/HOL/Page?handle=hein.journals/airfor41&div=6&g_sent=1&collection=journals#130>) Hou

There are at least six mass extinctions that have been linked with large impacts on Earth from space. 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 a 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. With 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.” 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 smaller impacts would have the potential to seriously damage human civilization, perhaps irreparably. In addition to the dust raised from the initial impact, smoke and particulate matter from vast, uncontrollable fires may greatly exacerbate this blackout effect**.** A large space object generates tremendous heat, regardless of whether it is destroyed in the atmosphere or physically hits the surface of the Earth. Theses fire scan reach far beyond the impact area, due to atmospheric phenomena associated with the entry of a huge, ultra-high speed object. A huge mass of dust, smoke, and soot lofted into Earth’s atmosphere could lead to effects similar to those associated with the “nuclear winter” theory, but on a much larger, much more deadly scale**.** Such effects are now widely believed to have been a major factor contributing to the mass extinction spasms.

## COLLISION ADV – IMPACT CALCULUS – MAGNITUDE OUTWEIGHS TIMEFRAME

**IRRELEVANT IF THE TIMEFRAME IS LONG – WE MUST FRAME OUR IMPACTS IN A SCHEMA OF MILLENIA**

**VERSCHUUR 1996** [Gerrit – adjunct professor of physics @ University of Memphis, *Impact: The Threat of Comets and Asteroids*, page 216] ttate

There is an even more subtle reason why we are unlikely to take collective and significant action to assure the long-term survival of our species. It manifests as the psychological syndrome known as the "illusion of invulnerability." Individuals cannot believe that they will personally succumb in the next catastrophe. This syndrome is at play in those who live happily in earthquake zones, in floodplains, or on the sides of active volcanoes. The existence of the syndrome poses a paradox. If we are concerned about the long-term survival of civilization, we must overcome our genetic predisposition to deal only with the immediate future. Dealing with short-term issues is natural in all animals, and represents the practical way in which to survive from day to day. However, this predisposition is not conducive to assuring a long-term existence. Perhaps that is what is at issue. We have learned much about the natural universe in recent years, and the mind's eye has only just developed the ability to scan millions of years of time. Yet that seems to be no more than an intellectual exercise with little practical use. Perhaps the evolution of our species may yet depend on whether we can succeed in making very long term plans and carrying them out for the benefit of life on earth. Scientific discovery has brought us to the point where we confront the awesome probability that collision with an earth-crossing object will bring an end to civilization. It is no longer a question of whether a massive impact will occur in the future; it is only a matter of when. Even if we think it will be a thousand years from now, the point of raising the issue is to ask ourselves what we plan to do about it. It may be time to think in terms of thousands of years into the future. I am assuming that we care that our species will be around for a long time, and that this question is worth thinking about.

## COLLISION ADV - IMPACT CALCULUS – TIMEFRAME

**THE RISK OF AN NEO COLLISION IS REAL AND PROBABLE – WE WILL BE FACING THE RISK WITHIN THE NEXT TWENTY YEARS**

BORCHERS 2009 [Brent W – major in the US Air Force, “Should the USAF be involved in Planetary Defense?’ *Air Command and Staff College Air University,* <http://www.dtic.mil/cgi> bin/GetTRDoc?AD=ADA539693&Location=U2&doc=GetTRDoc.pdf] ttate

Some numbers do exist to help us quantify the consequences when tied in with the probability of the risk. Again, we know that the Earth will be impacted by a meteorite at some point, but the key is when? The human mind has a hard time grasping the chances of something occurring during our short life span when we talk in probabilities of an event that occurs only once every hundreds of thousands or millions of years. According to scientists, your chance of dying during a civilization ending impact is greater than the following chances:10 - About 300 times greater than the risk of dying from botulism - About 100 times greater than the chance that you will die in a fireworks accident - About 10 times greater than the chance of dying in a tornado - About 1/3 the risk that you will die in a firearms accident - About 1/30th the chance that you’ll be murdered - About 1/60th the chance that you’ll die in an auto accident Putting the risks in these terms certainly makes it more understandable and implies that the risk of death from the impact of a NEO is real and does exist. In fact, the risk and probability seems even more likely and personal when looking at a list of known NEOs that will pass frighteningly close to the earth in the next twenty to thirty years. In a little less than twenty years, our usually quiet Earth-Moon system is going to have a lot of visitors. In August 2027, Asteroid Number (AN) 10 is going to get about one lunar distance from Earth. Estimates for its size range from one half to two kilometers in diameter, or plenty large enough to create a regional or global catastrophe if it strikes the earth. Just six months after AN10 passes by object WN5 will get even closer, just about splitting the difference between Earth and the Moon. At 700 meters in diameter this asteroid has the potential for major damage also. By far one of the most famous among the scientific community of end-bringing objects we know about in our solar system is asteroid Apophasis. Astronomers initially thought for a while that this 270 meter-wide rock had an almost 3% chance of hitting us. Since then, odds have been lowered to 1 in 43,000 that it could slam into Earth in 2029. But if it passes through a gravitational keyhole, a tiny region in space that could tweak its orbit ever so slightly, usually where two large object’s gravitational pulls effectively cancel each other out, an impact could still happen on April 13, 2036.11

**EVEN IF THE NEGATIVE WINS LOW PROBABILITY AND LONG TIMEFRAME, VOTE AFF – WE CAN’T DELAY OUR PREPARATION**

**BRIDGES 2004** [Andrew – science writer, “Scientists call for strategy to fend off space rocks, *MSNBC*, February 23,

<http://www.msnbc.msn.com/id/4356390/ns/technology_and_science-space/t/scientists-call-strategyto-fend-space-rocks/>] ttate

The asteroid believed to have wiped out dinosaurs 65 million years ago was rare but hardly unique, say scientists gathered to discuss ways of aggressively defending our planet from another such space rock, including by detonating nukes in space. Asteroids capable of inflicting damage on a global scale hit Earth roughly every million years, and we shouldn’t dawdle in developing a method of deflecting them**,** according to the scientists attending a four-day planetary defense conference in suburban Orange County.

## COLLISION ADV – IMPACT CALCULUS – MORAL IMPERATIVE

**HUMANITY HAS A MORAL IMPERATIVE TO PROTECT ITSELF AND FUTURE GENERATIONS FROM AN ASTEROID IMPACT**

**URIAS ET AL 1996** [John M – colonel, “Planetary Defense: Catastrophic Health Insurance for Planet Earth”, A research paper presented to Air Force 2025, October, <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf>] ttate

Although promising signs exist in terms of more frequent workshops, technical discussions, and increased international cooperation, we must address several issues to resolve the planetary defense problem by 2025. First and foremost, does the global community believe that an unacceptable risk to the EMS exists, and, if so, is it committed to developing a solution? Obviously, the concepts presented in this paper require many new technologies that will take much time, talent, and resources to develop. Commitment does not 62 equate to paper studies alone—it must be supported by substantial research and funding for these studies to be followed up with action. In an era of declining budgets, this issue presents a significant dilemma for leaders across the world. It should be remembered, however, that the threat of nuclear war was uncertain and even improbable during the cold war period; yet, the US spent more than $3 trillion over this 50-year time frame to maintain its strength against this uncertainty. These authors suggest that one needs only to consider the potential catastrophic effects from a large (>1 km diameter) ECO impact to concludethat humanity has a moral obligation to protect humanity.

## SMALL ASTEROIDS ADV – SQ DETECTION OF SMALL NEOs POOR

**WE LACK THE ABILITY TO EFFECTIVELY DETECT SMALLER NEOs – THE ONES WE DETECT IS USUALLY BY COINCIDENCE**

**Schweickart and Chapman 05** (Russell L., former NASA astronaut, and Clark R., planetary scientist at the Southwest Research Institute at Boulder, Colorado, “Better Collision Insurance,” American Scientist, Vol. 93, No. 5, pp. 392-394, September-October 2005, <http://www.jstor.org/stable/27858632>) [Iuliano]

The need to be on the lookout for such an immense catastrophe is clear enough, as more than one Hollywood blockbuster has made widely known. The capability of the current search effort, however, is inadequate to address the danger posed by the far more populous cohort of smaller near-Earth asteroids, those down to about 100 meters in diameter. Such objects can cause serious local or even regional destruction. The impact of a 100-meter diameter body would release the equivalent of an 80 megaton bomb and thus could devastate an area the size of a large city, for example. And a several hundred-meter body could cause a tsunami rivaling or exceeding last year's horrific Indian Ocean event. Objects in this range of diameters are discovered only incidentally today by the modest equipment that has been dedicated to finding their larger siblings. A recent addition to the list of small asteroids that have a small but real chance of striking the Earth is a 330-meter diameter asteroid named 99942 Apophis (formerly known as 2004 MN4). It has a l-in-32,000 chance of impacting in April 2035 and a l-in-12,000 chance of strik ing in April 2036. So there's no need to become alarmed at this stage. Yet one of these smaller asteroids is far more likely than their larger counterparts to constitute a danger in the foreseeable future. They are also easier to deflect away from Earth using space technology. The problem is that today astronomers have discovered such a low percentage of the smaller near-Earth asteroids that a strike with no warning whatsoever is far and away more likely than our having enough time to undertake an effort at deflection.

## SMALL ASTEROIDS ADV – LEADS TO NUCLEAR MISCALCULATION

**EVEN A SMALL ASTEROID COLLISION CAN TRIGGER NUCLEAR WAR – COUNTRIES DON’T OFTEN SHARE SATELLITE INFORMATION – IT COULD TAKE DAYS FOR ADVERSARIES TO REALIZE THAT IT WAS AN ASTEROID, NOT A STRIKE**

**Whitt 02 (**Kelly, writer for Astronomy.com, feature writer for Astonomy and Space, “Small Near-Earth Objects Could Trigger Nuclear War”, Astronomy.com, Sept 17 2022, <http://www.freerepublic.com/focus/news/752087/posts>) Rory

Near-Earth objects (NEOs) pose a threat to our global security, and not just from a catastrophic impact. A large meteorite exploding in Earth's atmosphere could trigger a nuclear war. Such a scenario was in the making on June 6, 2002. Just as the tensions between India and Pakistan were reaching their boiling point, a meteor exploded as it entered the atmosphere over the Eastern Hemisphere, causing an energy release of 12 kilotons, equivalent to the blast that destroyed Hiroshima. Fortunately, the bright flash and damaging shock wave of the detonating meteorite occurred over the Mediterranean Sea, just west of the disputed Kashmir region. If the explosion had happened a little earlier while it was over the countries in conflict, the confusion and panic could easily have sparked a nuclear response from either country. While the United States was able to quickly determine the source of the explosion, India and Pakistan, as well as most other countries, do not have the resources available to distinguish whether an explosion's source is natural or man-made. Brigadier General Simon P. Worden, the U.S. Space Command's deputy director for operations at Peterson Air Force Base in Colorado, would like to change that. The Department of Defense already tries to notify nations that are facing potential missile attack of meteorite strikes; however, the data they collect is through classified systems, which can result in a several-week delay before the information is released. Worden recently told the Commission on the Future of the U.S. Aerospace Industry in Washington, D.C., that an NEO warning center could be established to assess and release the data more quickly without jeopardizing sensitive information. He believes that no more than 10 extra people in the current centers would be required to catalog and provide warning of future NEO threats.

**LIKELIHOOD OF A SMALL ASTEROID COLLISION IS HIGH – THEY DETONATE WITH THE SAME ENERGY AS A NUCLEAR BOMB – THESE EXPLOSIONS ARE NOT DISTINGUISHABLE FROM NUCLEAR DETONATIONS IN THE STATUS QUO**

**Correll 03** (Randall R., National Security consultant, writer for The Marshall Institute, “National Security Implications of the Asteroid Threat”, 2-4-2003 http://www.marshall.org/pdf/materials/120.pdf)[JHegyi14]

The chance of asteroids large enough to cause global or regional destruction impacting the earth is extremely rare, but smaller asteroids pose an indirect threat with much greater likelihood. These smaller asteroids detonate in the atmosphere with an energy equivalent to a small nuclear weapon, on the size of up to several million tons (MT) of TNT. The smaller of these, exploding high in the atmosphere, would cause little damage on the ground but would be quite noticeable if they occurred above populated areas. The larger of these may penetrate deeper into the atmosphere causing significant damage on the ground, as in the case of the 1908 Tunguska event shown in Figure 2. In both cases, the blast effects from these detonating asteroids would be indistinguishable from a nuclear detonation unless one uses the right remote sensing technology. The United States has operational systems capable of distinguishing between nuclear detonations and asteroid impacts, but at the present time there is no procedure for processing the data from these systems in a routine manner. On June 6, 2002, an asteroid entered the earth's atmosphere and detonated high over the Mediterranean with a yield roughly equivalent to the Hiroshima atomic bomb. There is no record of a human witness to this event, but DoD satellites recorded the explosion. Had the asteroid impacted the earth a few hours earlier, occurring near India or Pakistan, it could have been mistaken for a nuclear explosion and possibly triggered a retaliatory nuclear strike. Researchers in the scientific and national security communities have recently raised this concern with renewed interest. Some of these concerns have been carried in the media with headlines reading: Could meteor touch off nuclear fear? MSNBC News, October 3, 2002 Asteroids a trigger for war? San Francisco Examiner, October 4, 2002 Asteroids have force of nuclear bomb? St. Petersburg Times, October 4, 2002 It's the Little Asteroids that Get You Time Online Edition, September 17, 2002 Satellites spy on meteorite explosions Nature, November 21, 2002

## SMALL ASTEROIDS ADV – LEADS TO NUCLEAR MISCALCULATION

**Explosions of small asteroids cause miscalc and nuclear war**

BBC News, 02. (Cites experts and military generals. July 15, 2002, “Asteroids ‘could trigger nuclear war’” lexis, CALLAHAN)

A small asteroid could accidentally trigger a nuclear war if mistaken for a missile strike, experts have warned. An asteroid explosion over India or Pakistan could unleash nuclear war. Scientists and military chiefs studying the threat are calling for a global warning centre to be set up to inform governments immediately of asteroid impacts. The risk is seen as particularly grave if an asteroid blast were to happen in areas of military tension, such as over nuclear-armed neighbours India and Pakistan Each year about 30 asteroids several metres in length pierce the atmosphere and explode, with even the smaller sized ones unleashing as much energy as the nuclear bomb dropped on Hiroshima in Japan. 'Panic' reaction Earlier this month, an Israeli pilot flying an airliner over the Ukraine reported seeing a blue flash in the sky similar to the type of blast caused by a surface-to-air missile, despite Ukrainian authorities saying no such missile had been fired. Experts now believe the pilot saw an explosion caused by an asteroid entering the Earth's atmosphere at high speed. Experts met last week in the US capital Washington DC to discuss what might have happened had such an explosion occurred over a volatile area such as the India-Pakistan region. "Neither of those nations has the sophisticated sensors we do that can determine the difference between a natural Neo (near-Earth object) impact and a nuclear detonation," Air Force Brigadier General Simon Worden from the US Space Command told the Aerospace Daily newspaper. "The resulting panic in the nuclear-armed and hair-trigger militaries there could have been the spark for a nuclear war." Warning centre call The incident over Ukraine was also extremely politically sensitive. Last year, 78 people died when a Russian airliner flying from Israel was hit over Ukraine by what was believed to have been a stray missile fired during a military exercise. Although the US has its own sophisticated military satellites which can detect launches and detonations of weapons and asteroid explosions, General Worden said that he and other experts would like to see a new warning centre established which would gather information on asteroid explosions and make it available to all governments. It is hoped that the shared information would prevent a disaster occurring, and a study looking at the possibility of such a centre is now reportedly being developed in the US Defense Department.

**A small asteroid explosion over India or Pakistan causes nuclear Indo-Pak war**

Herald Sun, 02. (News organization in Melbourne, Australia that cites air force generals and scientists working on the problem. July 15, 2002, “Nuke war fear,” lexis, CALLAHAN)

NEW YORK -- A small asteroid could accidentally trigger a nuclear war if it exploded over one of the world's trouble hot spots, experts warn. Scientists and military chiefs are calling for action to meet the growing threat of a meteor blast being mistaken for a nuclear attack. Each year about 30 asteroids more than a few metres across pierce the atmosphere and explode with as much energy as the atom bomb dropped on Hiroshima. In June, an asteroid estimated at five to 10 metres across exploded high above the Mediterranean with the force of a one kilotonne bomb. Experts in Washington last week discussed what might have happened had the burst occurred over India or Pakistan. Air force Brigadier General Simon Worden said: "Neither of those nations has the sophisticated sensors we do that can determine the difference between a natural near-earth object impact and a nuclear detonation. "The resulting panic in the nuclear-armed and hair-trigger militaries there could have been the spark for a nuclear war."

**SMALL ASTEROIDS COULD BE MISTAKEN AS NUCLEAR STRIKES – GLOBAL HOTSPOTS UNIQUELY VULNERABLE FOR THIS MISCALCULATION**

**Munro, 2002** (Margaret – senior writer, National Post Canada, “How small asteroids could trigger nuclear war”, November 22, 2002, LexisNexis Academic) [Max Waxman]

A leading space scientist is warning that small asteroids from space that detonate like bombs as they crash into Earth's atmosphere might accidentally set off a nuclear war. "They mimic nuclear explosions when they hit the atmosphere," said Professor Peter Brown, of the University of Western Ontario, who led a report in the journal Nature yesterday on asteroids that slam almost weekly into Earth's upper atmosphere and explode as fireballs. If one of the bigger rocks was to explode over a country such as Iraq or India when tensions are high, Brown said there is a danger it might be mistaken for a nuclear detonation and provoke retaliation. "By misinterpretation it might trigger a nuclear war." For the study, he and his colleagues were privy to classified information from U.S. military satellites on explosions caused by 300 space rocks, measuring between one and 10 metres in diameter, that have crashed into the upper atmosphere in the last eight and a half years. The United States is the only country with an ability to distinguish between explosions from small asteroids and those caused by nuclear weapons. Brown said he would like to see more effort made to track small asteroids and to share the information. "You'd get a heads up," he said, "and less potential for misinterpretation."

## SMALL ASTEROIDS ADV – LEADS TO NUCLEAR MISCALCULATION

**Similarities between a nuclear and asteroid explosion cause misinterpretation and potential backlash**

Shiga 9 (David, contributing writer for New Scientist, “It’s behind you!,”, New Scientist, Vol. 203 Issue 2727, p30-33, 9/26/09, EBSCO) [Iuliano]

Now picture this ugly scenario, which worried some participants in the air force exercise: an asteroid flies out of nowhere and explodes over a sensitive nuclear-armed region, like South-East Asia or the Middle East. There's a reasonable chance that such an airburst could be misinterpreted as a nuclear attack. Both produce a bright flash, a blast wave and raging winds. Such concerns were one reason why, when NASA found 2008 TC3 in its sights, it not only issued a press release but also alerted the US State Department, military commanders, and White House officials, says Lindley Johnson at NASA headquarters, who oversees the agency's work on near-Earth objects. "If it had been going down in the middle of the Pacific somewhere, we probably would not have worried too much more about it, but since it was [going to be] on land and near the Middle East, we did our full alerting," he says.

Common small asteroid explosions could be misinterpreted as an attack from an enemy by countries that lack the capabilities to distinguish the difference

Hull 86 (John D., correspondent and Midwest Bureau Chief for Time magazine, “Science: Dealing with Threats From Space,” Time, 6/9/86, <http://www.time.com/time/magazine/article/0,9171,961564,00.html>) [Iuliano]

It is a sunny afternoon in Karachi, and the streets of Pakistan's largest city are crowded with shoppers, apparently unconcerned about the rising tension between Pakistan and India. Suddenly, a second sun bursts into view overhead, so bright it temporarily blinds thousands and so hot it blisters the skin. Thirty seconds later, the shock wave hits, crumbling buildings and throwing people to the ground. To the Pakistanis, only one explanation is possible for the tremendous blast: India has launched a nuclear attack. They immediately order their bombers, armed with atomic bombs, to strike back at India, which responds in kind. Only later do the surviving officials learn of their mistake. The object that exploded over Karachi was not a nuclear weapon but a large meteor hurtling in from outer space. Though this scenario sounds like the plot for a made-for-TV movie, Eugene Shoemaker, a respected U.S. Geological Survey scientist, is concerned that just such an event--and an unwarranted reaction--could occur. Shoemaker expressed his fears at a recent Baltimore meeting of the American Geophysical Union (AGU): "The effect of a meteor blast appears the same as a high- altitude nuclear explosion," he said. "If this happens in the wrong place, people will think they've been nuked." Meteors, which are asteroids or cometary debris that has entered the atmosphere, continually shower the earth. Most of them are small and either break up or are burned to ash by frictional heat generated by their plunge through the atmosphere. But, explains Shoemaker, the incineration of larger asteroids is far more violent. An asteroid 80 ft. across, striking the atmosphere at 50,000 m.p.h., compresses the air in its path so much that in effect the asteroid is stopped dead in its tracks, converting kinetic energy almost instantaneously into heat, light and a powerful shock wave. That causes a tremendous explosion, in this case equivalent to the blast of a one-megaton bomb. If a meteor were to burst in the atmosphere tomorrow, Shoemaker says, "the Soviets and the U.S. would know what it was" and not react militarily. Their detectors could distinguish between a nuclear explosion, which generates million-degree temperatures, X rays and gamma rays, and an exploding meteor, which would produce considerably lower temperatures and no deadly radiation. But smaller nations, unaware of the nature of the blast, might react violently. Says Shoemaker: "Suppose it happens over Syria or Pakistan?" He proposes that the U.S. immediately try to determine whether the explosion was of cosmic origin and notify the affected nation.

**SMALL ASTEROID COLLISIONS CAN LEAD TO MISCALCULATION – WE FACE THIS THREAT MORE THAN THIRTY TIMES A YEAR**

**Correll 03** (Randall, a national security consultant with Science Applications International Company, served as researcher in the U.S. Air Force, “National Security Implications of the Asteroid Threat”, Feb 4, 2003, <http://www.marshall.org/pdf/materials/120.pdf>) Rory

Every year about thirty asteroids enter Earth’s atmosphere and explode, releasing as much energy as the Hiroshima A-bomb. In addition to the damage an asteroid impact could cause, a small asteroid could be mistaken for a missile strike and precipitate a nuclear conflict. The United States has technology to differentiate between missile attacks, nuclear detonations and asteroid explosions, but many less advanced nations do not. Dr. Correll discussed the challenge of distinguishing between asteroid collisions and missile strikes and the feasibility of establishing a global warning center for asteroid explosions.

**Asteroids are easily mistaken as nuclear explosions—could trigger an Indo-Pak war**

**USPC, 2002**, (United States Space Command, “Speech by Gen. Simon Worden: "Military Perspectives on the Near-Earth Object (NEO) Threat", July 10, 2002, <http://www.spaceref.com/news/viewpr.html?pid=8834>) [Waxman]

A few weeks ago the world almost saw a [nuclear](http://www.spaceref.com/news/viewpr.html?pid=8834) war. Pakistan and India were at full alert and poised for a large-scale war - which both sides appeared ready to escalate into nuclear war. The situation was defused - for now! Most of the world knew about this situation and watched and worried. But few know of an event over the Mediterranean in early June of this year that could have had a serious bearing on that outcome. U.S. early warning satellites detected a flash that indicated an energy release comparable to the Hiroshima burst. We see about 30 such bursts per year, but this one was one of the largest we've ever seen. The event was caused by the impact of a small asteroid - probably about 5-10 meters in diameter on the earth's atmosphere. Had you been situated on a vessel directly underneath the intensely bright flash would have been followed by a shock wave that would have rattled the entire ship and possibly caused minor damage. The event of this June caused little or no notice as far as we can tell. But had it occurred at the same latitude, but a few hours earlier, the result on human affairs might have been much worse. Imagine that the bright flash accompanied by a damaging shock wave had occurred over Delhi, India or Islamabad, Pakistan? Neither of those nations have the sophisticated sensors we do that can determine the difference between a natural NEO impact and a nuclear detonation. The resulting panic in the nuclear-armed and hair-trigger militaries there could have been the spark that would have ignited the nuclear horror we'd avoided for over a half-century. This situation alone should be sufficient to get the world to take notice of the threat of asteroid impact.

## SMALL ASTEROIDS ADV – LEADS TO NUCLEAR MISCALCULATION

**Many countries could mistake a small asteroid for a nuclear bomb, triggering war**

Zabarenko 2 (Deborah, environment correspondent for Reuters, “Small Asteroid Could Be Mistaken for Nuclear Blast”, Reuters, 10/3/02, <http://www.freerepublic.com/focus/f-news/762473/posts>) [Iuliano]

Even small asteroids that never hit Earth could have deadly consequences, because they might be mistaken for nuclear blasts by nations that lack the equipment to tell the difference, scientists said on Thursday. One such asteroid event occurred June 6, when U.S. early warning satellites detected a flash over the Mediterranean that indicated an energy release comparable to the atomic bomb dropped on Hiroshima, U.S. Brig. Gen. Simon Worden told a congressional hearing. The flash occurred when an asteroid perhaps 10 yards in diameter slammed into Earth's atmosphere, producing a shock wave that would have rattled any vessels in the area and might have caused minor damage, Worden said. Little notice was taken of the event at the time, but Worden suggested that if it had occurred a few hours earlier and taken place over India and Pakistan, the outcome might have been horrifying. "To our knowledge, neither of those nations have the sophisticated sensors that can determine the difference between a natural NEO (Near Earth Object, such as an asteroid) and a nuclear detonation," Worden said. "The resulting panic in the nuclear-armed and hair-triggered opposing forces could have been the spark that ignited a nuclear horror we have avoided for over half a century," he told a committee investigating the risk posed by asteroids and other objects that might collide with Earth. SHOCK WAVES AND TSUNAMIS Astronomers have long been concerned about damage from asteroids, meteors and comets, and since 1998 NASA has worked to identify 90 percent of all large near-Earth objects -- those with a diameter of .6 miles or more -- by 2008. NASA's head of space science, Ed Weiler, told the committee that scientists have identified 619 of the suspected big, dangerous asteroids, which is about half the number astronomers believe are out there. This kind of large asteroid hits Earth a few times every million years, and when it does, causes regional calamity. By contrast, a so-called doomsday asteroid 3 miles across -- like the one believed to have wiped out the dinosaurs -- hits once every 10 million years or so. The one that caused the flash over the Mediterranean in June was probably about the size of a car, and was harmless to Earth. Such asteroids hit the atmosphere twice a month. However, asteroids ranging from about 100 feet to hundreds of yards can cause serious damage, including spawning a powerful shock wave or a tsunami if it lands in an ocean, causing widespread catastrophe if the tsunami occurs near a populated shore. These smaller bodies are not part of NASA's survey, and Worden suggested there might be an Air Force role in tracking these smaller objects, and also the potential for sharing early warning of incoming celestial objects with other countries that lack the technology. Worden said the United States is unique in the world in being able to determine whether an incoming object is an asteroid or a bomb in less than a minute. The United States spends about $4 million a year to track asteroids and comets, but very little on strategies to get them out of Earth's way, scientists said last month.

## SMALL ASTEROIDS ADV – IMPACTS – OUTWEIGHS NUCLEAR WAR

**EVEN A SMALL NEO COLLISION WOULD OUTWEIGH YOUR NUCLEAR WAR IMPACTS – “AIR HAMMER” EFFECT**

**ARENTZA et. al. 2010** [Robert – researcher at NASA Ames Research Center, “NEO Survey: An efficient search for Near-Earth Objects by an IR Observatory in a Venus-like Orbit”, Propulsion & Energy Sciences International Forum,

Crucial to the politics of NEO searches is the size-frequency distribution, which until the past two or three years has statistically indicated that the next significant impact is not likely for maybe 1,000 years, enough time for the groundbased community to find most of the NEOs with diameters roughly larger than 100 meters. However, M. Boslough (2009), of Sandia National Labs, has recently changed this argument by applying supercomputing-based numerical codes, used to model nuclear detonations, to the enigma of the Libyan Desert Glass (LDG) event. Boslough concluded that a 100-meter-class NEO disintegrated in the air far above the Saharan desert, with all of its kinetic energy and momentum continuing downwards as something informally referred to as an “air hammer.” When this air hammer struck the Earth’s surface, the entrained fireball initially had core temperatures on the order of 5,000 kelvin. The fireball portion of this complex event then spread laterally to about 20 kilometers in diameter. The air hammer also produced a hypersonic blast wave that extended radially for perhaps 50 kilometers. The fireball portion of the interaction remained on the ground for about 40 seconds and melted a patch of sand some 15 kilometers in diameter and several centimeters thick to produce the Libyan Desert Glass. Occasional expeditions to the site collect 100s of kilograms of the glass and sell it on the internet for a few dollars a gram. Boslough (2009) also modeled the 1908 Tunguska event and rescaled the estimated size of the Tunguska body downwards from ~80 meters to ~30 meters. At this new size, the mean interval between impacts is 150 years. Here is where the astrosociology of this paper’s contents becomes pertinent— This newly recognized threat régime (diameter >30 meters) contains far more objects than the diameter >140 meter NEOs. This 140-meter threshold arose circa 2003 when the United States Congress set the goal of compiling a catalogue complete to 90% by 2020 of all NEOs larger than 140 meters in diameter. This 90%, 140 meter, 2020 set of goals was named in honor of George E. Brown (GEB). Merging the GEB goals to Boslough’s (2009) work gives two results. The first is that all the 1,000-year-interval arguments no longer work. Instead, the mean interval between serious impacts is roughly 150 to 200 years. This shortened mean-interval forcefully argues for an efficient and timely NEO survey being completed in the next few years. Next (and this point is both subtle and powerful), typical arguments against performing a spacebased survey usually begin by a person saying something like-- “Yes, an event similar to Tunguska might happen in the next 100 years, but so what? Roughly six percent of the Earth’s surface is populated, so the next event is likely to be a non-event in terms of fatalities.” However, even though ~6% of the Earth’s surface is populated, the world’s widely distributed infrastructure is vastly larger and extremely vulnerable to the physics of Boslough’s (2009) modeled airbursts. A typical LAA airburst could create a cascade of failures across many distributed and interconnected networks which would be extensive, unpredictable, and impossible to quantify. Additionally consider the following: Suppose a large-scale airburst occurred above the Indian Ocean and killed no one. The resulting psychological trauma around the world could create panic on an unprecedented scale, panic which would at least ripple though the global financial markets. And if such an airburst happened without warning in places like the Middle East, or the much larger, and nuclear- armed areas of Asia or Russia, the resulting response could initiate a chain of human events resulting in severe military action. It’s this nonlinear psychological aspect that needs addressing in this conference because its message has been overlooked in the past. Most risk analyses done to date have only considered what can be quantified—the immediate body count and all the property damage arising from the initial impact. Perhaps this conference should place an added emphasis on the world’s vastly extended infrastructure and its interdependency, as well as the realities of large-scale human reaction to a sudden and catastrophic airburst vent.

## SMALL ASTEROIDS ADV– IMPACTS – ENVIRONMENT

**EVEN A SMALL ASTEROID HAS THE POTENTIAL TO CREATE MASS ENVIRONMENTAL DAMAGE – TSUNAMIS AND WORLDWIDE WINTER**

**PRADO 2002** [Mark – physicist who worked in advanced planning in the US space program, and who now is a consultant working overseas for multinational engineering and construction companies “1.7 Earth Impact by an Asteroid: Prospects and Effects”, *Asteroids Near Earth – Materials for Utilization,* <http://permanent.com/a-impact.htm>] ttate

If an asteroid of size 200 meters hit the ocean (which covers 70% of the Earth), the tsunami (i.e., giant wave) it would create would inflict catastrophic destruction of coastal cities and substantial worldwide human casualties along coastlines. If an asteroid of size 1 kilometer hit Earth, it would cause a dust cloud which would block out sunlight for at least a year and lead to a deep worldwide winter, exhausting food supplies. The latter is what caused the dinosaur extinction, as well as other major extinctions of smaller creatures in geologic time scales. The 200 meter asteroid hits, which are far more common than the 1 km+ hits, wouldn't show up much in geologic histories on a global scale.

## SMALL ASTEROIDS ADV– IMPACT EXTS – AGRICULTURE

Even a small asteroid impact would cause climate change to destroy crops for a year, wiping out most of the population

Dye 91 (Lee, science writer for the LA times, “Scientists Assess Danger of Earth's Demise by Asteroid,” The Los Angeles Times, 7/3/91, <http://articles.latimes.com/1991-07-03/news/mn-1558_1_near-earth-asteroid>) ben i

Shoemaker believes that if an asteroid of a few miles diameter were speeding toward the Earth, it probably would have been detected by one of several searches now under way. "The odds are there isn't anything out there bigger than (half a mile in diameter) that's going to hit us," he said. Even a much smaller object of only a few hundred feet in diameter could devastate a large region. Such an asteroid would be very dim in the evening sky and could easily escape detection. Although the scientists attending the conference, which ends today, had varying views on the seriousness of the heavenly threat, there was agreement on one point: If a large asteroid were to strike tonight, or sometime in the next few million years, it would be one spectacular show. Such an impact would kick up so much dust that "it would cover the entire planet several feet deep," said David Morrison, chief of the space science division of NASA's Ames Research Center in Mountain View. Morrison has emerged as the most eloquent evangelist for the doomsday scenario, and this veteran of some of NASA's most successful programs roams the planet like a guru descended from the mountain top in a three-piece suit. Dust from such an impact would "turn off the sun and we would have hot rocks falling out of the sky," Morrison told several hundred people who turned out for a public meeting on the issue. Even a relatively small asteroid would cause climatic changes that could destroy one year's crops around the planet, and "that would probably lead to the death of most of the population," he said. About 75,000 years ago, a modest asteroid about the size of the Los Angeles Coliseum slammed into what is now eastern Arizona and blasted out Meteor Crater, which is about a mile wide. That crash undoubtedly had a profound impact on the local region, and it proves that such things do happen, although not too frequently.

**AN ASTEROID IMPACT WOULD DEVASTATE GLOBAL AGRICULTURE – CLIMACTIC SHIFTS**

**URIAS ET AL 1996** [John M – colonel, “Planetary Defense: Catastrophic Health Insurance for Planet Earth”, A research paper presented to Air Force 2025, October, <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf>] ttate

Regardless of the tendency to downplay the ECO threat, the probability of an eventual impact is finite. When it happens, the resulting disaster is expected to be devastatingly catastrophic. Scientists estimate the 8 impact by an asteroid even as small as 0.5 kilometers could cause climate shifts sufficient to drastically reduce crop yields for one or several years due to atmospheric debris restricting sunlight. Impacts by objects one to two kilometers in size could therefore result in significant loss of life due to mass starvation. Few countries store as much as even one year's supply of food. The death toll from direct impact effects (blast and firestorm, as well as the climatic changes) could reach 25 percent of the world's population.8 Although it may be a rare event, occurring only every few hundred thousand years, the average yearly fatalities from such an event could still exceed many natural disasters more common to the global population.

**EVEN A SMALL ASTEROID CAN CAUSE DEVASTATON – IT CAN WIPE OUT LARGE PORTIONS OF LAND**

**Jones, 08** (Thomas, Veteran Astronaut, Space Scientist and Author, “Asteroid deflection: Planning for the inevitable”, Aerospace America, October 2008, <http://www.aiaa.org/aerospace/images/articleimages/pdf/View%20from%20Here1.pdf>) [JHegyi14]

Recent research by Mark Boslough of Sandia National Laboratories explains Tunguska as the impact of a small asteroid, perhaps 40 m in diameter. The object detonated in a 3-5-megaton airburst some 5 km up, scorching and flattening 2,000 km2 of Siberian forest. Compared with previous estimates of the impact energy, this smaller explosion implies a smaller impactor as well (the old estimate was a diameter between 60 and 100 m). Because smaller asteroids are more numerous, a Tunguska-like event should occur more often, perhaps every 300 years or so, rather than at the previously estimated rate of approximately once every millennium. NEOs that have been there all along, but are now cataloged and tracked, will soon confront us with an asteroid-sized headache: What will we do about the thousands of NEOs that have a slight but stubbornly nonzero chance of causing a catastrophe?

A small asteroid would destroy agriculture production

Smith 86 (Joseph V., Louis Block Professor of Physical Sciences at the University of Chicago, “The Defence of Earth,” New Scientist, 4/17/86, <http://books.google.com/books?id=-rE0nQCROdQC&lpg=PA40&ots=TWmOmDh-bU&dq=%22even%20a%20small%20asteroid%2C%20however%22&pg=PA40#v=onepage&q=%22even%20a%20small%20asteroid,%20however%22&f=false>) ben i

The death of the dinosaurs marked the end of the Cretaceous period, about 65 million years ago. The high content of iridium in the clay marking the boundary between the Cretaceous and the Tertiary periods is consistent with impact by one or more asteroids or comets. A single body would have been about 10 kilometres across and would have blasted a crater at least 100 kilometres in diameter. Our current mathematical models of the atmosphere are not yet good enough to let us calculate the likely effect of such an impact on the climate. Even a small asteroid, however, could so disrupt the climate as to endanger agriculture throughout the world. Fires in cities, forests and deposits of fossil fuels would aggravate the problems caused by dust in the atmosphere.

## SMALL ASTEROIDS ADV– IMPACT EXTS – OZONE MODULE

**EVEN A SMALL ASTEROID COLLISION WOULD DESTROY MORE THAN HALF OF OUR OZONE LAYER**

Hsu, 10.(Jeremy is a senior writer for LiveScience, a sister site to Life’s Little Mysteries. Oct 26, 2010 “Asteroid Strike Could Force Humans Into Twilight Existence,” http://www.livescience.com/8825-asteroid-strike-force-humans-twilight-existence.html, CALLAHAN)

An asteroid splashdown in one of Earth's oceans could trigger a destructive chemical cycle that would wipe out half the ozone layer, according to a new study. The massive loss of protection against the sun's ultraviolet (UV) radiation would likely force humans into a vampire-style existence of staying indoors during daylight hours. The worst scenario based on an asteroid 0.6 miles (1 kilometer) wide would re-create the hole in the ozone layer, which appeared over Antarctica during the 1990s, except this would be worldwide. UV levels in the study's simulation soared beyond anything measured so far on Earth by the UV Index's daily forecasts of overexposure to UV radiation, and remained that way for as long as two years. "An asteroid impact in the ocean is always dismissed as being a danger for coastal sites, but not much else has been discussed about it," said Elisabetta Pierazzo, a senior scientist at the Planetary Science Institute in Tucson, Ariz. "I was looking at the asteroid hazard from climatic effects." To do that, Pierazzo combined her expertise in crater-impact modeling with simulations developed by U.S. and German atmospheric scientists that show the interactive chemistry of the atmosphere. They tested scenarios with a 0.6-mile asteroid and a 0.3-mile asteroid (500 meters) at a specific location and specific time of year. They had no idea what to expect. Breaking bad The models showed how ozone destruction would result from an asteroid strike launching seawater vapor hundreds of miles up into the highest parts of the atmosphere. Chemical elements such as chloride and bromide that separated from the water vapor could then wreak havoc by destroying the ozone layer that protects life on Earth from the worst of mutation-causing UV rays. "The thing with the asteroid is that it ejects the water vapor way up there — we're talking hundreds of kilometers," Pierazzo told LiveScience in a phone interview. "It really goes to the highest extent of the atmosphere." Model results showed a 0.3-mile asteroid that hit at a latitude 30 degrees north in the Pacific Ocean in January would lead to a local impact on the ozone layer — though "local" still meant an ozone hole that spread across the entire Northern Hemisphere. By contrast, the 0.6-mile asteroid strike led to a worldwide drop in UV protection — at which point the "hole" ceases to be a hole. Location of the asteroid strike matters because of atmospheric circulation patterns, Pierazzo explained. Time of year in each hemisphere also matters, because the strength of the ozone layer changes by season based on the amount of sunlight reaching the atmosphere. (In the upper atmosphere, ozone (O3) forms when oxygen molecules are broken apart by the sun's UV light.) A strike by the 0.3-mile asteroid saw a jump in ultraviolet radiation as measured by the ultraviolet index (UVI) to values above 20 in the northern subtropics for several months. Normally, a UVI of 10 or more can burn people with fair skin with just a few minutes of sun exposure, and some of the highest recorded UVI values on Earth (around the equator) have reached just 18. On certain days, a UVI of 20 was recorded at a high-altitude desert in Puna de Atacama, ArgentinaDescription: http://images.intellitxt.com/ast/adTypes/mag-glass_10x10.gif. A strike by the larger of the two model asteroids boosted UVI values above 20 within a 50-degree latitude band north and south of the equator for about two years. Some areas within the band saw UVI spikes as high as 56. That band's northern end would include cities such as Seattle and Paris, while the southern end would extend into cities within countries such as New Zealand, Chile and Argentina. Long-term effects of such high UV radiation would include skin-reddening, changes in plant growth and genetic mutations for humans and other organisms. The future threat Such scenarios represent the likelier outcomes of an asteroid impact on Earth — an asteroid has about twice the chance of striking water rather than hitting land. Those odds come from the fact that over 70 percent of the Earth's surface is covered by water, with about two-thirds covered by oceans more than a mile deep. Asteroid hunters have found about 903 of an estimated 1,050 near-Earth objects (NEOs) with diameters of 1 kilometer or greater as of Oct. 1. That still leaves well over 100 objects in the 1-2 kilometer size undiscovered. More cause for worry may come from smaller NEOs less than 1 kilometer wide. NASA has found just 5 percent of the estimated count for such NEOs, which leaves tens of thousands of unknowns. "As you go down in asteroid size, there's a lot more objects out there that have not been identified that could be a threat," said Pierazzo, whose research was detailed online Oct. 2 in the journal Earth and Planetary Science Letters. But finding NEO threats to Earth remains NASA's job. Pierazzo's next step with her colleagues will involve modeling the atmospheric impact of an asteroid strike on land. That may prove an even more complicated scenario, because of the combination of dust blocking out incoming sunlight and other possible chemical effects on the ozone.

**AND, THAT EQUALS EXTINCTION**

Greenpeace ’95 [“Full of Holes: Montreal Protocol and the Continuing Destruction of the Ozone Layer”, *A Greenpeace Report,*  <http://archive.greenpeace.org/ozone/holes/holebg.html>]

When chemists Sherwood Rowland and Mario Molina first postulated a link between chlorofluorocarbons and ozone layer depletion in 1974, the news was greeted with scepticism, but taken seriously nonetheless. The vast majority of crediblescientists have since confirmed this hypothesis. The ozone layer around the Earth shields us all from harmful ultraviolet radiation from the sun. Without the ozone layer, life on earth would not exist. Exposure to increased levels of ultraviolet radiation can cause cataracts, skin cancer, and immune system suppression in humans as well as innumerable effects on other living systems. This is why Rowland's and Molina's theory was taken so seriously, so quickly **-** the stakes are literally the continuation of life on earth.

## SMALL ASTEROIDS ADV – IMPACT EXTS – OZONE IMPACTS

**DESTRUCTION OF THE OZONE LEADS TO MASS BIODIVERSITY LOSS AND RUNAWAY GLOBAL WARMING**

De Gruijl, 95.(Frank R. is a biophysicist involved in the study of ozone depletion and is on the committee of the United Nations Environment Programme. Summer 1995, “Impacts of a Projected Depletion of the Ozone Layer,” http://www.gcrio.org/CONSEQUENCES/summer95/impacts.html, CALLAHAN)

All animals and plants and other organisms that are exposed to the Sun, though well shielded by the ozone layer, have developed ways to cope with and protect themselves from the small fraction of solar UVB radiation that normally reaches the Earth's surface. Even a small amount of UVB radiation can have a significant effect on ecosystems. In the tropics, for example, where a thinner ozone layer and a higher Sun result in systematically stronger UV dosage, certain trees have been found to be restricted in their growth by current levels of solar UV radiation. In ecosystem studies, as in medicine, science has not yet reached the point where any practically useful assessments of the consequences of increased dosages can be made. Research has thus far been mainly limited to more rudimentary studies in laboratories and greenhouses that test the sensitivity of different plant species to enhanced UV radiation. Only a few field investigations have been performed on an appreciable scale, and proper ecological studies are still in their infancy. In general, it appears that plant species can react in widely different ways to increased levels of UVB radiation: some may be clearly limited in their growth; other varieties may be insensitive or rapidly become so by adaptive mechanisms; and still others may even exhibit enhanced growth. Under added stress, as through drought, the differences in UV sensitivity may be completely lost. The majority of plant species that have been tested were agricultural plants; trees appear to run a higher risk of accumulating UV damage over their far longer lifetimes. In addition to direct effects on photosynthesis and growth, there may also occur more subtle changes, such as a delay in flowering, a shift in the distribution of leaves, a change in leaf structure, or a change in a plant's metabolism. As verified in field studies, such subtle changes may have far-reaching consequences by causing a plant to loose ground to neighboring plants with whom they compete. Thus, dramatic shifts in plant populations and in biodiversity may ensue. Similar processes can occur in the marine ecosystems that exist at shallow depths in photosynthetically active zones. UV radiation can penetrate tens of meters into clear ocean water. It has been found that *phytoplankton*--the minuscule, plant-like organisms that float on or near the surface of the ocean and that serve as the base of the entire marine food chain--are sensitive to the levels of UVB radiation that penetrate the ocean's surface. Recent studies have focused particularly on the waters that bound the Antarctic continent, directly under the ozone hole, and rates of phytoplankton production were indeed found to be depressed relative to other similar areas. These potentially significant disturbances at the basis of terrestrial and marine food webs may have a domino effect that could ultimately affect mankind. Moreover, loss of biodiversity due to enhanced UV radiation may render an ecosystem more vulnerable to the other stresses such as are expected to accompany greenhouse- induced climate change. Higher levels of UVB levels could also reduce the global plant cover that serves as a sink for CO2, thus enhancing climatic change. Unfortunately, at this time scientific research has produced only limited and widely varying data on possible impacts on single plants or species, and much remains to be done to quantify the possible effects on any marine, terrestrial, or agricultural ecosystem. Ecosystems may be further disturbed by deleterious effects of UV radiation on animals, especially in vulnerable, early stages of life such as larvae or the eggs of frogs in shallow water.

**AND, THE THRESHOLD FOR BIODIVERSITY LOSS IS SMALL – WE ONLY NEED TO LOSE A FEW KEYSTONE SPECIES FOR SNOWBALL TO TOTAL EXTINCTION**

Mills et al, 93.(L. Scott Mills is a graduate student in the Department of Biology at UC Santa Cruz, Michael E. Soulé is a professor and the department chair, and Daniel F. Doak is an assistant professor in the Department of Environmental Studies, Apr 1993, “The Keystone-Species Concept in Ecology and Conservation,” http://ckwri.tamuk.edu/fileadmin/user\_upload/PHOTOS/Deer-Research\_Program/Student\_papers/keystone.pdf, CALLAHAN)

Will the extinction of a single species in a community cause the loss of many others? Can we identify a set of species that are so important in determining the ecological functioning of a com- munity that they warrant special con- servation efforts? The answer to these questions hinges on the existence of a limited number of species whose loss would precipitate many further ex- tinctions; these species have often been labeled keystone species. The term keystone species has en- joyed an enduring popularity in the eco- logical literature since its introduc- tion by Robert T. Paine in 1969: Paine (1969) was cited in more than 92 publications from 1970 to 1989; an earlier paper (Paine 1966), which in- troduced the phenomenon of keystone species in intertidal systems but did not use the term, was cited more than 850 times during the same period. As used by Paine and other ecolo- gists, there are two hallmarks of key- stone species. First, their presence is crucial in maintaining the organiza- tion and diversity of their ecological communities. Second, it is implicit that these species are exceptional, rela- tive to the rest of the community, in their importance. L. Scott Mills is a graduate student com- pleting his dissertation in the Depart- ment of Biology, University of Califor- nia, Santa Cruz, CA 95064. Michael E. Soule is a professor and the department chair and Daniel F. Doak is an assistant professor in the Department of Environ- mental Studies, University of California, Santa Cruz, CA 95064. ? 1993 American Institute of Biological Sciences. The term keystone species is poorly defined and broadly applied. Given the assumed importance of keystone species, it is not surprising that biologists have advocated that key or keystone species be special targets in the efforts to maximize biodiversity protection (e.g., Burkey 1989, Frankel and Soule 1981, Soule and Simberloff 1986, Terborgh 1986) and as species in need of priority protection (e.g., Cox et al. 1991). Management to protect keystone spe- cies has been suggested to resolve general policy and land-use dilem- mas. For example, it has been pro- posed that management for individual keystone species should be a focus for the management of whole communi- ties (Rohlf 1991, Woodruff 1989). Further, Carroll (1992) argues that managed keystone species could be used to support populations of other species in reserves that would other- wise be too small to contain viable populations. Conway (1989) sug- gested that, for restoration, keystone species are necessary to help reestab- lish and sustain ecosystem structure and stability.

Studies prove ozone depletion will be a major extinction level event.

Mellot &Thomas '11 (Adrian, Brian, Professors of Physics and Astronomy, "Astrophsical Ionizing Radiation and Earth: A brief Review and Census of Intermittent Intense Soucres," Ozone Depletion Research Today, <http://ozonedepletion.researchtoday.net/>)

Abstract Cosmic radiation backgrounds are a constraint on life, and their distribution will affect the Galactic Habitable Zone. Life on Earth has developed in the context of these backgrounds, and characterizing event rates will elaborate the important influences. This in turn can be a base for comparison with other potential life-bearing planets. In this review, we estimate the intensities and rates of occurrence of many kinds of strong radiation bursts by astrophysical entities, ranging from gamma-ray bursts at cosmological distances to the Sun itself. Many of these present potential hazards to the biosphere; on timescales long compared with human history, the probability of an event intense enough to disrupt life on the land surface or in the oceans becomes large. Both photons (e.g., X-rays) and high-energy protons and other nuclei (often called "cosmic rays") constitute hazards. For either species, one of the mechanisms that comes into play even at moderate intensities is the ionization of Earth's atmosphere, which leads through chemical changes (specifically, depletion of stratospheric ozone) to increased ultraviolet B flux from the Sun reaching the surface. UVB is extremely hazardous to most life due to its strong absorption by the genetic material DNA and subsequent breaking of chemical bonds. This often leads to mutation or cell death. It is easily lethal to the microorganisms that lie at the base of the food chain in the ocean. We enumerate the known sources of radiation and characterize their intensities at Earth and rates or upper limits on these quantities. When possible, we estimate a "lethal interval," our best estimate of how often a major extinction-level event is probable given the current state of knowledge; we base these estimates on computed or expected depletion of stratospheric ozone. In general, moderate-level events are dominated by the Sun, but the far more severe infrequent events are probably dominated by gamma-ray bursts and supernovae. We note for the first time that so-called "short-hard" gamma-ray bursts are a substantial threat, comparable in magnitude to supernovae and greater than that of the higher-luminosity long bursts considered in most past work. Given their precursors, short bursts may come with little or no warning.

## SMALL ASTEROIDS ADV– IMPACTS – MASS CASUALTIES

**A SMALL ASTEROID COLLISION CAN HAVE THE SAME DEVASTATION AS A NUCLEAR WEAPON**

Worden, 2k. (Air Force Brigadier General S. Pete Worden, February 7, 2000, “NEOs, Planetary Defense and Government – A View from the Pentagon,” http://abob.libs.uga.edu/bobk/ccc/ce020700.html, CALLAHAN)

I will assume that most readers share in the view that NEOs have and will continue to play a central role in the evolution of life on this planet. I'll also assume that we more or less agree that we face a continuing threat from these objects. Most analyses focus on the big threats--objects which can threaten life globally and have the potential to destroy or seriously damage our species. I for one believe we should pay more attention to the "Tunguska-class" objects--100 meter or so objects which can strike up to several times per century with the destructiveness of a nuclear weapon. NEO discussions in the United States have, as I believe they have everywhere, suffered from the fact that catastrophic NEO impacts are so rare and hence so unlikely to occur in our lifetimes. Whereas people may pay good money to see a movie thriller about asteroid strikes or read with great interest of the demise of the dinosaurs, a once-every-few-tens-of-millions-of-years possibility is not real to most people. Decision makers simply are unwilling to spend scarce resources on such an unlikely catastrophe--however terrible it may be or even if it is inevitable. Conversely, I can show people evidence of real strikes inflicting local and regional damage less than a century ago. Even more compelling are the frequent kiloton-level detonations our early warning satellites see in the earth's atmosphere. These are threats the public and its leaders will take seriously. These are threats we can understand. And these are even threats we could mitigate, if required, without recourse to nuclear technology.

**EVEN A SMALL NEO COLLISION WITH EARTH WILL HAVE MASSIVE CASUALTIES – LARGE TSUNAMIS**

**Cooke 06** (Bill, astronomer with NASA's Marshall Space Flight Center in Huntsville, Alabama, “Fatal Attraction,” Astronomy, 5/1/06, http://elibrary.bigchalk.com/elibweb/elib/do/document?set=search&dictionaryClick=&secondaryNav=&groupid=1&requested

=lib\_standard&resultid=3&edition=&ts=5FE4E122D9D27930CBA198F29069D5FD\_1310428693563&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B122812709) [Iuliano]

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**EVEN THE SMALLEST OF ASTEROIDS CAN CREATE 300 FOOT CRATERS – EVEN A SMALL ASTEROID PUNCTURING THE EARTH’S ATMOSPHERE WILL CAUSE MASS CASUALTIES**

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HAVE SOME PROMINENT SCIENTISTS INADVERTENTLY BEEN PLAYING Chicken Little? Working from computer models, several researchers warned that asteroid impacts could trigger devastating tsunamis with frightening frequency, at least once every 4,000 years. Never fear: Philip Bland, a planetary scientist at Imperial College London, says his improved calculations show that the actual rate is probably much lower. The previous simulations portrayed incoming asteroids as continuous blobs--picture a ball of glue flattening and spreading as it hits a hard surface. Bland developed a more realistic model that allows asteroids to disintegrate on the way in. "We're looking at the forces acting on stone or iron fragments as an object breaks up upon entering the atmosphere," he says. Fragmentation greatly reduces the odds of a major tsunami. To generate a 16-foot-high tidal wave, an object must be about 720 feet wide when it hits the surface. According to Bland's model, few objects that large survive passage through the atmosphere. Asteroid fragments 15 feet wide, capable of forming 300-foot craters, strike Earth every 200 to 400 years, he finds. Chunks large enough to trigger a significant tsunami fall just once every 170,000 years.Bland does not dismiss the danger of asteroids, however. "Even if an asteroid shatters in the atmosphere, it's a substantial threat to human life" he says. The still-mysterious Tunguska Event, an explosion in Siberia in 1908, was most likely caused by a comet or meteorite. Although the object disintegrated in the air, it still managed to flatten 800 square miles of terrain. And scientists still do not really understand how the atmosphere interacts with really large impactors, which will be the next focus of Bland's research. "That would let us see what kind of effect a big comet, for example, might have" he says. PHOTO (COLOR): The Wolf Creek Crater in Western Australia testifies to the destructive power of asteroids on land.

## SMALL ASTEROIDS ADV – IMPACTS – MASS CASUALTIES

**EVEN A SMALL ASTEROID COLLISION WILL LEAD TO MASS CASUALTIES – STATUS QUO IS DOING LITTLE TO DETECT THE SMALLER ASTEROIDS**

Ahlstrom, 08. (Dick is the science editor for the Irish Times who cites several astronomers and professors. April 2, 2008, “Forget about the big one: small asteroid could inflict great damage,” lexis, CALLAHAN)

SOME ASTRONOMERS worry about "the big one", a civilisation-destroying impact between the earth and a kilometre-wide asteroid. However being hit by a "little one" would still be devastating, an astronomer has warned. This year marks the 100th anniversary of the 1908 Tunguska event when an incoming asteroid no more than 60 metres across blew up over Siberia. This puny object managed to flatten 2,000 sq km (772 sq miles) of forest, more than twice the area of Co Dublin. If a similar asteroid "air burst" happened over Dublin today it would completely destroy the city, stated Prof Mark Bailey, director of Armagh Observatory. Last night he delivered a talk on Tunguska and the risk of asteroid impacts as part of the Royal Astronomy Society's national annual meeting, which started yesterday at Queen's University Belfast. The subject gives a whole new meaning to the question, "Did the earth move for you?" If we are talking asteroids, it most certainly did. Tunguska in fact was not even that bad as things go. It was a rocky asteroid and so blew up eight kilometres overhead after slamming into the upper atmosphere. The energy released was equivalent to the bang given off by up to 10 million tonnes of high explosives. A similar-sized asteroid made mostly of nickel-iron had an even bigger impact when it slammed into what is now Arizona about 50,000 years ago. Travelling at several kilometres a second, it punched a huge hole 1.2km across and 170m deep to deliver the famed Meteor Crater. Armagh Observatory has long conducted research on the "near Earth objects" that pose a threat to earth. There are an estimated 1,100 "big ones" out in space and only some of these have so far been located, Prof Bailey said. While they have the potential on impact to plunge the earth into years of winter and wipe out a quarter of the world's population, such impacts might only occur once in 100,000 years, he suggested. These big objects are much easier to find compared to the "little ones" however, and the small-object impacts typically occur once every few hundred years. While they won't wipe out the planet, Tunguska and Meteor Crater show that these impacts could cause "local devastation", Prof Bailey added. Little is being done or can be done about them. "In a way we live with that risk," Prof Bailey said.

**EVEN THE SMALLEST ASTEROID COULD WIPE OUT MAJOR CITIES – COULD KILL MILLIONS**

**Schweickart 11** (Russell, Former Astronaut, Humans to Asteroids: Watch Out! 5/9/11 [http://elibrary.bigchalk.com/elibweb/elib/do/document?set= search&dictionaryClick=&secondaryNav=&groupid=1&requestid=lib\_standard&resultid=2&edition=&ts=30A3C8FD80E61E12196656D00B4A3984\_1310662986265&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B192537719&pdfflag=y](http://elibrary.bigchalk.com/elibweb/elib/do/document?set=%20search&dictionaryClick=&secondaryNav=&groupid=1&requestid=lib_standard&resultid=2&edition=&ts=30A3C8FD80E61E12196656D00B4A3984_1310662986265&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B192537719&pdfflag=y)) steven

A few months ago, a 30-footwide asteroid zipping along at 38,000 miles per hour flew 28,000 miles above Singapore. Why should you care about a near miss from such a tiny space object? Because asteroids don't always miss. If even a little one struck a city, millions of people could be wiped out because of its speed. And if the object is bigger, well, just think about the asteroid seven to eight miles across that annihilated die dinosaurs (and 75 percent of all species) 65 million years ago. Fortunately, our advanced telescopes now allow us to predict dangerous asteroid impacts decades ahead of time. We can even use today's space technology and fairly simple spacecraft to alter an asteroid's orbit enough to avoid a collision. We simply need to get a program up and running.

**EVEN A SMALL ASTEROID COLLISION COULD CAUSE MASSIVE DEVASTATION – COULD LEAD TO MASS CASUALTIES**

**Reeves 7** (Robert, phd in astronomy, “Who will save us from a killer asteroid?” 11/01/07 [http://elibrary.bigchalk.com/elibweb/elib/do/ document?set=search&dictionaryClick=&secondaryNav=&groupid=1&requestid=lib\_standard&resultid=2&edition=&ts=FEA18CE1DD3627162238AAC207841E36\_1310604862440&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B145564410](http://elibrary.bigchalk.com/elibweb/elib/do/%20document?set=search&dictionaryClick=&secondaryNav=&groupid=1&requestid=lib_standard&resultid=2&edition=&ts=FEA18CE1DD3627162238AAC207841E36_1310604862440&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B145564410)) steven

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## SMALL ASTEROIDS ADV– IMPACTS – MASS CASUALTIES

**A SMALL ASTEROID COLLISION CAN HAVE THE SAME DEVASTATION AS A NUCLEAR WEAPON**

Worden, 2k. (Air Force Brigadier General S. Pete Worden, February 7, 2000, “NEOs, Planetary Defense and Government – A View from the Pentagon,” http://abob.libs.uga.edu/bobk/ccc/ce020700.html, CALLAHAN)

I will assume that most readers share in the view that NEOs have and will continue to play a central role in the evolution of life on this planet. I'll also assume that we more or less agree that we face a continuing threat from these objects. Most analyses focus on the big threats--objects which can threaten life globally and have the potential to destroy or seriously damage our species. I for one believe we should pay more attention to the "Tunguska-class" objects--100 meter or so objects which can strike up to several times per century with the destructiveness of a nuclear weapon. NEO discussions in the United States have, as I believe they have everywhere, suffered from the fact that catastrophic NEO impacts are so rare and hence so unlikely to occur in our lifetimes. Whereas people may pay good money to see a movie thriller about asteroid strikes or read with great interest of the demise of the dinosaurs, a once-every-few-tens-of-millions-of-years possibility is not real to most people. Decision makers simply are unwilling to spend scarce resources on such an unlikely catastrophe--however terrible it may be or even if it is inevitable. Conversely, I can show people evidence of real strikes inflicting local and regional damage less than a century ago. Even more compelling are the frequent kiloton-level detonations our early warning satellites see in the earth's atmosphere. These are threats the public and its leaders will take seriously. These are threats we can understand. And these are even threats we could mitigate, if required, without recourse to nuclear technology.

**EVEN A SMALL NEO COLLISION WITH EARTH WILL HAVE MASSIVE CASUALTIES – LARGE TSUNAMIS**

**Cooke 06** (Bill, astronomer with NASA's Marshall Space Flight Center in Huntsville, Alabama, “Fatal Attraction,” Astronomy, 5/1/06, http://elibrary.bigchalk.com/elibweb/elib/do/document?set=search&dictionaryClick=&secondaryNav=&groupid=1&requested

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## SPACE LEADERSHIP ADV – PLAN KEY TO SPACE LEADERSHIP

**A SUCCESSFUL ASTEROID POLICY ALLOWS THE US TO SHORE UP SPACE LEADERSHIP**

**FRIEDMAN 2010** [ Lou – former Executive Director of The Planetary Society and the current Director of the Society's LightSail Program; former Navigation and Mission Analysis Engineer and Manager of Advanced Projects at JPL., “The case for a human asteroid mission,” *The Space Review*, December 13http://www.thespacereview.com/article/1742/1] ttate

I believe that this nation should commit itself toachieving the goal, before this decade is out, of landing a human on a near Earth asteroid and returning him (or her) safely to the Earth. No single space project in this period will be more impressive to humankind, or more important for the long-range exploration of space. Why? Because it will finally be a new human achievement outward from our planet, five decades after our previous giant step outward for humankind. It will be our first dip into the cosmic ocean of interplanetary space. I apologize for stealing President Kennedy’s immortal words of May 25, 1961, and unabashedly adapting them to make my point that a human asteroid mission could and should be an inspiring goal to restore optimism and achievement to human space flight. Even more**,** it could reinvigorate American leadership in the best of ways, not with chauvinism, but by example and engagement of the whole world. Such leadership could promote international cooperation among the world’s space agencies to expand solar system exploration and development. What has been missing from the debate about the future of space exploration is optimism and confidence. Even President Obama’s effort in this regard in Florida last April was too defensive and mired in politics. An achievement of a three- to six-month journey by astronauts to, around, on, and back from an asteroid would enhance popular interest in, and the perception of value of, space exploration. The sight of astronauts gently bouncing on and off the asteroid, conducting experiments, and digging below the surface would be more engaging than the pale terrestrial “Dancing With the Stars.” What a boost it would give to our understanding about these strange objects, and what an education for our citizenry about a future which will certainly involve deflecting some object threatening our planet. When The Planetary Society presented its Roadmap To Space at the National Press Club in Washington two years ago, one young journalist asked, “How will we feel if [because of this Roadmap], China beats us to the Moon?” Simultaneously and spontaneously several of us on the panel, and Buzz Aldrin in the audience, jumped to our feet and exploded, “We’ve already been first to the Moon!” America can’t be first to the Moon again. No one can. But American leadership would be absolutely secure if we were leading an international mission in deep space beyond Earth orbit,while other nations (and perhaps even private companies) were getting their feet “wet” on the Moon. The spirit of space—optimism for the future—has been sadly lacking in recent years. We are bogged down in small questions looking at our feet instead of using our minds to look at the stars. I have been pretty downbeat myself, as readers of some of my recent columns and articles have noticed. Perhaps the achievement last week of our friend and colleague, Elon Musk, with Falcon 9 and Dragon has provided some buoyancy to my view. Elon’s drive is not just to achieve Earth orbit, but also to help us one day reach Mars. His current achievement is just a milestone on the way. In one of his interviews last week Elon said he is developing this system so that NASA can focus on exploration and new achievements in human space flight. The rubble pile on which the present human space program perches could actually provide enough of a foundation on which to start building. Returning to my use of President Kennedy’s statement, I asserted my view that a human asteroid mission can be done within the decade; that is, by the end of 2020. This is faster than President Obama’s 2025 goal and faster than most folks in the space program feel is possible. I think it can be done within the budget guidelines laid out in the President’s proposed fiscal year 2011 budget (still to be passed by Congress). It’s a push, to be sure, but I was heartened by Lockheed Martin’s recent proposal that they could do such a mission with their Orion Crew Vehicle in that time period. If the established aerospace industry players would cooperate with the government and “NewSpace” companies for new human space achievements, I have no doubt that a 2020 timetable is possible. As SpaceX put it in a Twitter message a half hour after their successful mission: “A big thank you to NASA for their continued support! What an awesome partnership!” The technical requirements of a human asteroid mission are big but straightforward. The mandate for the heavy-lift rocket needed for deep space missions is already in place. So is the crew vehicle, although it may need some kind of service module attachment. The commercial arrangements may even give us some competitive choices in this time period. The longer flight of an asteroid mission will need more supplies. We need to accelerate development of the crew life support capability required for the several-month interplanetary voyage, but we have already agreed to use the International Space Station for that training. International capabilities from the other spacefaring nations can keep the cost within today’s bounds. The rubble pile on which the present human space program perches could actually provide enough of a foundation on which to start building. But the endeavor needs an “architect” to lead it. America and the world need their “can-do” spirit restored. A human asteroid mission is not the answer to all (or even most) of our problems, but like Apollo it can foster the spirit that enables much more to be accomplished. Do we have it in us?

## SPACE LEADERSHIP ADV – SPACE SPENDING KEY TO SPACE LEADERSHIP

**Government spending on space exploration is key to leadership**

**Mankins 09**(John C,  John C. Mankins managed numerous advanced space technology programs during his 25 years at NASA Headquarters and the Jet Propulsion Laboratory, and is widely known as an expert in space solar power and as one of the creators of the widely used “technology readiness level” (TRL) scale, “ To boldly go: the urgent need for a revitalized investment in space technology”, 5/18/09, <http://www.thespacereview.com/article/1377/1//sb>) rory

At the beginning of the space age, the United States realized that preeminence in space exploration and development could only be achieved through a commitment to robust investments in advanced space research and technology. Starting with the Kennedy Administration, and continuing until just the past four years, the US civil space program has been characterized not only by remarkable achievements in space (e.g., Surveyor, Mercury, Pioneer, Gemini, Apollo, and other programs), but also by ambitious investments in space technology. For example, in the mid-1960s, NASA’s investment in advanced space research and technology was approximately $1 billion per year (in current year dollars), and was directed toward truly ambitious technical objectives such as nuclear propulsion, high-energy cryogenic engines, thermal protection for reusable launch vehicles, electric propulsion, solar energy, automation and robotics, and more. For its day, NASA’s advanced space research and technology program was truly transformational—pressing the frontiers in technology and enabling the space missions of the 1970s and 1980s to achieve goals that were unimaginable for any other nation in the world.

**Budget cuts are causing a loss in leadership- plan is key to regain leadership**

**Mankins 09**(John C,  John C. Mankins managed numerous advanced space technology programs during his 25 years at NASA Headquarters and the Jet Propulsion Laboratory, and is widely known as an expert in space solar power and as one of the creators of the widely used “technology readiness level” (TRL) scale, “ To boldly go: the urgent need for a revitalized investment in space technology”, 5/18/09, <http://www.thespacereview.com/article/1377/1//sb>) rory

Space has never been more important to our national security than it is today. The opportunities for truly profound scientific discoveries through space exploration have never been greater. And the pace of international development of new capabilities for space operations has never been faster. Federal budgets for advanced research and technology to enable future space exploration and development have been reduced in scope and focused on near-term system developments to the point that US preeminence in space activities is in question. NASA’s advanced space research and technology budget was over $2 billion in fiscal year (FY) 2005, with a focus on objectives five to ten years in the future and with the purpose of informing program and design decisions, while retiring both technical and budget risks of those future programs. The President’s FY 2007 budget for NASA exploration technology declined to less than $700 million, and of that only a small fraction (perhaps less than $200 million) still addressed longer-term objectives. The corresponding budgets in 2008 and 2009 were further reduced. Little to none of the remaining investment deals with enabling fundamentally new goals or objectives, or dramatically reducing expected costs. With these funding levels and program goals, it is unlikely that the US will maintain leadership in space exploration beyond the current generation of projects—all of which are founded on the “seed corn” harvested from past investments in innovative new space capabilities. Further, declining support for space research and technology is creating an innovation vacuum in the US as small business opportunities evaporate, and funding for universities and students vanishes. This trend jeopardizes America’s long-term leadership in space exploration and development, and damages our ability to achieve important national security goals.

## SPACE LEADERSHIP ADV – SPACE KEY TO HEG EXTS

**SPACE LEADERSHIP IS A PREREQUISITE TO GLOBAL HEGEMONY**

YOUNG ET. AL. 2008 [A. Thomas - Chairman Lieutenant, “ Leadership, Management, and Organization for National Security Space,” *Institute for Defense Analyses*, July, <http://www.armyspace.army.mil/ASJ/Images/National_Security_Space_Study_Final_Sept_16.pdf>] ttate

The IAP’s assessment, our findings, and our recommendations for aggressive action are based on the understanding that space-based capabilities are essential elements of the nation’s economic infrastructure and provide critical underpinnings for national security. Space-based capabilities should not be managed as derivative to other missions, or as a diffuse set of loosely related capabilities. Rather, they must be viewed as essential for restoring and preserving the health of our NSS enterprise. NSS requires top leadership focus and sustained attention. The U.S. space sector, in supporting commercial, scientific, and military applications of space, is embedded in our nation’s economy, providing technological leadership and sustainment of the industrial base. To cite one leading example, the Global Positioning System (GPS) is the world standard for precision navigation and timing, directly and indirectly affecting numerous aspects of everyday life. But other capabilities such as weather services; space-based data, telephone and video communications; and television broadcasts have also become common, routine services. The Space Foundation’s 2008 Space Report indicates that the U.S. commercial satellite services and space infrastructure sector is today approximately a $170 billion annual business. Manned space flight and the unmanned exploration of space continue to represent both symbolic and substantive scientific “high ground” for the nation**.** The nation’s investments in the International Space Station, the Hubble Telescope, and scientific probes such as Pioneer, Voyager, and Spirit maintain and demonstrate our determination and competence to operate in space. They also spark the interest of the technical, engineering, and scientific communities and capture the imaginations of our youth. 3 The national security contributions of space-based capabilities have become increasingly pervasive, sophisticated, and important. Global awareness provided from space—including intelligence on the military capabilities of potential adversaries, intelligence on the proliferation of weapons of mass destruction, and missile warning and defense—enables effective planning for and response to critical national security requirements. The communications bandwidth employed for Operation Iraqi Freedom today is over 100 times the bandwidth employed at the peak of the first Gulf war. Approximately 80 percent of this bandwidth is being provided by commercial satellite capacity. Military capabilities at all levels—strategic, operational, and tactical— increasingly rely upon the availability of space-based capabilities. Over the recent decades, navigation and precision munitions were being developed and refined based on space-based technologies. Space systems, including precision navigation, satellite communications, weather data, signals intelligence, and imagery, have increasingly provided essential support for military operations, including most recently from the very first days of Operation Enduring Freedom in Afghanistan. Similarly, the operational dominance of coalition forces in the initial phase of Operation Iraqi Freedom provided a textbook application of the power of enhancing situational awareness through the use of space-based services such as precision navigation, weather data management, and communications on the battlefield. These capabilities are continuing to provide major force-multipliers for the soldiers, airmen, sailors, and marines performing stabilization, counter-improvised explosive device (IED), counterterrorism, and other irregular warfare missions in Iraq, Afghanistan, and arou nd the world. As the role and importance of space-based capabilities for military operations grows, the users are demanding that they be more highly integrated with land-, sea-, and air-based capabilities. During the first decades of the Cold War, the premier applications of space could be exemplified by the highly specialized systems that enabled exposed photographic film to be parachuted from space, developed and analyzed by intelligence experts, and rushed to the situation room in the White House for strategic purposes. Space-based capabilities were uniquely capable of providing visibility into areas of denied access. Today and in the future, the employment of space-based capabilities will increasingly support military operations. And for all users, the employment of spacebased capabilities will be more accurately exemplified by sophisticated database searches of a range of relevant commercially available and specialized national security digital information, using tools that integrate such information across all sources. For all the reasons cited here—military, intelligence, commercial, scientific— there can be no doubt that continued leadership in space is a vital national interest that merits strong national leadership and careful stewardship.

**CONTINUED DOMINANCE AND CONTROL OF SPACE KEY TO OUR OVERALL LEADERSHIP AND MILITARY EFFECTIVNESS**

**Globus 11** (Al - senior computer scientist with Computer Sciences Corporation @ NASA Ames Research Center, “Why Build Orbital Space Colonies”, last modified July 12, 2011, http://webcache.googleusercontent.com/search?q=cache:2iqBa43vOjUJ:space.alglobus.net/Basics/why.html+asteroid+detection+will+allow+colonies&cd=12&hl=en&ct=clnk&gl=us&source=www.google.com) rory

The space age was born of a power struggle. In the 1960's the U.S. and the Soviet Union were locked in a struggle for world domination called the Cold War. It never became a shooting war because each combatant had nuclear tipped missiles capable of devastating the other; and there was no defense. Neither the U.S. nor the U.S.S.R. made China's mistake, both vigorously tried to expand. The traditional way to do this is warfare, which was suicide. Since they couldn't fight each other directly, the U.S. and U.S.S.R. fought a series of proxy wars around the globe, and engaged in a wonderful competition to put a man on the Moon. This ended when the American Neil Armstrong set foot on the lunar surface in 1969. The Moon race was expensive but it was a big improvement over the proxy wars in Korea, Vietnam, Afghanistan, Africa, Nicaragua, El Salvador and elsewhere that killed millions and wrecked entire countries. The Moon race only killed three Americans and not a whole lot more Russians. No towns or cities were destroyed. A great deal of wealth producing knowledge was gained, we learned how to work in space, and got some moon rocks to show off. The U.S. won the Moon race in 1969 and by about 1990 the Cold War as well. I don't think that was a coincidence. In any case, losing the Cold War cost the Soviet Union dearly. The USSR collapsed and disappeared, replaced by roughly fifteen independent countries. Things are so bad today the population of the old USSR is actually declining. Space dominance has served the U.S. well. Our spy satellites allowed us to keep track of what's going on in the world, particularly the status of the Soviet Union's nuclear weaponry. Spy satellites played an important role in defeating the Soviet Union's invasion in Afghanistan, giving the rebels a birds-eye view of Soviet positions. The Global Positioning System (GPS), a satellite system developed by the U.S. military allows one to know exactly where in the world one is. It has been crucial in the U.S. military victories in the Persian Gulf. GPS not only lets troops know exactly where the are, but allows the U.S. to accurately hit military targets with long range weapons with far, far fewer civilian casualties that and previous long range weapon. Space is a crucial component of the current U.S. military global dominance. It is perfectly reasonable to expect space to play an increasing role in Earth's wars, as long as those wars persist. The nations that control space will tend to win, those that don't will tend to lose - and the only thing worse than fighting a war is losing one. However, military dominance is only one form of power that space provides. Another important one is economic.

**AND, SPACE LEADERSHIP KEY TO OVERALL US HEGEMONY**

**Hall et al., 2008** (Thomas Young, IDA chairman; Edward Anderson, Lieutenant General; Lyle Bien, Vice Admiral; Ronald R. Fogleman, General; Keith Hall; Lester Lyles, General; Hans Mark, Doctor, “Leadership, Management, and Organization for National Security Space,” IDA Group Report, 7/12/11, <http://www.armyspace.army.mil/ASJ/Images/National_Security_Space_Study_Final_Sept_16.pdf>) Hou

Space capabilities underpin U.S. economic, scientific, and military leadership. The space enterprise is embedded in the fabric of our nation’s economy, providing technological leadership and sustainment of the industrial base. To cite but one example, the Global Positioning System (GPS) is the world standard for precision navigation and timing. Global awareness provided from space provides the ability to effectively plan for and respond to such critical national security requirements as intelligence on the military capabilities of potential adversaries, intelligence on Weapons of Mass Destruction (WMD) program proliferation, homeland security, and missile warning and defense. Military strategy, operations, and tactics are predicated upon the availability of space capabilities. The military use of space-based capabilities is becoming increasingly sophisticated, and their use in Operation Enduring Freedom and Operation Iraqi Freedom is pervasive.

## SPACE LEADERSHIP ADV– SPACE KEY TO HEG EXTS

**CONTINUED US SPACE LEADERSHIP KEY TO OUR OVERALL LEADERSHIP – VITAL TO OUR NATIONAL INTEREST**

**Hall et al., 2008** (Thomas Young, IDA chairman; Edward Anderson, Lieutenant General; Lyle Bien, Vice Admiral; Ronald R. Fogleman, General; Keith Hall; Lester Lyles, General; Hans Mark, Doctor, “Leadership, Management, and Organization for National Security Space,” IDA Group Report, 7/12/11, <http://www.armyspace.army.mil/ASJ/Images/National_Security_Space_Study_Final_Sept_16.pdf>) Hou

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**US MUST CONTINUE TO EXPAND ITS INFLUENCE IN SPACE POLICY – RUSSIA AND CHINA LOOKING TO COUNTER-BALANCE**

**Hall et al., 2008** (Thomas Young, IDA chairman; Edward Anderson, Lieutenant General; Lyle Bien, Vice Admiral; Ronald R. Fogleman, General; Keith Hall; Lester Lyles, General; Hans Mark, Doctor, “Leadership, Management, and Organization for National Security Space,” IDA Group Report, 7/12/11, <http://www.armyspace.army.mil/ASJ/Images/National_Security_Space_Study_Final_Sept_16.pdf>) Hou

The United States must be prepared to face adversaries who have obtained the available advanced capabilities. Both the Chinese and the Russians have an interest in common— to eventually remove the United States from its current dominant military and economic position in the world. They will continue to develop capabilities to deter or deny the employment of U.S. space assets, and they may also use surrogates to accomplish this objective. Continued investments in technical capabilities to attack space systems, and the proliferation of associated technologies, signal the capability and intent to intimidate, deter, and perhaps attack space-based systems. Ultimately, the United States must be prepared to face challenges to our freedom of action in space, and perhaps actual conflict in space.

## MINING ADV – HYDROGEN MODULE

**ASTEROID MINING LEADS TO DEVELOPMENT OF PLATINUM, WHICH IS KEY TO A TRANSITION TO A HYDROGEN ECONOMY**

**Space Wealth 11** (William BC Crandall MBA FounderSpace Wealth Larry Gorman PhD Professor of Finance Cal PolySan Luis Obispo Peter Howard PhD Senior Scientist ExelixisInc‑ South San FranciscoCA Frans von der Dunk PhD Professor of Space Law University of Nebraska%Lincoln Martin Elvis PhD Senior AstrophysicistHarvard% Smithsonian Center for Astrophysics Dante Lauretta PhD DirectorSouthwest Meteorite Center University of ArizonaTucson Jordi Puig#Suari PhD Professor of Aerospace Engineering Cal PolySan Luis Obispo Hon Andrea Seastrand Executive Director California Space Authority Mark Sonter MAppSc Asteroid EnterprisesPty Ltd QueenslandAustralia, (Is profitable asteroid mining a pragmatic goal?”, Feb. 23, 2011, <http://spacewealth.org/files/Is-P@M-Pragmatic-2011-02-23.pdf>) rory

Some of these resources have outstanding value. Space agencies intent on addressing fundamental economic needs should focus on these materials. Platinum, for example, has sold at over $1,700/oz since January. 25 Platinum group metals (PGMs) are great catalysts. Used in automotive catalytic converters, which are required by national governments worldwide, 26 PGM supplies are quite limited. Some models point to terrestrial depletion within decades. 27 Platinum group metals are also critical as catalysts in hydrogen fuel cells, which are key to a possible postcarbon, “hydrogen economy.” 28 In 2008, The National Research Council identified PGMs as the “most critical” metals for U.S. industrial development. 29 Platinum group metals are abundant in certain types of near Earth asteroids (NEAs). NEAs that are mineralogically similar to one of the most common types of “observed fall” meteorites (Htype, ordinary chondrites) offer PGM concentrations (4.5 ppm) 30 that are comparable to those found in profitable terrestrial mines (36 ppm). 31 Other meteorites suggest that some asteroids may contain much more valuable metal. 32

**AND, A TRANSITION TO A HYDROGEN ECONOMY SOLVES FOREIGN OIL DEPENDENCE AND GLOBAL WARMING**

**Thomas 02** (C.E. Ph.D., president of H2Gen Innovations, “Hydrogen Fuel Cells: Pathway to a sustainable Energy Future”, white paper, 2/20/02, <http://www.fuelcelltoday.com/media/pdf/archive/Article_941_WhitepaperSustainableEnergy%20-%20Sandy%20Thomas.pdf>) rory

Humankind must eventually find alternatives to burning fossil fuels to power our modern society. Fossil fuels will never run out, but their total societal cost will continue to increase in the future due to some combination of environmental damage including climate change impacts, local air and water pollution, scarcity, increasing difficulty of extraction and processing, and military costs to protect our crude oil lifeline to unstable regions of the world. Fossil fuels will be the backbone of our energy system for at least several decades. But eventually society will have to move toward a sustainable energy system – an energy supply system that generates no pollution and consumes no non-renewable or exhaustible natural resources, at least during operation. While it may take many decades to transition to a predominately non-fossil fuel future, energy choices we make now can help implement or could impede progress toward society’s long-term goal of energy sustainability. Given the choice between two energy options today that have approximately equal security and environmental benefits, we should lean toward those options that facilitate a transition to a truly sustainable energy future. Only two energy systems meet this strict definition of sustainability: nuclear fusion and renewable hydrogen.

## MINING ADV – DETECTION LEADS TO MINING

**ASTEROID DEFLECTION LEADS TO ASTEROID MINING**

**MURRILL AND WHALEN 1998 [**Mary Beth and Mark – researchers at NASA, “JPL will establish Near-Earth Object Program Office for NASA,” July 24, <http://neo.jpl.nasa.gov/program/neo.html>] ttate

Yeomans noted that personnel within the program office will maintain an up-to-date database of near-Earth objects and "routinely propagate their motions forward for tens of years to see whether any of these objects will make interesting, close-Earth approaches." This activity is not only for hazard assessment, he said, but also to identify optimal opportunities for ground-and space-based observations of these objects and "to identify which bodies might be exploited for their mineral wealth in the next century. Asteroids offer extraordinary mineral resources for the structures required to colonize the inner solar system and comets, and with their vast supplies of water ice, could provide life-sustaining water as well as the liquid oxygen and hydrogen required for rocket fuel." "It seems ironic that the very objects that bear watching because they could threaten Earth are the same ones that are most easily accessible to future space missions - missions that might exploit their considerable resources," he said.

**A planetary defense system is key to asteroid mining**

**Ahern et al 96** (COL (Sel) John M. Urias (USA) Ms. Iole M. DeAngelis Maj Donald A. Ahern Maj Jack S. Caszatt Maj George W. Fenimore III Mr. Michael J. Wadzinski, United States Air Force, “Planetary Defense:

Catastrophic Health Insurance for Planet Earth”, presented to the United States Air Force, October 1996, <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf>) rory

It is conceivable that not only would the PDS serve as a defensive system for EMS protection, it also could be used to maneuver selected asteroids into stable earth orbits for various operations. A particularly interesting benefit involves mining asteroids for their rich deposits of metals and other valuable minerals. A thought brings into focus a space mining company making frequent trips into space to mine the asteroid that presented the original global threat. Further, controlled asteroids could be used as space bases or platforms60 for space stations or space colonies. Indeed, such possibilities would enhance the attractiveness of the PDS effort due to their economic potential.

## MINING ADV – HYDROGEN ECONOMY EXTS – ASTEROIDS HAVE PLATINUM

**Over 8,000 Asteroids with platinum – 100 meter diameter holds 40 tons of it**

**Blair, 00** (Brad R. Blair, Metal Economics, Colorado School of Mines, "The Role of Near-Earth Asteroids in Long-Term Platinum Supply," May 5, 2000, http://www.nss.org/settlement/asteroids/RoleOfNearEarthAsteroidsInLongTermPlatinumSupply.pdf, 7/19/11) Hou

**Given the estimated population density** of LL chondrite NEAs, **there are over 8000 candidate bodies** less than 100 meters **that are high enough in grade to host platinum production.** It is important to note that **a 100-meter sphere of rock weighs in at almost 1.4 million metric tons, and could contain over 40 tons of platinum** at grades measured in meteorite samples. Lewis (1996) estimates that the minimum size that could completely disintegrate during accidental Earth entry is 100 meters, providing an upper size limit for assurance against damage.

## MINING ADV – HYDROGEN ECONOMY EXTS – PLATINUM KEY

**Platinum is the only metal that works in hydrogen fuel cells, nothing even comes close in comparison- this is from the Department of Energy**

**Satyapal 2010** (Dr. Sunita, Program Manager US Department of Energy, Fuel Cell Technologies Program, “DOE Hydrogen and Fuel Cell Overview”, December 14, 2010, <http://www.cleanenergystates.org/assets/Uploads/WebinarforWebsite12142010.pdf>) rory

3M has developed technology that will reduce the amount of platinum necessary in a fuel cell system by using nano-catalyst particles that actually make surface atoms more efficient at producing energy. Platinum is needed in fuel cells because no other metals are even close to being as effective at speeding up chemical reactions to make power. 3M is among a handful of fuel cell system suppliers in the U.S., and these advancements will help the company produce a cost-effective product, enabling more purchasers to buy American made fuel cell systems that could end up in electric-drive vehicles.

**Platinum is a key catalyst, other alternatives are consumed or altered when catalyzing making them less efficient, and new platinum aerogels make platinum cost effective**

**Beiner 2009** (Juergen, Lawrence Livermore National Laboratory, experiments were conducted at Stanford University, “Improving Catalysis with a “Noble” Material”, May 2009, <https://str.llnl.gov/AprMay09/pdfs/05.09.04.pdf>) rory

Platinum is an effective catalyst because it can accelerate chemical reactions without being consumed or altered. As an example, catalytic converters on gas-powered vehicles use platinum to convert poisonous carbon monoxide into carbon dioxide through oxidation. In hydrogen fuel cells, platinum is used to catalyze the electrochemical reactions that produce electrical energy. For technologies such as these, more platinum means higher conversion rates. Unfortunately, platinum is expensive, making technologies that require large amounts of the material too costly for everyday applications. However, by incorporating platinum into carbon aerogels, scientists from the Laboratory, Stanford University, and the University of Bremen in Germany have shown that when it comes to platinum, less can do more.

**Platinum is the best catalyst for hydrogen fuel cells**

**Sandia Laboratories 09** (Sandia is a world leader in the technology required for development, fabrication, and production of microelectronic, photonic, micromachine and microsensor devices and products, “Platinum Nanostructures for Enhanced Catalysis”, Feb, 2009, http://www.sandia.gov/mission/ste/stories/2009/Shelnutt%20SM-2-09vF.pdf)

One of the promising renewable energy technologies today is the hydrogen-powered fuel cell. A key challenge for fuel cells in their ability to be a practical and cost-effective solution to meet energy needs is for more durable, efficient, and inexpensive electrocatalysts. Since it is well-known that platinum is the best substrate for catalytic reactivity, it is paramount that the rare and expensive material be used as sparingly and efficiently as possible. Sandia has developed an innovative approach for producing platinum catalysts at the nanoscale that offers much greater control over the shape, size, porosity, composition, stability, and other functional properties than those achieved by previous methodologies. Due to the high surface area and durability of the nanostructures, the process is expected to reduce platinum usage not only in fuel cells, but in other applications in the renewable energy sector as well.

**Platinum is key to fuel cells and new technology**

**Anglo Platinum 09** (worlds primary producer of platinum group metals, “Platinum: Aprecious metal for a precious planet” sustainable development report, 2009, <http://www.angloplatinum.com/pdf/2010/library/angloplatinum_sdr_2009.pdf>) rory

Platinum can help save the planet. Imagine if a metal was that useful. That precious. Platinum is used to break down the pollutants in detergents, creating cleaner air. It’s also used in catalytic converters, which reduce harmful emissions from automobiles. Platinum is key in new technologies. It’s an essential ingredient in lifesaving cancer treatments, and in pacemakers to keep hearts beating. Imagine the possibilities of Platinum - a metal of the future.

## MINING ADV – HYDROGEN ECONOMY EXTS – TRANSITION FEASIBLE

**A hydrogen fuel cell economy is feasible and clean**

Blauvelt, 07. (Euan is the Director of Research at ABS Energy Research. July 12, 2007, “The Hydrogen Economy.” <http://worldenergydiscussion.blogspot.com/2007/07/hydrogen-economy.html>, CALLAHAN)

The world currently exists in a carbon economy. 80% of the primary energy which drives the world is derived from hydrocarbon fossil fuels; oil 35%, coal 24% and natural gas 21% and 11% is contributed by renewables, almost all renewable biomass. In the last two centuries the volume of carbon consumption has increased exponentially with the world’s industrialisation. The carbon economy has given great economic benefits to mankind but it is subject to two limitations. Although new reserves of hydrocarbons and new technologies to exploit them are being discovered all the time, these resources are not limitless. Secondly, fossil fuels emit greenhouse gasses and other pollutants when they are burned and these emissions have reached dangerous proportions. Alternatives to the carbon economy are feasible although wide scale use is some years in the future. A hydrogen economy is one such option, in which the sustainable energy supply system of the future features electricity and hydrogen as the dominant energy carriers. Hydrogen will be produced from a diverse base of primary energy feedstocks, or from water using renewable electricity in the process. The use of hydrogen energy would reduce dependence on petroleum and the pollution and greenhouse gas emissions caused by carbons. The development of the hydrogen economy will advance on two fronts. The development of another technology, the fuel cell, is essential to the exploitation of hydrogen; the two are interlinked. It is important to understand that hydrogen is not a primary energy source like coal and gas; it is an energy carrier, like electricity. Hydrogen can be converted to energy via traditional combustion methods and through electrochemical processes in fuel cells. Initially it will be produced using existing energy systems based on different conventional primary energy sources and carriers. In the longer term renewable energy sources could become the most important source for the production of hydrogen. Fuel cells utilise the chemical energy of hydrogen to produce electricity and thermal energy. A fuel cell is a quiet, clean source of energy. Water is the only by-product it emits if it uses hydrogen directly. Fuel cells are similar to batteries in that they are composed of positive and negative electrodes with an electrolyte or membrane. The difference between fuel cells and batteries is that energy is not recharged and stored in fuel cells as it is in batteries. Fuel cells receive their energy from the hydrogen or similar fuel that is supplied to them. No charge is thereby necessary.

## MINING ADV – HYDROGEN ECONOMY EXTS – HYDROGEN ECONOMY GOOD

**Hydrogen energy is key to the environment, energy independence, and the economy**

FY, 03. (Progress Report based on President Bush’s 2003 State of the Union address. “Hydrogen, Fuel Cells, and Infrastructure Technologies.” <http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/benefits.pdf>, CALLAHAN)

The President's FreedomCAR and Hydrogen Fuel Initiative is designed to reverse America's growing dependence on foreign oil by developing the technology to enable production of hydrogen-powered fuel cell vehicles and fueling infrastructure to support them. This initiative was chosen not only because of the energy security benefits associated with a domestic fuel that can be produced from a wide range of feedstocks, but also because of the potential environmental benefits in both transportation and stationary markets. Energy Security America's transportation sector relies almost exclusively on refined petroleum products. More than one-half of the petroleum consumed in the United States is imported, and that percentage is expected to rise steadily for the foreseeable future. Even with the significant energy efficiency benefits that gasolineelectric hybrid vehicles and diesels can provide, we must ultimately find an alternative fuel that can be domestically produced. Hydrogen (along with biofuels) is a versatile energy carrier that is environmentally clean and could be produced in large quantities entirely from domestic sources. Traditional sources of energy - fossil fuels like natural gas and coal; renewable energy sources such as solar radiation, wind and biomass; and nuclear energy can all be used to produce hydrogen. Its use as a major energy carrier would provide the United States with a more diversified energy infrastructure. Environmental While addressing the energy security issue, we must also address our environmental viability. Air quality is a major national concern. It has been estimated that 60% of Americans live in areas where levels of one or more air pollutants are high enough to affect public health and/or the environment. Personal vehicles and electric power plants are significant contributors to the nation's air quality problems. Most states are now developing strategies for bringing their major metropolitan areas into compliance with the requirements of the Clean Air Act. Widespread use of fuel cell vehicles, because they are zeroemission vehicles and have no on-road emission deterioration, could have a measurable effect on reducing nitrogen oxides, volatile organic compounds, and particulate matter produced by light-duty vehicles. “Hydrogen fuel cells represent one of the most encouraging, innovative technologies of our era.... One of the greatest results of using hydrogen power, of course, will be energy independence for this nation... think about a legacy here at home, about making investments today that will make future citizens of our country less dependent on foreign sources of energy. And so that’s why I’m going to work with the Congress to move this nation forward on hydrogen fuel cell technologies. It is in our national interest that we do so.” President George W. Bush The National Building Museum February 6, 2003Hydrogen, Fuel Cells, and Infrastructure Technologies FY 2003 Progress Report 3 Emission of greenhouse gases, such as carbon dioxide and methane, has been cited as a major global concern. Build-up of these gases in the atmosphere is thought to have detrimental effects on the global climate. Although there is not yet agreement on what the exact impact will be, when it will be realized, or how best to address the issue, there is agreement that emissions of these gases needs to be reduced. Hydrogen offers a unique opportunity to address this problem, since carbon emissions can be decoupled from energy use and power generation. When used in a fuel cell, the only emission is water vapor. Efficient hydrogen production technologies and the possibility of carbon sequestration make natural gas and coal viable feedstock options, even in a carbon-constrained environment. In the case of renewable and nuclear options, greenhouse gases can virtually be eliminated. Economic Competitiveness Abundant, reliable, and affordable energy is an essential component in a healthy economy. When energy prices spike, as has occurred several times recently due to supply interruptions and/or high demand, Americans suffer, particularly those in lower-income brackets. Hydrogen offers unique opportunities to drastically increase the efficiency with which we generate and use energy. And because it can be produced from a wide variety of domestically-available resources, we can reduce the impact of externalities on energy prices. The technical and economic success of hydrogen-based distributed energy systems will stimulate new business ventures. Hydrogen power parks will provide an economic development path for the integrated production of energy services such as electricity, transportation fuels, and heating and cooling. This may lead to the creation of high-tech jobs to build and maintain these systems. Hydrogen also offers a wide variety of opportunities for the development of new centers of economic growth in both rural and urban areas that are currently too far off-line to attract investment in our centralized energy system. The success of current U.S. industry is also of vital importance to the well-being of our people and of the Nation as a whole. For example, the U.S. auto industry is the largest automotive industry in the world, producing 30% more vehicles than the second largest producer, Japan. For every worker directly employed by an auto manufacturer, there are nearly seven spin-off jobs. America's automakers are among the largest purchasers of aluminum, copper, iron, lead, plastics, rubber, textiles, vinyl, steel and computer chips. The auto industry is also a major exporter, accounting for 12% of all non-agricultural exports. Remaining competitive in the international market is essential to the U.S. economy.

## MINING ADV – ASTEROID MINING FEASIBLE

**Asteroid with large quantities of rare earth metals are common and easier to reach than the moon**

**Paine, 99** (Michael, writer for the Planetary Society, “Riches in the Rubble” Space.com, 5/11/99, <http://idisk.mac.com/mpaineau-Public/rocks_from_space/riches_in_rubble.pdf>) [JHegyi14]

An example of the possible riches amongst this rubble of the solar system is the asteroid Amun. The orbit of this mile-wide object comes close to the Earth's orbit and, over millions of years, it could be a threat to the Earth. Before then, however, it is likely that mankind will have visited the asteroid and mined it away to nothing, because research indicates Amun is made from that primordial stainless steel. Planetary Scientist John Lewis, from the University of Arizona, estimates that the iron, nickel and cobalt in this single asteroid is worth about $20,000 billion at market prices. Amun is unusually rich in metals and is typical of perhaps only 5 percent of asteroids. Most asteroids contain more rock than metal, but at least half of the material in these so-called stony asteroids could also be put to human use. Some half a million asteroids 100 yards across or larger orbit the Sun along paths that cross or come close to the orbit of the Earth. In principle, it is easier to reach about 100,000 of these "Near Earth Asteroids" and return a payload to the Earth than it is to return the same payload from the Moon.

**ASTEROID MINING FEASIBLE AND LUCRATIVE – MANY ASTEROIDS ARE EASIER TO ACCESS THAN OTHER SPACE RESOURCE HOUSES**

**Herold Sun, 2008,** (*Herold Sun*, Australian newspaper, “STRIKING IT RICH”, August 5, 2008, LexisNexis Academic) [Max Waxman]

ASTEROIDS near Earth pose both a threat and a promise. There is the danger an asteroid could collide with Earth, causing regional or even global disaster. But asteroids could also provide enough resources to support our long-term prosperity on Earth, and movement into space and the solar system. About 10 per cent of what are known as near-Earth asteroids (NEAs) are easier to get to than the Moon. Earth's first trillionaires might make their money by mining these thousands of asteroids for nickel-iron metal, silicate minerals, semi-conductor group metals, hydrocarbons and frozen water. Many asteroids contain valuable platinum group metals, with grades 10 to 20 times higher than that on Earth. The development of orbital hotels, solar-powered station satellites and zero-gravity manufacturing services will require masses of materials for construction, shielding and ballast. When purified and made available in low-Earth orbit, most materials from asteroids will be worth about $500,000 a tonne. Water is a potentially lucrative product from asteroid mines. It would supply drinking water for deep-space voyagers, and hydrogen and oxygen for rocket fuel for the return journey. These resources could conceivably support a quadrillion people.

**Asteroid mining tech viable**

**Conover 08** (Scott, Senior staff writer for dailybarometer.com “A different way to fix our economy” <http://www.dailybarometer.com/forum/a-different-way-to-fix-our-economy-1.2379192>) steven

In the future of economics, asteroid mining will be a staple of spatial living. Akin to any other form of mining or extraction, it will have the added benefit of being in null gravity of space. Yet, there are questions inherent to the process of extracting ore: how do you transport it to a mining facility, how do you refine it and how do you get it down to the deep blue planet, Earth? The problems of transportation and refining have relatively simple solutions. For long-term transportation in spatial environments, one needs only build a sturdy ship out of a small asteroid, and equip a nuclear fission power core in a shielded enclosure. Ion drives would serve as excellent propulsion, and chemical drives would only be used as an emergency precaution.  As for a facility, given a nuclear fission core and equipped ion drives, it is relatively simple to have two portions of a facility: first, an automated refining facility could be used to refine the actual ore, whether it be aluminum, gold, silver, platinum, etc. Second, for living quarters, a fission power core and ion drives could be equipped on an asteroid suitable for settling, and gravity established by exerting a spin on the asteroid, thus providing living quarters for miners, explorers, scientists and even family, lovers and loved ones.  For transportation to the deep blue planet Earth, it is relatively simple to enclose ore in ceramic containers (or similarly heat-resistant containers), and equip simple computer-controlled modules on the sides, top, and bottom of the container in order to control trajectory. From there, it is a simple task to drop the goods at a predetermined site, say in a desert or a dead lake. This is far easier than it sounds once you design the spatial goods and have them built. A gradually decaying orbit is not difficult to simulate for computers today, and it would be a relatively simple task to drop these valuable minerals down to Earth for use and consumption in the world at large.

## MINING ADV – MINING GOOD EXTS – SURVIVAL

**ASTEROID MINING KEY TO HUMAN SURVIVAL**

**HONAN 2011** [Daniel – managing editor @ *Big Think*, “The first trillionaires will make their fortunes in Space”, *Big Think*, May 05, <http://bigthink.com/ideas/38186>] ttate

Asteroids represent a dual threat and opportunity for humanity. In the starkest terms, an asteroid collision could lead to the extinction of the human race, as presented in this terrifying computer-simulated video. And yet, asteroids also represent an opportunity for the salvation of the human race. Asteroids contain a wide range of resources, including nickel-iron metal, silicate minerals, trapped or frozen gasses, and water, which could be utilized by a spacecraft's steam propulsion rocket for a return trip to Earth. Asteroids have also been thought of as a possible site for the colonization of space. After all, it was the impact of asteroids that transformed life on Earth and may have made human life possible in the first place. As Peter Diamandis has noted, there are many motivations for going to space. It was curiosity that drove NASA's budgets for fifty years. Another fundamental motivator to go to space is to back up the biosphere. Diamandis suggests that we "record all of the genomes on this planet, all the works of art, and back it up off earth." Twenty trillion dollars isn't bad motivation either, and the drive to create wealth from space may very well prove the key to human survival and our future prosperity.

## MINING ADV – MINING GOOD EXTS – ECONOMY

**ASTEROID MINING WOULD STRENGTHEN THE ECONOMY – GIVES US ACCESS TO EXTREMELY VALUABLE AND NECESSARY RESOURCES**

Hopkins et. al, 10 [ Josh, Adam Dissel, Mark Jones, James Russell, and Razvan Gaza - researchers at Lockheed Martin, “Plymouth Rock: An Early Human Mission to Near Earth Asteroids Using Orion Spacecraft,” June 2010, [http://www.lockheedmartin.com/data/assets/ssc/Orion/Toolkit/OrionAsteroidMissionWhitePaperAug2010.pdf][Max](http://www.lockheedmartin.com/data/assets/ssc/Orion/Toolkit/OrionAsteroidMissionWhitePaperAug2010.pdf%5d%5bMax) Waxman]

Some of these resources have *outstanding* value. Space agencies intent on addressingfundamental economic needs should focuson these materials. Platinum, for example,has sold at over $1,700/oz since January.25Platinum group metals (PGMs) are greatcatalysts. Used in automotive catalytic

converters, which are required by national governments worldwide,26 PGM supplies are quite limited. Some models point to **terrestrial depletion within decades.**27 Platinum group metals are also critical as catalysts in hydrogen fuel cells, which are key to a possible post-carbon, “hydrogen economy.”28 In 2008, The National Research Council identified PGMs as the “most critical” metals for U.S. industrial development.29 Platinum group metals are abundant in certain types of near-Earth asteroidds (NEAs). NEAs that are mineralogically similar to one of the most common types of “observed fall” meteorites (H-type, ordinary chondrites) offer PGM concentrations (4.5 ppm)30 that are comparable to those found in profitable terrestrial mines (3-6 ppm).31 Other meteorites suggest that some asteroids may contain much more valuable metal.32 The PGM value of a 200 m asteroid can exceed **$1 billion,** or possibly **$25 billion.**33 Over 7,500 NEAs have been detected.34 Close to a fifth of these are easier to reach than the moon; more than a fifth of those are ≥200 m in diameter: 200+ targets.35 President Obama requested, and Congress has authorized, a four-fold increase in detection funding ($5.8 m to $20.4 m/year).36 This could lead to ~10,000 known 200 m NEAs in a decade.37 But detection is just a start. The costs to locate, extract, and process asteroid ore are not well understood.38 Before significant private capital is put at risk, we need to learn more.

**EVEN ONE OF THE SMALLEST ASTEROIDS CAN YIELD THOUSANDS OF BILLIONS OF DOLLARS WORTH OF RESOURCES**

**Lewis 97** (John, professor of planetary sciences at University of Arizona’s lunar and Planetary laboratory, “Mining the Sky: Untold Riches from the Asteroids, Comets, and Planets”, Bart Leahy, 1997, <http://www.nss.org/resources/books/non_fiction/NF_011_miningthesky.html>) rory

As an example of the economic value of space resources, let's consider the smallest known M-type asteroid, the near-Earth asteroid known as 3554 Amun (two kilometers in diameter): The iron and nickel in Amun have a market value of about $8,000 billion, the cobalt content adds another $6,000 billion, and the platinum-group metals add another $6,000 billion.

**ASTEROID MINING HAS TRILLIONS OF DOLLARS OF UNTAPPED POTENTIAL**

**Globus 11** (Al - senior computer scientist with Computer Sciences Corporation @ NASA Ames Research Center, “Why Build Orbital Space Colonies”, last modified July 12, 2011, <http://webcache.googleusercontent.com/search?q=cache:2iqBa43vOjUJ:space.alglobus.net/Basics/> why.html+asteroid+detection+will+allow+colonies&cd=12&hl=en&ct=clnk&gl=us&source=www.google.com) rory

As we've mentioned before, John Lewis [Lewis 1996a, page 112] estimates that the current market value of the metals in one, small two-kilometer diameter (a bit over a mile), near-Earth asteroid called 3554 Amun is about $20 trillion (that's with a 'tr'!). 3554 Amun is about the size of a typical open-pit mine on Earth, with a mass of roughly thirty billion tons. The nickel and iron in Amun are worth something like $8 trillion, the platinum-group metals perhaps $6 trillion, and the cobalt maybe another $6 trillion. 3554 Amun is pretty easy to get to and it's only one of several hundred asteroids that cross Earth's orbit. Space colonization is going to make a lot of people absolutely filthy rich. And not just in mining. Consider the 300 square miles of real estate we can make from a 1km diameter asteroid. That's a lot of land. We can easily house 160,000 people per asteroid. Assuming a low $100,000 per home and families of four, we are looking at $4 billion dollars worth of residential real estate alone. That doesn't count commercial, industrial, and agricultural land values. If all 1000 or so near-Earth asteroids in this size range were developed, the residential real estate would be worth perhaps $4 trillion. However, these are just theoretical arguments. The numbers could be off (although probably low). What does history tell us? Ferdinand and Isabella are quite likely the only Spanish king and queen most people have ever heard of. Is this because of their domestic policies? Was it because they pushed the Muslims out of the Iberian Peninsula? No. It's because they invested in Christopher Columbus and his obviously insane scheme to go west to India; at a time when everyone knew that India lay to the East. At the time, Spain was not a particularly dominant power. But Spain was able to steal vast amounts of gold from the 'new' world 'discovered' by Columbus and other Spanish expeditions (the 'new' world was actually quite well known to the local inhabitants). This wealth made Spain the premier power in Europe for centuries. The wealth that comes from growth flows to societies not just to individuals. I don't mean to pick on Spain. Many European powers of the time were involved in a bloody worldwide expansion. Empires throughout history have murdered and pillaged their way to great wealth. Spain is, however, an unusually clear example of discovery and colonization leading to great wealth, even if that wealth was derived from American gold obtained by pretty ugly means. However, there are two ways to gain wealth: by stealing or producing. Spain's was a combination, after all the Spanish did produce a very capable fleet even if they stole the gold. Fortunately, space colonization does not require theft in any form. Orbital space colonization can generate wealth and power almost purely by production. Production of, at least, metals, real estate, energy and knowledge.

## MINING ADV – MINING GOOD EXTS – ECONOMY

**MINING OF NEAR-EARTH ASTEROIDS WOULD YIELD BILLIONS OF DOLLARS IN PROFIT FROM RARE MINERALS**

**Conover 08** (Scott, Senior staff writer for dailybarometer.com “A different way to fix our economy” http://www.dailybarometer.com/forum/a-different-way-to-fix-our-economy-1.2379192)

Many asteroids in space contain heavy metals. 16 Psyche, for instance, contains an immense amount of nickel iron ore. But this concept of heavy metal also applies to near-earth asteroids. For example, 433 Eros is the first near-earth asteroid to be discovered. This asteroid, after being mapped and examined remotely, was found to likely contain at least 3% heavy metals in its 3,466 cubic mile frame. According to the BBC, "a very cautious estimate suggests 20,000 million tonnes of aluminium along with similar amounts of gold, platinum and other rarer metals." Assuming a price of $1,000 for a troy ounce of gold, this means that a tonne of gold would be worth around $36 million. Given this much money for a tonne of ore, this would mean that 433 Eros is worth 720 billion dollars in gold alone. This does not include the other metals that may lie on the surface or be hidden in the depths of 433 Eros. The fact of the matter is that asteroid mining is well worth the cost and effort. In 2008, the NASA budget was 17.3 billion dollars. Given a higher budget, or just the greater efficiency of private industry, the mining of 433 Eros and the many other near-earth asteroids would not only enrich the miners and extractors, but the entire world. Imagine computers wired entirely with gold. Imagine catalytic converters being far cheaper in cars due to the low cost of platinum. Should we, as individuals and as nations, reach for the stars? We can have it all in our grasp, If only we would just try!

NEO’s are enormously profitable – precious metals and resources

Lewis, ’96 (John S. Lewis is a professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, “Rain of Iron and Ice,” Chapter 15, 7/14/11, Northwestern Library) Hou

But there is another way of looking at near-Earth bodies: a large proportion of the most threatening objects are also the most accessible bodies in the solar system for spacecraft missions from Earth. Our emphasis in this book has been on the stick rather than the carrot, but the other side of the story s equally compelling. Researchat the University Of Arizona Space Engineering Research Center, building upon the Spacewatch discoveries, the spectroscopic studies of NEAs by Larry Lebofsky and his coworkers, and on round-trip logistic calculation, strongly suggests that these bodies are the most promising sources of raw materials for a wide range of future space activities. They may provide the propellants for future interplanetary expeditions, the metals for construction of solar power satellites to meet Earth’s energy needs in the third millennium, the life-support materials and radiation shielding to protect space colonies, and the precious and strategic metals needed by Earth’s industries. The smallest known metallic (M-type) asteroid, 3554 Amun, is a NEA with a radius of 500 meters. It contains over $1,000 billion worth of cobalt**, $**1,000 billion worth ofnickel**,** $800 billion worth of iron, and $700 billion worth of platinum metals. The total value of this single small asteroid is approximately equal to the entire national debt of the United States.By comparison, the uncontrolled impact of Amun with Earth would deliver a devastating 7-million-megaton blow to the biosphere, killing billions and doing hundreds of trillions of dollars worth of damage. Thus we come to our final, and most startling, discovery: The stick that threatens the Earth is also a carrot. Every negative incentive we have to master the impact hazard has a corresponding positive incentive to reap the bounty of mineral wealth in the would-be impactors by crushing them and brining them back in tiny, safe packages, a few hundred metric tons at a time, for use both in space and on Earth. Dealing with near-Earth objects should not be viewed grudgingly as a necessary expense: it is an enormously profitable investment in a limitless future; liberation from resource shortages and limits to growth; an open door into the solar system-and beyond.

Why study NEOs at all**?** Dan Durda, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, and a proponent of human missions to asteroids, provided a rationale that can be summed up in three words: fear, greed, curiosity.Fear comes from the fact that NEOs have, and will continue to, collide with the Earth. Right now the emphasis is on simply finding NEOs and determining which ones could pose a risk to the Earth in the future. If any do pose a major hazard, then attention will have to turn to mitigating that threat, most likely by deflecting the object’s orbit. That will require significant knowledge of the asteroid and how to operate on it: detonating nuclear weapons, a popular proposal for deflecting asteroids, might instead simply break apart an object that is a loosely-bound rubble pile. “I don’t want to invoke Chicken Little,” said Durda in a recent interview, “but it is a real threat**.”** Curiosity comes from the scientific study of NEOs, including work that can only be done on the asteroid itself, preferably by people. Studying these objects, said Durda, offers a window into the origins of the solar system, since these objects are virtually unaltered since the formation of the solar system. Greed is linked to the wealth of resources, from water ice and other volatiles to platinum-group metals, found on asteroids. Scientists and science-fiction authors have long talked about mining asteroids: while there’s no need for these resources on Earth for the indefinite future, such spacebased resources may be useful, if not vital, to any long-term settlement in space. Durda notes that NEOs, the most easily accessible asteroids, are hundreds of times richer in unprocessed materials than the Moon. “They’re literally gold mines in the sky**,”** he said. By contrast, the lunar regolith “has a composition similar to mining slag.”

## MINING ADV – MINING GOOD EXTS – HYRODEN ECONOMY EXTS

A**STEROIDS HAVE A LOT OF PLATINUM METAL GROUPS**

**Sonter 6** (Mark, Editor ad astra online, Asteroid Mining:  
Key to the Space Economy [http://www.nss.org/settlement/asteroids/key.html 2/06](http://www.nss.org/settlement/asteroids/key.html%202/06)) steven

Development and operation of future in-orbit infrastructure (for example, orbital hotels, satellite solar power stations, earth-moon transport node satellites, zero-g manufacturing facilities) will require large masses of materials for construction, shielding, and ballast; and also large quantities of propellant for station-keeping and orbit-change maneuvers, and for fuelling craft departing for lunar or interplanetary destinations. Spectroscopic studies suggest, and ‘ground-truth' chemical assays of meteorites confirm, that a wide range of resources are present in asteroids and comets, including nickel-iron metal, silicate minerals, semiconductor and platinum group metals, water, bituminous hydrocarbons, and trapped or frozen gases including carbon dioxide and ammonia. As one startling pointer to the unexpected riches in asteroids, many stony and stony-iron meteorites contain Platinum Group Metals at grades of up to 100 ppm (or 100 grams per ton). Operating open pit platinum and gold mines in South Africa and elsewhere mine ores of grade 5 to 10 ppm, so grades of 10 to 20 times higher would be regarded as spectacular if available in quantity, on Earth.

**Hydrogen is the only feasible long term renewable energy source**

**Thomas 02** (C.E. Ph.D., president of H2Gen Innovations, “Hydrogen Fuel Cells: Pathway to a sustainable Energy Future”, white paper, 2/20/02, <http://www.fuelcelltoday.com/media/pdf/archive/Article_941_WhitepaperSustainableEnergy%20-%20Sandy%20Thomas.pdf>) rory

This leaves renewable hydrogen as the only long-term sustainable energy option that is technically feasible today. In a renewable hydrogen system, all energy would come from either wind, solar, hydroelectric, biomass or municipal solid waste. With the exception of hydroelectric and more recently wind power, renewable energy is too costly today to compete with cheap fossil fuels, at least if total societal environmental, health and national security costs are excluded from the calculation of fossil energy price. In this future sustainable energy system, renewable electricity would be consumed via the power grid (if available) whenever possible. However, renewable electricity has two deficiencies: it cannot be economically stored, and- barring any breakthrough in battery technology – electricity cannot be effectively used in the transportation sector 3 that currently accounts for almost 71% of al crude oil products consumed in the US. As intermittent renewables reached 20% to 25% of grid penetration in any region, then some type of storage would be required to save solar energy for later use when the sun was not shining or the wind was not blowing. Hydrogen solves both problems as an energy carrier. Hydrogen gas can be stored indefinitely, and hydrogen can be used to provide power for virtually all transportation applications. A hydrogenpowered fuel cell 5-passenger vehicle has been designed (but not built – See Figure 1) that would have the full 380-mile range required under the PNGV program with passenger and trunk volumes and accelerations equal to those of conventional gasoline cars. In a renewable hydrogen future, then, hydrogen would complement electricity as a zero-emission energy carrier. The transportation sector would be powered almost exclusively by hydrogen, and hydrogen would also be used as a load-leveling energy storage system as needed for the electrical power grid.

**Switching to a hydrogen society cuts ties to foreign oil- key for national security**

**Thomas 02** (C.E. Ph.D., president of H2Gen Innovations, “Hydrogen Fuel Cells: Pathway to a sustainable Energy Future”, white paper, 2/20/02, <http://www.fuelcelltoday.com/media/pdf/archive/Article_941_WhitepaperSustainableEnergy%20-%20Sandy%20Thomas.pdf>) rory

The security and well being of the United States as we know it depends to a large degree on the continued functioning of our energy system. That security is threatened in part by our dependence on imported crude oil and could be in jeopardy in the future due to our reliance on a centralized electricity supply system with vulnerable transmission and distribution links. 2.1. Imported Oil The transportation sector depends almost exclusively on gasoline and diesel fuel extracted from crude oil 4 , more than half of which is imported to the US. Increasing the fuel economy of existing vehicles could reduce this dependence on imported oil, or it could be eliminated by switching to fuels derived from domestic natural gas or from renewable energy. However, over the last decade, automakers have chosen to increase the acceleration and power of passenger vehicles instead of increasing fuel economy, and attempts to convert to alternatively fueled vehicles have been marginal at best. The EPA reports that the average light duty vehicle fuel economy of 20.4 mpg (24.2 for cars and 17.3 for light trucks, including 22% SUVs) is now at its lowest point since 1980. At the same time that fuel economy has stagnated and slightly declined, average vehicle weight is up approximately10%, top speed is up 12%, and vehicle power is up 50% since 1980 5 . Technology such as hybrid electric vehicles (HEVs) 6 or fuel cell vehicles (FCVs) could improve fuel economy by 50% to 250% over existing gasoline internal combustion engine vehicles (ICEV). However, the EIA projects that fuel economy of the light duty fleet will increase only slightly over the next twenty years, from 19.8 mpg in 2000 to 21.0 mpg in 2020 7 . At the same time vehicle miles traveled are projected to increase from 2.3 billion miles to 3.6 billion miles, an increase of 57%. As a result, the EIA predicts that energy consumption in the transportation sector will increase by 44%, from 27.3 quads in 2000 to 39.4 quads in 2020. If all of this energy were still derived from crude oil in 2020, our dependence on foreign oil would continue to grow, decreasing our security and further imperiling our environment over time. The best interim approach to reducing our dependence on imported oil would be to convert to a fleet of direct hydrogen FCVs powered by hydrogen derived from natural gas. This option totally cuts our ties to crude oil. Hydrogen would come primarily from natural gas produced in North America. Initially some FCVs might be powered by hydrogen produced by electrolysis of water, using grid electricity as the primary source of power 8 . This electrolytic hydrogen would also be nearly free of any connection to imported oil 9 .

## MINING ADV – MINING GOOD EXTS – SPACE EXPLORATION

**ASTEROID MINING KEY TO FURTHER SPACE TRAVEL AND EXPLORATION – PROVIDES NECESSARY RESOURCES**

**Herald Sun, 2008,** (*Herold Sun*, Australian newspaper, “STRIKING IT RICH”, August 5, 2008, LexisNexis Academic) [Max Waxman]

ASTEROIDS near Earth pose both a threat and a promise. There is the danger an asteroid could collide with Earth, causing regional or even global disaster. But asteroids could also provide enough resources to support our long-term prosperity on Earth, and movement into space and the solar system. About 10 per cent of what are known as near-Earth asteroids (NEAs) are easier to get to than the Moon. Earth's first trillionaires might make their money by mining these thousands of asteroids for nickel-iron metal, silicate minerals, semi-conductor group metals, hydrocarbons and frozen water. Many asteroids contain valuable platinum group metals, with grades 10 to 20 times higher than that on Earth. The development of orbital hotels, solar-powered station satellites and zero-gravity manufacturing services will require masses of materials for construction, shielding and ballast. When purified and made available in low-Earth orbit, most materials from asteroids will be worth about $500,000 a tonne. Water is a potentially lucrative product from asteroid mines. It would supply drinking water for deep-space voyagers, and hydrogen and oxygen for rocket fuel for the return journey. These resources could conceivably support a quadrillion people.

**ASTEROID MINING BENEFICIAL – GIVES US INFORMATION ABOUT THE EVOLUTION OF THE SOLAR SYSTEM**

**Space Wealth, 11** [ Space Wealth is dedicated to the proposition that profitable asteroid mining (P@M) is a pragmatic goal. The organization works to bring asteroid researchers, data, and publications together, in order to promote extraterrestrial resource development, Directed by: William BC Crandall, MBA ,Founder, Larry Gorman PhD Professor of Finance  Cal Poly, Peter Howard, PhD, Senior Scientist Exelixis Inc‑, “Is Asteroid Mining A Pragmatic Goal?”, 2-23-11, <http://spacewealth.org/files/Is-P@M-Pragmatic-2011-02-23.pdf>] [Max Waxman]

 We have concluded that the dual-Orion configuration can probably support deep space mission durations of five to six months. Longer missions are constrained by radiation exposure, volumetric packaging limits for life support consumables, and the small habitable volume available. There are at least three opportunities between 2015 and 2030 when such a mission could be performed. These occur in 2019-2020, 2028, and 2029. All of the asteroids in question are small, between 5 m and 50 m in diameter. The number of opportunities is increasing as more asteroids are discovered. A dual-Orion configuration probably represents the minimum capability necessary to perform an asteroid mission. Several additional mission opportunities to larger asteroids would be feasible for an upgraded spacecraft with a larger propulsion system. Desire for enhanced capabilities, such as a larger crew size and improved extravehicular activity (EVA) support may drive the need for a larger spacecraft. One of the two Orion spacecraft could be modified into an Orion Deep Space Vehicle with a larger habitat module suited for deep space operations rather than reentry. By sending astronauts to explore these asteroids and bring back samples for study on Earth, we can learn about the formation and evolution of our solar system. We can improve our understanding of the threat to our planet from asteroid impacts, develop the practical knowledge needed to protect ourselves if necessary and even test this capability. We could also assess the feasibility of harnessing asteroid resources for a growing human civilization. If performed prior to the next lunar landing, a mission like Plymouth Rock can support lunar exploration plans by proving out the launch vehicles, spacecraft, and many of the operations for a lunar mission before the lunar lander is ready, much as the Apollo 8 mission did in 1968. A mission to an asteroid would also be valuable practice for a trip to Mars. Progressively more challenging asteroid missions provide an opportunity to incrementally develop expertise needed for long missions in deep space, without the leap in cost, complexity, duration, distance, and radiation exposure required for a Mars mission.

## INTERNATIONAL LAW ADV – PLAN ADHERES TO I-LAW

Failing to act to prevent destruction of societies from asteroid collision violates international law – obligation to preserve global welfare

Seamone 03 (Evan R., J.D., University of Iowa College of Law; M.P.P. and B.A., University of California, Los Angeles. Evan Seamone is an attorney and a Judge Advocate in the U.S. Army stationed at Fort Polk, Louisiana, “The Duty to ‘Expect the Unexpected’: Mitigating Extreme Natural Threats to the Global Commons Such as Asteroid and Comet Impacts with the Earth,” Columbia Journal of Transnational Law, 2003, Lexis [Iuliano]

Legal approaches applicable to extreme natural disasters, such as a natural impact, a plague similar to the Black Plague, or the projected collapse of the Cumbre Vieja Volcano into the ocean, exist on a continuum. n24 On one end of the spectrum, nations might proceed from principles of blame and culpability. This has been the position [\*743] of nations on the issue of space debris. n25 Yet, legal standards on even that issue have been difficult to achieve because it is almost impossible to prove that a nation caused harm. n26 When the threat is not man-made, as is the case for unforeseen natural harms, principles of blame remain largely inoperative until the harm has already occurred, in which case, it may be too late to apply such principles. Therefore, nations must reject the principle of blame as a legal framework for mitigating crises like natural impact. n27 At the other end of the spectrum are notions of charity and "good will." Currently, in dealing with natural disasters of a smaller magnitude, nations operate from these principles. Even in routine cases, this framework creates problems, indicating that governments must also disregard charity as a viable principle, especially when addressing a larger threat. n28 Numerous agencies and organizations respond on the basis of charity, each with different and incompatible views that may exacerbate the harm suffered by victims of disaster. n29 For these reasons, it will be harmful for policymakers to assume that nongovernmental organizations and various arms of the U.N. will successfully respond to the harms posed by an unexpected and extreme natural disaster. n30 The optimal approach to the mitigation of sudden and widespread natural harm rests somewhere near the center of the continuum where well-settled principles of self-preservation lie. These principles recognize that governments cease to exist without citizens whose welfare is preserved. Because such notions are so fundamental, formal sources of international law and domestic obligations require intergovernmental cooperation for the purpose of [\*744] self-preservation. One very significant obstacle to the attainment of effective mitigation of natural harm at the international level is the notion that treaty law is the only source of governmental obligations. n31 Many of the principles that are applicable to extreme natural disasters are binding, even though they do not exist in any treaty. According to the Statute of the International Court of Justice, international tribunals, and national courts interpreting international law, there are multiple "sources of international law" based on the practices of nations over time and other norms that impose requirements on the joint action of nations. n32 One source of law that applies to a threat like natural impact is "customary international law." n33 The duty to warn another nation of a known danger arguably falls within this category. n34 This duty exists where nations have met two specific requirements for a customary obligation - they have: (1) repeatedly engaged in this practice when dealing with each other over time; and (2) demonstrated their interest in being bound by the duty. n35 Therefore, under customary international law, as applied to natural impact, once a nation is aware of an existing threat, its government has a duty to notify any nation likely to be harmed. n36 Another applicable source of law is the obligation to act in "good faith" when reaching international agreements. This broader duty is considered a "general principle of international law." n37 Different requirements pertain to general principles. These notions help to fill gaps that would otherwise leave international courts [\*745] without a basis to settle a dispute. n38 Applied to natural impact, certain duties to cooperate in detecting the particular threat, or in rendering aid to those harmed by a comet or asteroid, would arise under general principles, rather than customary obligations because nations have not acted in the same manner previously. Aside from obligations arising from the established practice of nations, there are also preemptory norms (jus cogens) - legal concepts which prohibit nations from engaging in specified behaviors. Genocide and the killing of prisoners of war are two noted examples. n39 These norms often overlap with the obligations of nations to the international community as a whole (obligations erga omnes). n40 Applied to natural impact, just as it may be a violation to willingly destroy an entire society, it may likewise be a violation to fail to act to prevent similar amounts of devastation resulting from an asteroid or comet collision**.**

## COLONIZATION ADV – PLAN LEADS TO SPACE COLONIZATION

**PLAN LEADS TO SPACE COLONIZATION**

**CAMBIER AND MEAD 2007** [Dr. Jean-Luc and Dr. Frank – researchers @ Air Force Research Laboratory, “On NEO threat mitigation”, October, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA474424&Location=U2&doc=GetTRDoc.pdf>] ttate

We have alluded in the previous sections that considerable leverage could be obtained for the NEO mitigation mission if a significant “space infrastructure” exists. What do we mean by this? There are several key technologies and capabilities that can be brought to bear in NEO mitigation: – Heavy-launch capability: this obviously facilitates the deployment of the vehicles and payloads for NEO characterization and mitigation missions, but also the deployment of space telescopes (visible and IR) and space-based radar arrays. This launch capability must be highly reliable, especially for mitigation. In the worst-case scenario of a comet-like impact with limited advance warning, it is critical to launch as rapidly as possible with extremely low risk of failure. The same heavy launch capability can be used for NASA missions to the moon, development of space tourism and other commercial activities, and advanced DOD missions (force projection, SBR, space-based missile defense). – Space nuclear power: multi-MW electrical power from nuclear fission reactors will play a key role in the deployment of large platforms for Planetary Defense as well as exploration, commercial and defense missions. For example, nuclear reactors can power high-performance OTVs, provide beam power for high-altitude DOD missions, SBR and missile defense operations. Within this category one could eventually include fusion power in the far future. – Large Structure assembly: such platforms can be used for phased-array radar, solar concentrators, and large radiators for very high power (100 MW-class) platforms. Such large structures could also play a dual role; for example, a very large array at L1 could be a phased-array radar, and very large solar power station for large-scale commercial power to be beamed to Earth, and a screen that reduces the solar flux to the Earth and reduce the effects of global warming. Such concepts are viable only if both transport (see the two previous items) and assembly can be performed reliably and at low cost. The development of robotic technology, self-assembling smart structures, redundant and self-repairing systems for long-term presence in the space environment, is an absolute requirement for this capability. The items listed above describe the leverage of a long-term, systematic space exploration and utilization program which can have in facilitating Planetary Defense. Conversely, a long-term Planetary Defense program yields benefits towards a space utilization program: – Asteroid mining: the same technology that may be required to drill into the core of an asteroid to plant a nuclear device would be an essential first step to mining the same object for essential elements and building blocks for space colonization. The capture and processing of the mined materials is an advanced technology that will also require full automation and large amounts of power. – Asteroid capture: deflecting the asteroid may lead to modifying its orbit to bring it into an Earth-centered or moon-centered orbit to bring raw materials closer for use, or as the anchor mass for space elevator concepts. This may be, however, a difficult mission to perform, and one that is likely to bring trepidations, since errors in trajectory modification may precisely bring about the danger that a Planetary Defense program intends to eliminate. This mission may be more acceptable once deflection missions have been repeatedly demonstrated. – Terra-forming: if comet-like objects or ice satellites from the rings of the gas giants could also be deflected and made to impact at precise locations (e.g. Mars), water ice could be brought to initiate terra-forming. Although these applications may seem far-fetched to some, they are within the realm of possibilities, albeit very long-term. Yet the Planetary Defense and the new NASA “Return to the Moon” programs are essential first steps in that direction. The “space infrastructure” is similar in some respects to the infra-structure developed by the U.S. government that facilitates commercial and national security operations, e.g. road and rail network, shipyards and harbors, airports, communication networks, etc. In space there are no roads, but a space transport and a space power network can play a similar role, using low-cost and/or re-usable access to space, long-duration OTVs, power generation/collection station and beaming, radar and optical/IR tracking stations, and refuel/repair robotic stations. This type of evolved infrastructure goes well beyond exploration missions but is truly a first step towards space utilization and exploitation of natural resources (e.g. [11]). Commercial presence in space is in its infancy and can progress only as far as the infrastructure allows it. In these early days of space utilization, national security, planetary defense and protection of commercial interests still play the most important roles. Therefore, it is logical that the DOD be a key player in the development of this infrastructure, at least in the early stages. Within this long-term context, there are a number of key components of a space infra-structure which must be developed, and for which the DOD is particularly suited in taking a leading role, at least initially, due to National Security needs. These are the following – Component #1: Low-cost, reliable launch. The exploration missions typically conducted by NASA are not sufficiently frequent to drive significant reductions in launch costs, and commercial activities have not yet reached a critical mass to become an economical driving force. However, DOD missions can be the dominant factor. For example, rapid reconstitution of US space assets after a surprise attack would require a high-frequency (“surge”) of launches into LEO and GEO. This requires operational procedures such as rapid launcher assembly, payload matching, and automatic launch and trajectory control. If highly reliable launchers already existed, with highly modular design (multiple booster configurations easily strapped-on for variable payload/orbit requirements), robotic assembly and large-scale routine manufacturing of the launcher components, the problem of rapid reconstitution would be much easier. Clearly this goes beyond the pace and approach of NASA operations. The detailed technology does not need to be specified yet, since competing approaches may be useful, i.e. from vertical launches with no re-usable components to a fully re-usable horizontal launch vehicle. The latter could also be leveraged from technology developed for hypersonic, long-range airplanes, even up to their use as a 1st-stage. By focusing on increased reliability and reduced cost, the DOD would satisfy key requirements for Planetary Defense and greatly stimulate commercial space development (including reducing insurance costs). The issue of heavy payload capability must be addressed immediately for Planetary Defense; thus, it may be that while NASA develops the ARES-V launcher, the DOD could focus on improving the design to increase modularity, automate operations, and increase component reliability. Whether this approach, or continued and parallel development of the Delta-class of launchers, or yet another approach is chosen depends on their respective merits within the framework of a long-term plan; such comparative studies and planning shoud be done with all urgency. – Component #2: Long-duration high-power OTV. These vehicles would be powered by nuclear reactors and have advanced propulsion systems capable of both high thrust and high specific impulse; they would fill the requirements of the first two rows of Table 4 shown in the previous section. As such, they would be essential components of the Planetary Defense campaign, allowing not only the “slow-push” of a large number of possible NEO threats, but also the launching of multiple characterization missions towards their targets in deep space. Such routine operations by high-performance OTVs would also have major implications for National Security, since these “space-tugs” could routinely pick-up satellites from LEO after launch (see component #1) and place them in the proper orbits, or bring back valuable assets for repair/enhancements (see component #4 below). They could also be used to push a large number of picosats for observation and monitoring of other assets, or for self-assembly into large structures (see component #5). Finally, such OTVs would greatly facilitate the current NASA mission for permanent occupation of the Moon and commercial activities in space (asteroid mining, space tourism, power generation stations). The development of this component requires nuclear space power technology, as the power requirements and the spacecraft trajectories preclude solar power. Nuclear space power has been developed through several decades, and operationally demonstrated by the former Soviet Union. A joint DOE/DOD/NASA multi-disciplinary effort can yield a new class of reactor designs with higher performance, longer operational lifetime and very high safety requirements, using the most advanced technologies available (e.g. novel materials from nano-technology). – Component #3: Power generation/beaming. These platforms play multiple key roles, collecting solar power and concentrating it to ablate material from an asteroid for a slow-push, or converting it into electricity and beam it to Earth, to vehicles in transit or space settlements. The deployment of very large-scale solar power stations could then have the benefit of commercial electricity generation (beaming power to Earth), while enabling space transport and Planetary Defense, and could possibly be used as a sun-shield to reduce the impact of global warming. The nuclear reactors of the OTVs (component #2) can also serve a dual-purpose and beam the electrical power to other satellites or vehicles. Of particular interest would be very high-altitude hypersonic vehicles (recon or bombing missions) using air-breathing electric propulsion systems, powered by the microwave beam from an OTV’s nuclear reactor in a high-altitude, nuclear-safe orbit. This would allow such vehicles to fly with unlimited range and loiter indefinitely, as well as having enough power for directed energy weapons, without having to place a nuclear reactor within the vehicle itself – a concept that is surely bound to raise objections. The beamed power can also be used to power that vehicle for orbit insertion, thus also playing a key role in routine, low-cost access to space (component #1). For Planetary Defense, the ability to generate highly-directional microwave beams for power transmission is immediately related to space-based radar and asteroid tracking at long distances. Thus, the same basic technology can be used for deep-space tracking and power beaming to DOD vehicles. One may also consider “relay-stations” over a deep-space network to extend the range and accuracy of the tracking. A similar network in the Earth vicinity would increase redundancy and coverage of the DOD hypersonic vehicles or launchers mentioned above. The same approach could also be used, for example, to beam power from a very large solar collector at L1 towards Earth to provide pollution-free commercial power. – Component #4: Robotic/AI operations. Automatic refueling of satellites and OTVs is another key step towards the space infrastructure development, and preliminary efforts in that direction have been under-way (DARPA). With appropriate system design, robotic mechanisms and AI software, there would be no need for manned operation (i.e. no “station attendant”). Combined with the low-cost launch of supplies from Earth (component #1), the on-orbit refueling stations are an important early step towards infrastructure development. Eventually, the same procedure could be applied in reverse, i.e. receiving raw materials from asteroid or Moon mining operations and transferring them into a vehicle bound back to the Earth surface. Repairing and re-furbishing satellites and transport vehicles would be the next step; new system components (e.g. optics, solar cells, batteries, and antenna), shielding, or nuclear fuel for space reactors could be inserted at the station. Although these procedures appear complex enough to necessitate human control, it is not unconceivable that specialized robots and advanced AI could lead to completely un-manned operations. Such operations would of course have an impact on DOD missions as well as civilian or international exploration missions. The use of an international space station to perform such operations for U.S. military systems would be very problematic; thus, it would be highly advisable to develop the necessary robotic and AI technology to perform these operations in a smaller station, and in a much more cost-effective manner. The same technology can of course be applied to commercial space operations, permanent space settlements and space resource exploitation (component #5). Robotic technology is also needed to drill and bury nuclear devices in the NEO and perform assembly functions of any other concept for mitigation (laser, sail, concentrator, etc.). – Component #5: Large-scale assembly/manufacturing. Some of the concepts for Planetary Defense and space utilization inevitably imply the deployment of very large structures in space. These are, for example, phased-array radars, very high-power solar collectors, highly directional arrays for power beaming and receiving/relay stations. These can be constructed from pre-manufactured modular components launched from Earth and transported to the desired location. These structures have a relatively simple pattern and can be assembled through simple rules, adequate for early phases of robotic and AI technology (component #4). Early phases of large-structure deployment, with implications for DOD missions, also include tethers, “nets” and membranes. These can be used for grappling satellites, protection against ASATs, very large optics for telescopes, space radiators, momentum-exchange boosters (using for example a small captured NEO for anchor), “bags” for raw materials, etc. Other large-scale structures, at increasing levels of complexity include space and lunar settlements (“habitats”) and asteroid mining and material processing (“factories”). This is the last critical step for space colonization.

## COLONIZATION ADV – PLAN LEADS TO SPACE COLONIZATION

**NEO DETECTION TECHNOLOGY COULD SPRINGBOARD SPACE COLONIZATION EFFORTS**

LU 2004[Dr. Ed – President of the B612 Foundation, “Near-Earth Objects”, Testimony before the Committee on Senate Commerce, Science and Transportation – Subcommittee on Science, Technology and Space, *Congressional Quarterly,* April 07, page lexis] ttate

Why does the asteroid need to be moved in a "controlled manner"? If the asteroid is not deflected in a controlled manner, we risk simply making the problem worse. Nuclear explosives for example risk breaking up the asteroid into pieces, thus turning a speeding bullet into a shotgun blast of smaller but still possibly deadly fragments. Explosions also have the drawback that we cannot accurately predict the resultant velocity of the asteroid - not a good situation when trying to avert a catastrophe. Conversely, moving an asteroid in a controlled fashion also opens up the possibility of using the same technology to manipulate other asteroids for the purposes of resource utilization. How can this be accomplished? This mission is well beyond the capability of conventional chemically powered spacecraft. We are proposing a nuclear powered spacecraft using high efficiency propulsion (ion or plasma engines). Such propulsion packages are currently already under development at NASA as part of the Prometheus Project. In fact, the power and thrust requirements are very similar to the Jupiter Icy Moons Orbiter spacecraft, currently planned for launch around 2012. The B612 spacecraft would fly to, rendezvous with, and attach to a suitably chosen target asteroid (there are many candidate asteroids which are known to be nowhere near a collision course with Earth). By continuously thrusting, the spacecraft would slowly alter the velocity of the asteroid by a fraction of a cm/sec - enough to be clearly measurable from Earth. What will we learn from this? It is important to remember that this mission is merely a first attempt to learn more about the mechanics of asteroid deflection. There are a number of technical complications, as well as many unknowns about the structure and composition of asteroids. However, the way to make progress is to build, fly, and test. Much of what we will learn is generic to many proposed asteroid deflection schemes, with the added benefit of being able to answer important scientific questions about asteroids themselves. The best way to learn about asteroids is to go there. How does this fit into the new Exploration Initiative at NASA? In the near term, this mission would be an ideal way to flight test the nuclear propulsion systems under development as part of the Prometheus Project. It could also serve as a precursor to a crewed mission to visit an asteroid. Such missions have been proposed as intermediate steps to test spacecraft systems for eventual longer term crewed missions to Mars. In the longer term, the ability to land on and manipulate asteroids is an enabling technology for extending human and robotic presence throughout the solar system. If we are to truly open up the solar system, this mission is a good way to start. It is likely that someday we will utilize asteroids for fuel, building materials, or simply as space habitats. The B612 mission would mark a fundamental change in spacecraft in that it would actually alter in a measurable way an astronomical object, rather than simply observing it. Human beings must eventually take charge of their own destiny in this manner, or we will someday go the way of the dinosaurs when the next great asteroid impact occurs.

## COLONIZATION ADV – SOLVES EXTINCTION

**STAYING ON THE ROCK DOOMS US TO EXTINCTION – WE MUST COLONIZE SPACE FOR SURVIVAL**

FALCONI 77 (Oscar, BS degree in Physics from M.I.T. and over the years has been a physicist and consultant in the computer and electro-optical fields, The Case for Space Colonization Now!, 1977, <http://www.nutri.com/space/>) theo

But it's impossible to solve the problem of preventing, with 100% certainty, our self-destruction here on earth. This problem is just too complicated, and asks too much of man - such as restraint, understanding, objectivity, intelligence, compromise, and common sense - characteristics which are necessary for future survival, but seldom met with in practice, particularly in politics. We are now left in the ludicrous position of hoping we'll survive through each year.

Butthe hope that no unforeseen catastrophe will destroy man is a flimsy basis on which to assume that our species will enjoy its maximum possible time in this universe. If you want insurance, you've got to pay the premium. And the premium is due now. The only known life in the universe exists on earth, and, for a surprisingly large number of reasons, could soon find itself destroyed.

Man is particularly susceptible to such a tragedy compared to the crustaceans, amphibians, insects, and the countless other hardy families. Only his superior brain has enabled him to successfully compete despite a relatively fragile constitution. Should we succeed in our self-destruction, it's doubtful that nature could once again turn the trick of creating another highly advanced being out of any primitive life remaining on earth.

By whatever philosophical standards one bases his thinking, one must conclude that life is better than no life at all. Man's first thought must be to preserve the human race at all costs. It must not be allowed to come to an end, and specifically, it mustn't be allowed to destroy itself.

In the far distant future, it appears that man will be doomed by the lack of available energy (the 2nd law). This may not come about for 100's of billions of years. Before that, a collapsing universe may put an end to all life. And before that, our sun will become a red giant, probably ending all life in our solar system. But even that won't come about for several billions of years. Whether these problems can be solved isn't known, but man has plenty of time to think about them.

More imminent, not in billions of years, but maybe in just a fraction of a decade, is the end of all life on earth that man himself has the capability to bring about!

## COLONIZATION ADV – OVERPOPULATION MODULE

**SPACE COLONIZATION SOLVES OVERPOPULATION AND WARS – CAN HOUSE OVER A TRILLION PEOPLE**

**Globus 11** (Al - senior computer scientist with Computer Sciences Corporation @ NASA Ames Research Center, “Why Build Orbital Space Colonies”, last modified July 12, 2011, <http://webcache.googleusercontent.com/search?q=cache:2iqBa43vOjUJ:space.alglobus.net/>

Basics/why.html+asteroid+detection+will+allow+colonies&cd=12&hl=en&ct=clnk&gl=us&source=www.google.com) rory Space colonization will enable almost unlimited growth. Growth of life, humanity, and the societies that choose to go. A single 1km (0.6 miles) diameter asteroid has enough materials to build about 800 square kilometers (~300 square miles) of orbital real estate . That's enough to house about 160,000 people quite nicely, probably in a number of separate colonies. There are about 1000 such asteroids in our neighborhood, so exploiting the near-Earth asteroids can provide housing for perhaps 160 million people, but it gets much better. Ceres, the largest asteroid, has enough material to build orbital colonies with a livable surface area about 200 times greater than the entire Earth. That's a lot of elbow room. In fact, that one asteroid there's enough space for at least one trillion people, assuming the same density as Earth. Of course most of the Earth is essentially unpopulated - the oceans cover 2/3 of the Earth and most deserts and mountains are pretty empty. But just in case my calculations are optimistic, lets say there's only room for ten trillion folks. Ten trillion is a nice round number and will do for now. While growth is its one reward, there are others. One immediate Earthly benefit of this growth potential is less war. Specifically, wars motivated by the desire for territorial won't make sense any more. Of course, some people think territorial wars don't make sense now and they have a point. However, if a country wants more land there's only one way to get it: force.

AND, Overpopulation makes Earth unsustainable - leads to extinction

Fowler 2005 (Charles W., Leader of the Systemic Management Studies Program at the National Marine Mammal Laboratory, “Sustainability, Health, and the Human Population,” EcoHealth Journal Consortium, January 31, http://www.springerlink.com/content/735l76l6kygtuby3/fulltext.html) naveena

Much attention has been focused on the issue of management in recent decades. Concerns include the depletion of resources, altered ecosystems, extinction, and other global changes. Sustainability and health are given special attention. Several important issues are addressed if management is defined as finding, achieving, and maintaining a way for humans to be sustainable, healthy participants within healthy systems such as ecosystems and the biosphere. This article shows how other species serve as examples of sustainability, providing information to guide management (systemic management: Fowler et al., 1999; Fowler and Perez, 1999; Fowler, 2002, 2003; Fowler and Hobbs, 2002, 2003). It addresses the question “What is an optimally sustainable human population?” and finds the current human population too large by orders of magnitude. It is so large as to be pathologic itself and to contribute to abnormalities observed among other species and ecosystems. To manage, humans must find and maintain sustainable existence and influence, whether as individuals or as a species. Systemic management (Fowler and Hobbs, 2002; Fowler, 2003) is intransitive rather than transitive management; that is, it avoids management of other species or ecosystems and emphasizes sustainability in our interactions with them and influence on them. It places primary emphasis on sustainability wherein humans take on sustainable roles in systems that can themselves sustainably maintain or support not only our species, but also others, to ensure the health of all involved. Through systemic management, ecosystems represent one of the hierarchical levels of biological organization within which humans are explicitly included with other species (Fowler, 2002, 2003). Systemic management acknowledges limited options for control: inclusive systems control or constrain their components more than components control the wholes of which they are parts (Bateson, 1972, 1979; Campbell, 1974; Allen and Starr, 1982; Salthe, 1985; Wilber, 1995; Holling and Meffe, 1996). This occurs because of the respective nested hierarchical levels and associated scales of time, space, and complexity; the collective effects of all species on one is typically greater than the effects of one species on any of the others. We cannot avoid the repercussions of what we do to other elements of the systems of which we are a part. With this perspective, systemic management extrapolates from the lessons learned from experience. Past lessons have shown that transitive management at the single-species level is not adequate (exemplified in fisheries and forestry), and we can only expect ecosystem management to be an even larger problem if approached transitively. Ecosystems cannot be managed (Mangel et al., 1996; Fowler et al., 1999). However, we can have the objective of desirable ecosystem states through a sustainable human presence and influence on such systems—objectives achieved through intransitive action. To perform any form of management, however, we need guidance. For systemic management, we need guidance for how humans (specifically as a species) can find a sustainable existence among, and composed of, complex biotic systems. The health of individual humans, our species, other species, ecosystems, and the biosphere depends on achieving such sustainability. Below, examples are presented for finding such guidance, with a focus on human population size, parallel to the focus on fisheries management in other publications (e.g., Fowler et al., 1999; Fowler, 2003). First, participation in complex systems and sustainability must be clearly understood, especially in terms of the mutual health of these systems and their components (e.g., ecosystems and the species in them). For species, participation includes the qualities and characteristics of being a species, especially in interactions. These interactions include relationships with other species and the environment along with all of the characteristics we ordinarily attribute to species. It includes all the ways species can be measured. Participation is exemplified by the extent to which each species is involved in the suite of dynamics associated with ecosystem processes and interactions with other species. These include the flow of materials and energy, evolutionary change, and interactions among populations. The rate of resource use, for example, is a participatory process (with its importance to fishery management; Fowler et al., 1999), as is the evolutionary influence each species exerts on others (e.g., coevolutionary interaction). Evolutionary reactions to human influence are seen in the development of resistance to antibiotics and pesticides by microorganisms, weeds, and various invertebrate species. Genetic changes also result from human use of resources (Law et al., 1993) and the domestication of resource species. The function of species in all interspecific interactions is included as part of their participation. Sustainability clearly includes persistence or endurance; abnormal death or extinction rates are signs of ill health. It must also account for the risks and benefits species experience, especially as parts of more inclusive systems. Endurance may be limited in ever-changing systems, but maximizing the time our species spends as a part of more inclusive systems is one aspect of achieving optimal sustainability. Thus, sustainability is attained through consideration of the suite of factors to which all species are exposed to minimize risk stemming from the collective forms of risk, including that of extinction—even human extinction (Darwin, 1953; Bateson, 1972, 1979; Ponting, 1991; Hern, 1993; Boulter, 2002).

## COLONIZATION ADV – OVERPOPULATION IMPACT EXTS

Population growth leads to extinction- warming, war, and resource depletion

Hedges 2011 (Chris, Sr. Fellow at the Nation Institute, received Amnesty International Award, teaches at Princeton, NYU, Columbia, “We are Breeding Ourselves to Extinction” University of California, Berkley, Dept of Nuclear Engineering, <http://www.nuc.berkeley.edu/node/4684>) naveena

All measures to thwart the degradation and destruction of our ecosystem will be useless if we do not cut population growth. By 2050, if we continue to reproduce at the current rate, the planet will have between 8 billion and 10 billion people, according to a recent U.N. forecast. This is a 50 percent increase. And yet government-commissioned reviews, such as the Stern report in Britain, do not mention the word population. Books and documentaries that deal with the climate crisis, including Al Gore’s “An Inconvenient Truth,” fail to discuss the danger of population growth. This omission is odd, given that a doubling in population, even if we cut back on the use of fossil fuels, shut down all our coal-burning power plants and build seas of wind turbines, will plunge us into an age of extinction and desolation unseen since the end of the Mesozoic era, 65 million years ago, when the dinosaurs disappeared. We are experiencing an accelerated obliteration of the planet’s life-forms—an estimated 8,760 species die off per year—because, simply put, there are too many people. Most of these extinctions are the direct result of the expanding need for energy, housing, food and other resources. The Yangtze River dolphin, Atlantic gray whale, West African black rhino, Merriam’s elk, California grizzly bear, silver trout, blue pike and dusky seaside sparrow are all victims of human overpopulation. Population growth, as E.O. Wilson says, is “the monster on the land.” Species are vanishing at a rate of a hundred to a thousand times faster than they did before the arrival of humans. If the current rate of extinction continues, Homo sapiens will be one of the few life-forms left on the planet, its members scrambling violently among themselves for water, food, fossil fuels and perhaps air until they too disappear. Humanity, Wilson says, is leaving the Cenozoic, the age of mammals, and entering the Eremozoic—the era of solitude. As long as the Earth is viewed as the personal property of the human race, a belief embraced by everyone from born-again Christians to Marxists to free-market economists, we are destined to soon inhabit a biological wasteland. The populations in industrialized nations maintain their lifestyles because they have the military and economic power to consume a disproportionate share of the world’s resources. The United States alone gobbles up about 25 percent of the oil produced in the world each year. These nations view their stable or even zero growth birthrates as sufficient. It has been left to developing countries to cope with the emergent population crisis. India, Egypt, South Africa, Iran, Indonesia, Cuba and China, whose one-child policy has prevented the addition of 400 million people, have all tried to institute population control measures. But on most of the planet, population growth is exploding. The U.N. estimates that 200 million women worldwide do not have access to contraception. The population of the Persian Gulf states, along with the Israeli-occupied territories, will double in two decades, a rise that will ominously coincide with precipitous peak oil declines. The overpopulated regions of the globe will ravage their local environments, cutting down rainforests and the few remaining wilderness areas, in a desperate bid to grow food. And the depletion and destruction of resources will eventually create an overpopulation problem in industrialized nations as well. The resources that industrialized nations consider their birthright will become harder and more expensive to obtain. Rising water levels on coastlines, which may submerge coastal nations such as Bangladesh, will disrupt agriculture and displace millions, who will attempt to flee to areas on the planet where life is still possible. The rising temperatures and droughts have already begun to destroy crop lands in Africa, Australia, Texas and California. The effects of this devastation will first be felt in places like Bangladesh, but will soon spread within our borders. Footprint data suggests that, based on current lifestyles, the sustainable population of the United Kingdom—the number of people the country could feed, fuel and support from its own biological capacity—is about 18 million. This means that in an age of extreme scarcity, some 43 million people in Great Britain would not be able to survive. Overpopulation will become a serious threat to the viability of many industrialized states the instant the cheap consumption of the world’s resources can no longer be maintained. This moment may be closer than we think. A world where 8 billion to 10 billion people are competing for diminishing resources will not be peaceful. The industrialized nations will, as we have done in Iraq, turn to their militaries to ensure a steady supply of fossil fuels, minerals and other nonrenewable resources in the vain effort to sustain a lifestyle that will, in the end, be unsustainable. The collapse of industrial farming, which is made possible only with cheap oil, will lead to an increase in famine, disease and starvation. And the reaction of those on the bottom will be the low-tech tactic of terrorism and war. Perhaps the chaos and bloodshed will be so massive that overpopulation will be solved through violence, but this is hardly a comfort.

## COLONIZATION ADV – SOLVES WAR

**THE ROOT CAUSE OF MOST WARS IS LAND CONQUEST – SPACE COLONIZATION SOLVES THE ROOT CAUSE OF MOST WARS**

**Globus 11** (Al - senior computer scientist with Computer Sciences Corporation @ NASA Ames Research Center, “Why Build Orbital Space Colonies”, last modified July 12, 2011, <http://webcache.googleusercontent.com/search?q=cache:2iqBa43vOjUJ:space.alglobus.net/Basics/why.html+asteroid>+ detection+will+allow+colonies&cd=12&hl=en&ct=clnk&gl=us&source=www.google.com) rory

When the German Nazis conquered much of Europe in the 1930's and 40's they were, in part, seeking lebensraum (literally, living room). What the Germans wanted, among other things, was room to grow. The Japanese had similar ambitions. Territorial growth is not unreasonable, however all the land on Earth is taken. Thus, the only way for the Germans and Japanese to grow was by conquest. The folks being conquered weren't at all happy about it and World War II was born. No one really knows how many people died in the war, but 50-100 million is a good guess. If space colonization had been an option the Germans and Japanese could have met their need to grow by peaceful means - building space colonies. This is not to say that that space colonization would definitely have prevented World War II. Maybe, maybe not. But rather that one of the primary, and most legitimate, motivations could have been satisfied by peaceful means. Although space colonization may or may not have prevented World War II, it probably would have prevented the Arab-Israeli conflict. Besides conquering much of Europe, the Nazis also tried to exterminate Europe's Jews and nearly succeeded. Not only did the German's nearly exterminate them, but Jews who fled Europe were often sent back to their death. The U.S. was one of the many countries that did this. After the war, the Jews, not surprisingly, believed that they needed a country of their own for protection from future genocide. The Jews wanted a country that would always take them in. There was a great debate in the Jewish community over where the new Jewish state should be. Needless to say, outer space was not an option. Too bad. Palestine (much of which is now known as Israel) was chosen. Israel/Palestine was attractive since Jews had viewed it their homeland for thousands of years. The Jewish religion holds that Palestine was promised the Jews by no less an authority than God himself. However, the Jews had been expelled from Palestine by the Romans and hadn't controlled that land since. Furthermore, many devout Jews believed that they should not return to Israel until the Messiah came. On a more practical note, most knowledgeable people believed that the Arabs, who had lived in Palestine for a very long time and considered it their own, would destroy Israel. The Arabs had professional armies and navies whereas the Jews did not. There were perhaps 20 million Arabs in the Mid-East and North Africa and only a few hundred thousand Jews in the holy land. Arabs controlled all of North Africa and most of the Mid-East. Israel is only about 300 miles long and 70 miles wide. In 1948, when Israel was established in part of Palestine, it seemed that the Jewish state would be extremely short lived. On the other hand, no matter where the Jews sought territory they would have had to fight. Every inch of the Earth is already claimed by someone. The Jews chose war. Absent space colonies, this isn't surprising. The state of Israel was created, survived the first and later Arab assaults and has been fighting the Arabs for over 50 years now. Had space colonization been an option in the late 1940s is it quite possible that the Jews would have chosen to go into space rather than the Mid-East. In effect, choosing to build rather than fight. In space there is no one who considers the land their own. You don't fight for land, you build it. This would have completely avoided the entire Arab-Israeli conflict, the creation of hundreds of thousands of Palestinian and Jewish refugees, and saved an enormous amount of money not to mention countless lives. World War II and the Arab-Israeli conflict are only two of many territorial wars throughout history. Many wars, although not all, are driven by a desire for land. The Mongol conquest, the European conquest of the Americas, the Roman conquests, the early expansionist wars of Islam, and countless others fall into this category. In some cases two peoples are very set on a particular piece of land and space colonization won't help there. However, often a people simply want more land and don't really care much where it is. In this case orbital space colonization can fill the need without war. Large-scale space colonization will eliminate the motive for this class of wars and, with just a little bit of luck, make our world a significantly safer place. For the first time in thousands of years it will be easier to build land than conquer it. Today we are trying to end war by fixing the boundaries of all countries, effectively preventing them from growing. This has worked to a certain extent, but stifling growth is a Sisyphean task. Countries are a lot like living things, and all living things grow. The desire to grow is one of the fundamental properties of life. It's not going to go away. Colonizing the solar system can give us somewhere to go.

## COLONIZATION ADV – SOLVES ENVIRONMENTAL DESTRUCTION

**SPACE COLONIZATION SOLVES ENVIRONMENTAL DESTRUCTION – INDEPENDENT AND ISOLATED COLONIES**

**Globus 11** (Al - senior computer scientist with Computer Sciences Corporation @ NASA Ames Research Center, “Why Build Orbital Space Colonies”, last modified July 12, 2011, <http://webcache.googleusercontent.com/search?q=cache:2iqBa43vOjUJ:space.alglobus.net/Basics/why.html+asteroid+detection>+ will+allow+colonies&cd=12&hl=en&ct=clnk&gl=us&source=www.google.com) rory

Earth is rapidly becoming more homogeneous, you can eat a MacDonald's hamburger in nearly any city on the planet. As transportation and communication systems improve, the diversity of social systems is declining. Earth's communities are closely tied together by a common environment and easy movement of people and materials. Thus, the ills of one society are readily visited on the next. For example, the polluted air and water of one country often comes to rest in another. The environmental sins of one are a problem for us all. Orbital space colonies can provide thousands, if not millions, of completely separate ecosystems with easy-to-control borders. Poorly run space colonies cannot easily export their environmental problems. Each colony, holding from a few hundred to perhaps as many as a million people, is a completely enclosed ecosystem separated from every other colony by a very complete vacuum. The environmental sins of one will not be visited on another. If a colony chooses to experiment, to try new things that don't work and creates some horrendous consequences, no other colony will be directly affected. There will be no need, as there is on Earth, for global treaties preventing a society from doing pretty much as it pleases. Not only is the environment of each colony separate and unique, immigration will be very easy to control. Getting in or out of a space colony requires going through an airlock. An air lock is a small room with two airtight doors, one opening into a colony and the other into space. When someone wants to get into a colony their ship attaches to the empty air lock. After the attachment has been sealed properly, air is pumped into the air lock then the colony door can then be opened and you can go in. This procedure doesn't lend itself to illegal immigration. Colonies that so choose can isolate themselves very easily. Although I personally wouldn't like the uniformity within my colony, this isolation can be expected to lead to great variety between settlements, everything from strict Muslim settlements where everyone is covered head-to-toe in public to colonies of nudists.

## MARS ADV – PLAN KEY TO GETTING TO MARS

**Asteroid detection is key to finding the best option for a steppingstone to Mars**

David 10 (Leonard, Research Associate for Secure World Foundation, has been writing about global space activities for some 50 years. He is an award-winning journalist and is SPACE.com's Space Insider Columnist, a correspondent for Space News newspaper, a contributing writer for the American Institute of Aeronautics and Astronautics (AIAA) Aerospace America magazine and also serves as a consultant to the Coalition for Space Exploration, “‘Plymouth Rock’ Deep Space Asteroid Mission Idea Gains Ground,”, Space.com, 8/30/11, http://www.space.com/9028-plymouth-rock-deep-space-asteroid-mission-idea-gains-ground.html ) [Iuliano]

Hopkins told SPACE.com that a study team has been steadily chipping away on the mission idea since 2007, seeing their plan as a way to explore the asteroids as stepping stones to Mars. The proposed asteroid mission concept, called Plymouth Rock, combines two Orion spacecraft with modifications to provide the necessary propulsion, living space and life-support capability for two astronauts. The dual-Orion configuration can probably support deep-space mission durations of five to six months, Hopkins said. “Because Orion is already designed to do missions far beyond low-Earth orbit, it already has most of the capabilities that we need,” Hopkins said. The work completed to date has been funded solely by Lockheed Martin, he added, and does not imply any programmatic intent or technical endorsement by NASA. Deep-space mission plans. One backer of a human asteroid mission is former NASA shuttle astronaut Thomas Jones. “NASA’s plans for how to execute a NEO mission are still in the formative stage, but a key component of any mission concept is a small piloted re-entry vehicle,” Jones told SPACE.com. “The updated Orion could serve this function, as part of a larger spacecraft capable of reaching and exploring a NEO.” NASA could build a NEO cruise vehicle in low-Earth orbit or at a stable point in space near Earth called a Lagrange point, Jones said. That craft would consist of a propulsion system, habitation volume, a small NEO surface exploration craft that Jones likened to a “space pod” and the re-entry vehicle. “An attractive change for NASA between the lunar architecture and proposed NEO missions is that most of this cruise vehicle could be re-used,” Jones said. This type of space-based architecture might be much more versatile and sustainable over several decades, Jones added, and its capabilities could be enhanced as better propulsion and life-support systems became available. Only the re-entry vehicle would have to be replaced, he added. The rest of the mission's assets could be left in Earth orbit to be used on later flights. The space-based components could be upgraded for new missions or repurposed for a space observatory, lunar or Mars-bound expeditions, Jones said. Asteroid destination not set. The potential candidate destinations for a manned asteroid mission will likely change in the near-term. “If we keep doing sky surveys at the level of effort that we’ve been doing in the last 10 years, I think the number of targets we can get to with Orion will roughly double,” Hopkins said. “If we do a more thorough survey, either with ground-based or space-based telescopes, that number could go up by a factor of ten or a hundred.” The study team has already identified candidate target asteroids with mission opportunities in 2015-2030. Those objects vary in size, from as small as 13 feet (4 meters) across to some 230 feet (70 meters) in size. There’s nothing in the Plymouth Rock proposal that would prevent a visit to an even larger space rock, if it was in an orbit easily accessible, Hopkins said. At the recent NASA NEO workshop, Hopkins proposed a “grand tour” of multiple asteroids via robotic craft to characterize space rock diversity. “It’s conceivable that there would be a pair of asteroids that a human mission could visit. But I would think that’s not likely near-term,” Hopkins said. A trip to two asteroids would likely require a beefier, Mars-class spacecraft, he added.

**ASTEROID DETECTION KEY TO GETTING TO MARS**

**Daily Planet 10** (“Billion Dollars To Track Deadly Asteroids”, Eco Care, 2010, <http://www.dailyplanetmedia.com/more_stories.php?id=4470&mode=10>) rory

An asteroid-hunting space telescope could go a long way toward playing catch-up and reaching the survey goal by 2022, but at the hefty cost of more than $1 billion. Even if scientists spot a looming asteroid threat, few immediate solutions exist. The NRC runs down past proposals that range from "slow push" or "slow pull" gravity tractors to small kinetic collisions by spacecraft that could nudge a space rock off course -- assuming that there's decades to spare. But only nuclear explosions stand ready as the current practical means for dealing with the biggest threats in the form of space rocks greater than 1 km in diameter. Several planned missions offer hope of not only studying asteroids for weaknesses, but even using them as a sort of "Plymouth Rock" stepping stone to colonize Mars. Such missions could represent small yet crucial steps toward generating interest in funding more asteroid detection and deflection methods.

**ASTEROIDS ARE KEY STEPPING STONES TO GETTING MARS – THEY PROVIDE NECESSARY RESOURCES AND KEY KNOWLEDGE ABOUT ORBITING BODIES**

**Cutright 11 (**Bruce L. Bureau of Economic Geology, University of Texas at Austin, TX, “The Near Earth Asteroids as the First Step on the Way to Mars”, oral presentation at AAPG Annual Convention and Exhibition, June 27, 2011, <http://www.searchanddiscovery.com/documents/2011/80157cutright/ndx_cutright.pdf>) rory

The recent cancelation of NASA’s Constellation program has shifted the emphasis of the US space program from returning to the moon to exploring Mars and the asteroids. The Apollo program and the Viking, Pathfinder and Mars Rover programs developed a significant body of information on the composition and characteristics of the Moon and Mars. We have progressed to the point that we can manufacture simulated Lunar and Martian regoliths for experimentation with extraction of useful materials for life support, construction materials and development of traction and weight-bearing capabilities for exploration vehicles. Although the near earth asteroids have not attracted the public attention that the Moon and Mars have, they represent the easiest accessible sources of fuels, minerals and life support materials once off the Earth’s surface. Further, expanding our knowledge of the asteroids, their composition and dynamics, addresses two critical parameters: the asteroids provide fundamental information about the origin of the inner planets and solar system, and detailed information on their orbital dynamics is the only way of predicting the fate of earth crossing and potentially Earth impacting asteroids.

## SOLVENCY EXTS – US KEY - EFFECTIVENESS

**UNITED STATES IS KEY – WE ARE THE ONLY COUNTRY WITH A PROGRAM LARGE ENOUGH IN SCOPE TO EFFECTIVELY DETECT**

**NAS 09** (National Academy of Sciences, “National Research Council, Near-Earth Object Surveys and Hazard Mitigation Strategies: Interim Report,” August 2009, <http://www.nasa.gov/pdf/378691main_NRC-Aug12InterimReport.pdf>)[JHegyi14]

Despite expressions of interest in various countries around the globe, the majority of search efforts and funding for discovering NEOs comes from the United States. Several smaller projects, such as the Beijing Schmidt CCD Asteroid Program (no longer operational) and the Asiago DLR Asteroid Survey (an ongoing joint venture between the German Aerospace Agency’s [DLR’s] Institute of Space Sensor Technology and Planetary Exploration, the University of Asiago, and the Astronomical Observatory of Padua in Italy), have made some inroads on detecting NEOs, but not on the scale of the U.S. projects. In addition, with the notable exception of Canada, through its Near-Earth Object Surveillance Satellite (NEOSSat) mission, and Germany, via its AsteroidFinder mission, which are both relatively limited in scope, no other countries have committed funding for a “next generation” NEO-discovery program.

## SOLVENCY EXTS – US KEY – TECHNOLOGY

Planetary radar technology is unique to the US and is key to NEO detection

Foruno 07 (Rep, Luis G., US congressman, “To provide for National Science Foundation and National Aeronautics and Space Administration utilization of the Arecibo Observatory,” The Library of Congress, 10-3-11, http://thomas.loc.gov/cgi-bin/query/z?c110:H.R.3737:) [JHegyi14]

SECTION 1. FINDINGS. The Congress finds the following: (1) Arecibo Observatory is the world's largest single-aperture telescope. It has been recognized as an Electrical Engineering Milestone by the Institute of Electrical and Electronics Engineers and as a Mechanical Engineering Landmark by the American Society of Mechanical Engineers. Its visitor center draws 120,000 visitors each year. (2) Arecibo radio astronomy led to the first discovery of planets outside our own solar system, the first discovery of a binary pulsar (resulting in a Nobel Prize), and the first detailed three-dimensional mapping of how galaxies are distributed in the universe. (3) Arecibo Observatory's planetary radar has unique abilities worldwide for research on our solar system, including near-Earth asteroids. Besides their scientific importance, near-Earth asteroids may be both a significant hazard to Earth and a potential source of future resources. (4) Arecibo Observatory is a leading United States laboratory for research on Earth's ionosphere. (5) Congress has mandated that the National Aeronautics and Space Administration detect, track, catalogue, and characterize near-Earth asteroids and comets in order to provide warning and mitigation of the potential hazard of such near-Earth objects to the Earth. By being on the forefront of basic research involving Near-Earth Objects, Space Weather, and Global Climate Change, the Arecibo Observatory is an outstanding resource to Congress and to the American People. (6) The efforts taken to date by the National Aeronautics and Space Administration and the National Science Foundation for detecting and characterizing the hazards of Earth orbit-crossing asteroids and comets are not sufficient to the threat posed by such objects to cause widespread destruction and loss of life. (7) The general welfare and security of the United States require that the unique competence of the National Aeronautics and Space Administration in science and engineering systems be directed to detecting, tracking, cataloging, and characterizing near-Earth asteroids and comets. The Arecibo Observatory is an invaluable and unique asset in warning and mitigating potential hazards posed by near-Earth objects.

## SOLVENCY EXTS – US KEY – LEADERSHIP

**OTHER NATIONS WAITING FOR US TO TAKE THE LEAD IN ASTEROID DETECTION – US ACTION SETS A MODEL FOR THE INTERNATIONAL COMMUNITY TO FOLLOW**

**FRANCE 2000** [Martin – lieutenant colonel in the US Air Force, “Planetary Defense: Eliminating the Giggle Factor”, *Air and Space Power Journal,* <http://www.airpower.maxwell.af.mil/airchronicles/cc/france2.html>] ttate

A key component of the Shoemaker Report, as in the earlier Spaceguard Survey, was its international character. However, it seems that most nations interested in the NEO threat are **still** awaiting America’s lead. Russia, for example, has the technology and interest (Tunguska) among its astronomy and military communities to play a significant role in the Spaceguard Survey, but economic circumstances have precluded them from taking the initiative. Australia has recently backed away from its fledgling telescope program, which played a critical role in confirming NEOs first seen by other telescopes from its unique location in the southern hemisphere, and international attempts to encourage the Australian government to bring its program back into operation have failed.23 The United Kingdom, home of some of the most enthusiastic NEO watchers, formed a "Task Force on NEOs" led by Dr. Harry Atkinson. This group of four scientists has limited funding and is only tasked with making recommendation to Her Majesty’s Government by mid-2000 on how the UK should best contribute to the international effort on NEOs.24 Additionally, Spaceguard is a loose, voluntary consortium of international observatories and interested parties that serves to relay NEO identification to concerned groups and fellow participants.

**US UNILATERAL ACTION IS KEY TO SPURRING INTERNATIONAL COOPERATION AND COALITION-BUILDING FOR MORE PLANETARY DEFENSE INITIATIVES**

**BARRETT 2006** [Scott – professor and director of International Policy @ School of Advanced International Studies @ Johns Hopkins University and Distinguished Visiting Fellow @ Center for the Study of Globalization @ Yale University, *Chicago Journal of International Law,* <http://www.allbusiness.com/legal/4069484-1.html>] ttate

But can we expect that this public good will be provided? Or will free riding undermine global provision of asteroid protection? The US would likely have the greatest incentive to provide this public good since it would, in absolute terms, bear the greatest loss from an asteroid collision. Indeed, it is easy to demonstrate that the economics of asteroid protection are so attractive that it would be beneficial for the US to finance the entire protection program.40 Since it pays the US to supply the public good unilaterally, theory suggests that the good will be supplied. As it happens, behavior is consistent with this prediction. The US is already "doing more about Near Earth Objects than the rest of the world put together."41 For example, the US has already funded a program to track large objects in space, a prerequisite for further action. (Fortunately, the nature of asteroid travel means that we should have decades, if not centuries, to prepare for a possible collision; however, comets with long-period orbits cannot be observed as easily, and these are thus particularly dangerous.) What theory cannot predict is how the public good of asteroid defense will be financed. It could be financed entirely by the US, but it could also be financed via any number of other burden-sharing arrangements.42 To illustrate this point, consider the financing of the 1991 Persian Gulf War. Removing Iraqi forces from Kuwait was also a best shot, global public good. It enforced the norm safeguarding a state's territorial sovereignty, stabilized the global oil market, and invigorated the United Nations by carrying out the threat expressed in Security Council Resolution 678, which authorized the use of "all necessary means" to free Kuwait.43 The US would have gained substantially from restoring Kuwait's sovereignty, but so would all other countries. Thus, while the US led the coalition against Iraq, many countries contributed, both financially and in kind. According to a Department of Defense study, foreign governments funded almost 90 percent of the military effort.44 Bennett, Lepgold, and Unger claim that other countries paid because the US would not have intervened without allied contributions.45 However, assuming that was not the case-meaning that the US was willing to intervene unilaterally-other countries would likely have contributed anyway. The US would have wanted to share the burden and other countries would have recognized their obligation to pay their fair share.

## SOLVENCY EXTS – US KEY – LEADERSHIP

**PLAN IS A PREREQUISITE FOR EFFECTIVE INTERNATIONAL COOPERATION ON FUTURE ASTEROID DETECTION PROGRAMS – US NEEDS TO TAKE THE LEAD**

Schweickart 07(Russell, Astronaut, M.S. in Aeronautics/Astronautics from the Massachusetts Institute of Technology, “The Sky is Falling. Really.” The New York Times, 3-16-2007, http://www.lexisnexis.com.turing.library.northwestern.edu/hottopics/lnacademic/?)[JHegyi14]

Why the concern? First, even with good intentions, launching a nuclear-armed missile would violate the international agreements by which all weaponry is banned from space. Second, the laws of probability say we would be struck by such a large asteroid only once every 200,000 years -- that's a long time to keep a standing arsenal of nuclear asteroid-blasters, and raises all sorts of possibilities of accidents or sabotage -- the old ''cure being worse than the disease'' phenomenon. In the end, of course, this is not just America's problem, as an asteroid strike would be felt around the globe. The best course is international coordination on deflection technology, along with global agreements on what should be done if a collision looks likely. Along these lines, the Association of Space Explorers, a group of more than 300 people from 30 nations who have flown in space (of which I am a member), is beginning a series of meetings in cooperation with the United Nations to work out the outlines of such an agreement. Still, as with many global issues, little will be accomplished unless the United States takes the lead. With the entire planet in the cross hairs, NASA can't be allowed to dither. If Congress's mandates and budget requests aren't energizing the agency, perhaps public hearings would shame it into action.

## SOLVENCY EXTS – NASA KEY

**ONLY NASA CAN DO THE PLAN**

**FORTUNO 2007** [“HR 3737: To provide for National Science Foundation and National Aeronautics and Space Administration Utilization of the Arecibo Observatory”, Bill introduced on October 03,

<http://www.spaceref.com/news/viewsr.html?pid=25609>] ttate

(1) Arecibo Observatory is the world's largest single-aperture telescope. It has been recognized as an Electrical Engineering Milestone by the Institute of Electrical and Electronics Engineers and as a Mechanical Engineering Landmark by the American Society of Mechanical Engineers. Its visitor center draws 120,000 visitors each year. (2) Arecibo radio astronomy led to the first discovery of planets outside our own solar system, the first discovery of a binary pulsar (resulting in a Nobel Prize), and the first detailed three-dimensional mapping of how galaxies are distributed in the universe. (3) Arecibo Observatory's planetary radar has unique abilities worldwide for research on our solar system, including near-Earth asteroids. Besides their scientific importance, near-Earth asteroids may be both a significant hazard to Earth and a potential source of future resources. (4) Arecibo Observatory is a leading United States laboratory for research on Earth's ionosphere. (5) Congress has mandated that the National Aeronautics and Space Administration detect, track, catalogue, and characterize near-Earth asteroids and comets in order to provide warning and mitigation of the potential hazard of such near-Earth objects to the Earth. By being on the forefront of basic research involving Near-Earth Objects, Space Weather, and Global Climate Change, the Arecibo Observatory is an outstanding resource to Congress and to the American People. (6) The efforts taken to date by the National Aeronautics and Space Administration and the National Science Foundation for detecting and characterizing the hazards of Earth orbit-crossing asteroids and comets are not sufficient to the threat posed by such objects to cause widespread destruction and loss of life. (7) The general welfare and security of the United States require that the unique competence of the National Aeronautics and Space Administration in science and engineering systems be directed to detecting, tracking, cataloging, and characterizing near-Earth asteroids and comets. The Arecibo Observatory is an invaluable and unique asset in warning and mitigating potential hazards posed by near-Earth objects.

**NASA UNIQUELY EFFECTIVE – THEY HAVE ASTEROID EXPERTISE AND ONGOING RESEARCH**

**MURRILL AND WHALEN 1998 [**Mary Beth and Mark – researchers at NASA, “JPL will establish Near-Earth Object Program Office for NASA,” July 24, <http://neo.jpl.nasa.gov/program/neo.html>] ttate

"We determined that in order to achieve our goals we need a more formal focusing of our near-Earth object tracking efforts and related communications with the supporting research community," said Dr. Carl Pilcher, science director for Solar System Exploration in NASA's Office of Space Science, NASA Headquarters. "I want to emphasize that science research solicitations and resulting peer reviews, international coordination, and strategic planning regarding future missions will remain the responsibility of NASA Headquarters." In addition to managing the detection and cataloging of near-Earth objects, the new NASA office will be responsible for facilitating communications between the astronomical community and the public should any potentially hazardous objects be discovered as a result of the program, Pilcher said. JPL was selected to host the program office because of its expertise in precision tracking of the positions and predicted paths of asteroids and comets. No significant additional staff hiring at JPL is expected at this time. "There is some extraordinary research being done on near-Earth objects and much of it is ongoing here at JPL," Yeomans said.

**NASA EMPIRICALLY SUCCESSFUL IN ASTEROID DETECTION**

**NATIONAL RESEARCH COUNCIL 2010** [“Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies”, Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, <http://www.nap.edu/catalog.php?record_id=12842>] ttate

The LINEAR program at the Massachusetts Institute of Technology Lincoln Laboratory is funded by the U.S. Air Force and NASA and was the most successful NEO search program from 1997 until 2004. The goal of LINEAR is to demonstrate the application of technology originally developed for the surveillance of Earth-orbiting satellites to the discovering and cataloguing of NEOs. LINEAR consists of a pair of GEODSS telescopes at the Lincoln Laboratory's Experimental Test Site at White Sands Missile Range in Socorro. New Mexico. These two I -meter-diameter telescopes were eventually joined by a third telescope used for the confirmation of NEO orbits and were able to detect asteroids as faint as M = 20. LINEAR has discovered 2.210 NEOs and accounted for more than 50 percent of all NEO discoveries from 1998 to 2004. In 2005. the rate of discoveries by the Catalina Sky Survey increased substantially and overtook that of LINEAR.

## SOLVENCY EXTS – NASA KEY

**NASA NEEDS TO TAKE THE LEAD IN NEO DETECTION – ITS EXPERTISE IS NEEDED TO ANCHOR THE DISSEMINATION OF INFORMATION TO OTHER AGENCIES**

SCHWEICKART ET AL 2010 [Russell – former astronaut and chairman of the B612 Foundation, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, October 06, <http://www.nasa.gov/pdf/490945main_10-10_TFPD.pdf>) ttate

Recommendation 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. The NEO hazard exists within the context of other natural and technological hazards, and that lens of experience shapes citizens’ and decision-makers’ perceptions. As extreme examples of low-probability, high-consequence events, NEO impact threats are especially susceptible to misperception. Few people have witnessed even a small impact into Earth’s surface, yet there is substantial and growing awareness that a devastating NEO impact is possible. 5.1. Societal Leadership. NASA should lead U.S. government efforts, in public and international forums, to educate, coordinate and act in reducing the threat of a NEO impact. With its broad expertise on the nature of the NEO hazard, NASA should cooperate with other elements of society that study, report on, and make decisions about NEO threats. Such societal elements include, but are not limited to: Media reporting newsworthy NEO developments and events The hazards community, including civil defense agencies and emergency responders Military elements with interests and responsibilities for national security space and disaster relief activities Educational institutions (including popular institutions like science museums) responsible for developing an informed citizenry Scientific communities (beyond the astronomical field), which have the expertise to undertake research on the physical, environmental, societal, and economic effects of threatened or actual impacts The space law community, which may be called on to apply legal principles developed in other contexts to the unique circumstances of a NEO impact threat Political leaders responsible for responding effectively and rapidly to unusual events affecting society 5.2. Impact Effects Research. NASA should support research addressing the breadth of physical, environmental, and social consequences of a range of NEO impact scenarios. With its investigation of the NEO hazard, NASA has interests in understanding impact consequences not deeply shared by other U.S. scientific agencies. More research is needed on Earth’s atmospheric response to large impacts during NEO entry and subsequent lofting of ejecta into the atmosphere. The same is true for the direct impact effects on the landscape and human infrastructure, adding to the limited understanding gained from nuclear test data of a half-century ago. Ocean impacts and the characteristics of impact-generated tsunamis require further study. NASA should also investigate the psychological and sociological consequences of a NEO impact, given how unfamiliar such disasters are to the public. 5.3. Impact Simulation. NASA and other PD-relevant agencies should develop representative impact threat timelines (linked to reference deflection missions), and initiate periodic multi- agency response simulations and evaluations. NASA must proactively extend its NEO impact knowledge to coordinating agencies, especially those responsible for disaster response, such as the DHS. Coordinated table-top exercises will be an essential training and evaluation tool in inter-agency impact threat preparations. A detailed impact scenario timeline from early detection to successful deflection or civil defense response will be the nucleus for any exercise. A set of such timelines, representing a plausible variety of cases and consistent with a set of design reference missions (see 4.5) will serve as an essential, multi-agency planning resource.

**NASA ACTION NECESSARY TO SPUR INTERNATIONAL EFFORTS – THEY HAVE THE TECHNOLOGICAL ABILITY**

NAC 10 (NASA Advisory Council, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, 10-6-10, http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf )[JHegyi14]

Society now possesses sufficiently mature space technology to provide two of the three elements necessary to prevent future damaging asteroid impacts. NASA currently searches for the largest objects of concern and issues warning information for any asteroid discovered to approach Earth. New ground- and space-based search systems can increase our capability to provide impact warning for the smaller, more numerous asteroids. Although NASA has not demonstrated a specific asteroid deflection capability, the agency’s current spaceflight technology shows that impact prevention is possible. Actual NEO deflection demonstrations are being studied and are excellent candidates to be part of future NEO science and technology missions. The missing third element for NEO impact prevention is the international community’s readiness and determination to respond to a predicted future asteroid collision with Earth. NASA is well-20 positioned to take a leading role in this government and international response, but to be ready, the agency must move well beyond search, analysis, and warning to develop the practical means for actually changing a threatening asteroid’s orbit. Without the ability to detect the most numerous asteroids, to alter NEO orbits, and to lead a global effort to plan a deflection campaign, the only possible U.S. response would be evacuation and disaster response. If NASA fails to prepare for Planetary Defense, and then a sizeable random NEO strikes Earth without warning, the damage to the U.S.’s leadership and reputation would swell the tally of the event’s devastating effects. NASA should begin work now on forging its warning, technology, and leadership capacities into a global example of how to effectively shield society from a future impact

**NASA HAS A DECADE OF EXPERIENCE BEHIND THEIR DETECTION PROGRAMS**

NAC 10 (NASA Advisory Council, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, 10-6-10, http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf )[JHegyi14]

For more than a decade, NASA has been searching for near-Earth objects (NEOs) that may pose a potential impact threat to Earth. Both the legislative and executive branches are considering what role NASA may play in expanding its NEO search and developing the capability to prevent or mitigate a future impact. The space agency has broad expertise in scientific exploration and characterization of near-Earth asteroids (NEAs) and comets (NECs), and NASA’s deep space operations experience could enable the development of deflection technologies to be used to divert a NEO threatening an impact.

## SOLVENCY EXTS – EARLY DETECTION KEY

**THE QUESTION IS NOT ABOUT BETTERING OUR DEFLECTION CAPABILITIES, BUT OUR EARLY WARNING CAPABILITIES – EVEN SMALL ASTEROIDS NEED YEARS OF PREPARATION AND DEFENSE IN ORDER TO EFFECTIVELY DEFLECT**

**Millis, 11.** (John is an assistant professor of astronomy and physics at Anderson University. He received his PhD from Purdue in High Energy Astrophysics. He has taught physics and astronomy at the collegiate level since 2001. No date, site updated in 2011, “Killer Asteroids and Comets: How Will We Stop Armageddon?” <http://space.about.com/od/frequentlyaskedquestions/a/KillerAsteroids.htm>, CALLAHAN)

There have been movies made about it. And some believe it will happen in 2012. A massive asteroid, meteor or comet threatens to destroy life on Earth as we know it. Only this scenario is not relegated only to movie theaters and science-fiction novels. There is a real possibility that a large object could one day be on a collision course with Earth. The question becomes, is there anything that we can do to stop the apocalypse? **The Key is Early Detection** History tells us that large comets or asteroids periodically collide with Earth, and the results can be devastating. There is evidence that a large object collided with Earth about 65 million years ago and caused the extinction of the dinosaurs. More recently, a iron meteorite impacted the Earth in modern day Arizona, leaving a crater that is 34 miles wide. Such a collision almost certainly destroyed all life within hundreds of miles from the impact site. Clearly these types of collisions do not happen very often, but when one does come along, what do we need to do to be ready? The more time that we have to prepare a plan of action the better. Under ideal circumstances we would have years to prepare a strategy on how to destroy or divert the object in question. Surprisingly, this is not out of the question. With such a large array of optical and infrared telescopes scanning the night sky, NASA is able to catalog and track the motions of thousands of Near Earth Objects (NEOs). Does NASA ever miss one of these NEOs? Sure, but such objects usually pass right by Earth or burn up in our atmosphere. When one of these objects does reach the ground, it is too small to cause significant damage -- loss of life is rare. If a NEO is of significant enough size to potentially threaten life on Earth NASA has a very good chance of finding it. The recently launched WISE infrared telescope will conduct a complete survey of the sky and should find any and all NEOs that are potential planet killers. But just because we don't detect any now, does not mean that we are safe forever. This is a continual process since the NEOs need to be close enough for us to detect, so there may be some coming this way that we just can't see yet. How Do We Stop Asteroids From Destroying Earth? Once a NEO is detected that could threaten Earth, we will devise a plan to prevent a collision. The first step will be to gather information about the object. Obviously the use of ground based and space based telescopes will be key, but it will likely extend beyond that. NASA will hopefully be able to land a probe of some sort on the object so that it can gather more accurate data about its size, composition and mass. Once this information is gathered and sent back to Earth for analysis, scientists could then develop the best course of action for preventing a devastating collision. The method used to prevent a cataclysmic disaster will depend on how large the object in question is. Naturally, because of their size, larger objects can be more difficult to prepare for, but there are still things that we can do. *Nuclear Bomb*: One of the easiest approaches to preventing a large collision is to try and divert the object from its course. There are several ways that NASA could do this. The first would be to detonate a nuclear weapon, or some other powerful bomb strategically near the object. The blast would knock the object off course. *Rocket Motor*: Alternatively, a rocket or motor could be attached to the object, and used to drive it onto a new course. In either case, it would not require a significant deviation of course to cause it to miss us, especially if there is an early detection. If launched early enough, a change of course of less than one degree could cause the object to miss the Earth by millions of miles. *Solar Sail*: Another proposed defense is to use the power of the Sun to help divert the object. The solar energy from the sun can actually apply pressure on an object. So a sail could be attached to the object to harness the solar wind, similar to how we use sail boats here on Earth, and divert the course of the object that way. *Break The Object Up*: NASA could also use a weapon to break the object up into smaller pieces. In theory this would accomplish two tasks, it would cause most of the pieces to miss Earth by changing their direction. But, more importantly, it would break the object up into such small pieces that even the ones that made it to Earth would likely burn up in the atmosphere. Sounds good in theory, but this would actually be very difficult to do well and would require extensive knowledge of the object and careful planning. This would be most effective on smaller objects. **Obstacles Still Remain** With the previously mentioned defenses in place we should be able to prevent future planet-killing collisions. The problem is that these defenses are not in place, some of them only exist in theory. Only a very small part of NASA's budget is designated for monitoring NEOs and developing technology to prevent a massive collision. The justification for the lack of funding is that such collisions are rare, and this is evidenced by the fossil record. True. But, what Congressional regulators fail to realize is that it only takes one. We miss one NEO on a collision course and we don't have enough time to react; the results would be fatal. Clearly early detection is key, but this requires funding and planning that is beyond what NASA is currently being allowed. And even though NASA can find the largest and deadliest NEOs, those 1 kilometer across or more, rather easily, we would need dozens of years to prepare a proper defense -- a forewarning that we may not readily have. The situation is worse for smaller objects (those a few hundred meters across or less) that are more difficult to find. We would still need significant lead time in order to prepare our defense. And while collisions with these smaller objects would not create the widespread destruction that the larger objects would, they could still kill hundreds, thousands or millions of people if we don't have enough time to prepare. Time we may not have unless the government begins taking these threats more seriously.

**The plan solves – detection is viable with more investment and attention**

Vergano, 09. (Dan is a science reporter at USA Today, and has worked at the Medical Tribune. August 13, 2009, “Panel: NASA needs to do more to spot killer asteroids.” Lexis, CALLAHAN)

NASA is falling well short in its goal to spot huge asteroids that could threaten Earth, and it needs more money and skywatchers to do the job, a science panel said Wednesday. In 2005, Congress asked the space agency to find 90% of all "potentially hazardous" near-Earth asteroids and comets, ones more than 460 feet wide (farther than home plate to deep centerfield in Yankee Stadium), by 2020. Instead, the three current survey efforts dedicated to the problem, supported at current levels, will likely find only about 15%, suggests the National Research Council panel. "For the first time, humanity has the capacity and the audacity to avoid a natural disaster," says Irwin Shapiro of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Mass., who headed the panel. "It really is a question of how much to invest in an insurance policy for the planet." Astronomers rate the odds of a civilization-threatening space impact at once every 2 million years. The chances of a smaller impact, such as the 1909 Siberian event that leveled nearly 800 square miles of forest, are rated at once every two centuries, according to a 2008 estimate by space scientist David Morrison of NASA's Ames Research Center in Moffett Field, Calif. The CfA lists 1,060 "potentially hazardous" asteroids or comets on its registry, those that pass within about 4.5 million miles of Earth as they orbit the sun and measure at least 245 feet across. That's big enough to cause a 3-megaton explosion, more than 100 times more powerful than the Hiroshima bomb . Despite the 90% detection mandate, "the administration has not requested and Congress has not appropriated new funds to meet this objective," the report notes. Says Laurence Young of MIT, who reviewed a draft of the report: "The sky is falling, but we don't know how fast, and we don't know where and when. We should be improving our abilities to detect these objects." The NRC report is an interim one, ahead of a final report later this year recommending further options for more asteroid observatories, including spacecraft. At least five new observatories, as well as German and Canadian spacecraft, are under consideration for Earth's asteroid-detecting capabilities. In July, NASA's Jet Propulsion Laboratory started an "Asteroid Watch" website to update the public on near-Earth asteroids and comets. Despite the report, Alan Harris of the Space Science Institute in La Canada, Calif., suggests that new telescopes planned for Hawaii will improve searches and lead to the detection of about 80% of the most threatening asteroids by 2020. "My personal opinion is that the risk reduction to be had by enhancing the discovery rate to literally meet the congressional goal is not worth the costs," Harris says. The panel's final report will examine the 90% goal, warning-time improvement and international collaboration. "I wouldn't get too frightened," Shapiro says. But he adds that all the proposed future observatories for finding more asteroids aren't funded yet. "Without the cameras in place, they aren't going to see anything."

## SOLVENCY EXTS – EARLY DETECTION KEY

**WE MUST HAVE PLENTY OF TIME TO DETECT IF WE WANT TO EFFECTIVELY DEFLECT A COLLISION – WE NEED YEARS, EVEN DECADES, OF WARNING**

**National Academy of Science, 10.** (National Academy of Science is comprised of the top scientists based on their individual work and achievements, no date, 2010, “Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies,” pdf document, CALLAHAN)

A key issue associated with the hazard from NEOs is that the length of time needed to execute a mitigation strategy involving orbit change is likely to require acting before the knowledge of the trajectory is sufficiently accurate to know with high confidence that an impact would occur without mitigation. It is possible, therefore, that action to mitigate could be deferred until it is too late if plans are not already in place to act when the probability of impact reaches some level that is well below unity. As addressed in Chapter 5, the time required to mitigate optimally (other than only by means of civil defense) is in the range of years to decades, but this long period may require acting before it is known with certainty that an NEO will impact Earth. Chodas and Chesley (2009) have simulated the discovery of objects that would impact within the 50 years starting at the beginning of the next generation of surveys (see Chapter 3), using estimates of the (decreasing) orbital uncertainty as observations are accumulated. Although there are many assumptions in this approach, the most important is whether or not the surveys and the follow-up programs to determine the orbits will be funded and will operate as assumed. Chodas and Chesley (2009) assume that an NEO is declared “truly hazardous” and worthy of mitigation preparations when the probability of hitting Earth reaches 0.5 (any other assumption regarding the decision point is also easily simulated). In this simulation, about 90 percent of impacting NEOs larger than about 140 meters in diameter are discovered in a 10-year survey. The temporal distribution of discoveries in this simulation showed that several percent of the 140-meter-sized objects that impact do so before discovery, but the total number of impactors per century is not large, so that a few percent represents an exceptionally unlikely event. Most of the impactors in this size range are discovered to be truly hazardous within several years of discovery, typically at the next time that the object is in a location in which it is viewable, thus providing warning times of a decade to several decades. By contrast, more than 10 percent of the objects larger than 50 meters in diameter that would impact within 50 years do impact before discovery, and there are many more of these than there are of the larger objects. Such smaller objects would generally be found to be truly hazardous within weeks to months before impact. Objects in the size range of 10 to 50 meters in diameter make up the majority of all potentially hazardous NEOs larger than 10 meters. The damage that could be caused by one of these smaller objects is less than for a larger object, but those smaller ones that are detected are likely to be found, at most, hours to months prior to their final plunge, with civil defense then being the only plausible mitigation strategy. Currently, by far the most probable scenario is that of a small impactor, likely to cause at most only local destruction. However, the assessed probability of any particular scenario is changing with time as the next generation surveys discover most of the larger objects and the understanding of impact processes, such as airbursts and tsunami generation, improves. Thus, planning for mitigation must continue to evolve over time. Furthermore, when working with the statistics of small samples, and particularly when less likely scenarios have outcomes that are so much more catastrophic than the most likely scenario, one should not assume that the next event will be the most likely one.

**Early-warning detection systems are key to effective deflection – it takes time to find, map, and calculate asteroid orbits before we can prepare to deflect them**

**Lynch, 07.** (David K., PhD, is an astronomer and planetary scientist. No date given, “Earth-Crossing Asteroids: How do we detect, measure, and deflect them?” <http://geology.com/articles/earth-crossing-asteroids.shtml>, CALLAHAN)

Can we do anything about an asteroid that is destined to hit the Earth? The answer is, yes, providing that it is small enough and that we have enough time to send a spacecraft to deflect it. As we will see, the longer the warning time we have, the larger the asteroid we will be able manage. Many of the aspects of asteroid impact mitigation were summarized in the Spaceguard Report. More recently, NASA has also completed a study and is being used by congress to decide what steps the US and other nations can and should take. Astronomers have spent a lot of time trying to figure out how to save the Earth from an asteroid impact. First you have to find all the asteroids, calculate their orbits and see which ones come dangerously close to Earth. Once you know the orbit, you can figure out when it will hit. This tells you how much warning time you have. And finally, if you can figure out the asteroid’s mass, you can compute how hard you have to push it in order to change its orbit just enough to miss the Earth. Hollywood’s notion of sending a bomb to “blow it up” is unrealistic because present-day launch vehicles can’t carry a big enough bomb. Besides, instead of one large body, you might end up with many small fragments headed toward Earth. **Finding Them** Finding asteroids is relatively easy. The first one was found by Giuseppe Piazzi in 1801. Several observatories are presently dedicated to finding asteroids and tracking them (Spacewatch, NEAT, Pan-STARRS, LONEOS and others). At the present time, about 80% of asteroids larger than 1 km in diameter have been found. None of these have orbits that would bring carry them to a terrestrial bulls-eye. In 2004, a 250 m size asteroid was discovered that is expected to pass close to Earth on April 13, 2029 (Friday the 13th!). Named Apophis, the asteroid’s impact probability is 1 in 45000 and is expected to decrease as the orbit is refined in coming years. Asteroid 1950 DA will come very close to the Earth in 2880. In view of the uncertainties in its orbit, impact remains a possibility. When it comes to asteroid impacts, size matters. Asteroids smaller than about 10 meters in diameter are little threat because they will break-up or burn up in the atmospheres. Those larger than about 5 km in diameter are too big for us to do anything about. These are only estimates because it is mass, not diameter that is important. Some asteroids are “rubble piles”, loosely consolidated collections of smaller bodies held together by the asteroid’s feeble gravity. Others are tough, dense rocks like chondrites and irons. But roughly speaking, the size range that matters is between 10 m and 5000 meters in diameter. So think in terms of rocks between the size of your house and Mt. Rushmore. If an asteroid is found that has the Earth’s name written on it, there is much to be done. Orbits are not known to infinite precision, there are always small uncertainties. Will it really hit the Earth or will it zip safely past us with a few thousand km to spare? (a few thousand km is very, very close!) While some astronomers work to tighten the accuracy of the orbit, others will try to measure the asteroid’s mass.

**Early-warning detection systems key to solve – undetected asteroid proves**

O’Neill, 08. (Jen O’Neill has worked as a writer for FindingDulcinea and worked for UnitedWay and the NYC Department of Education, December 29, 2008, “Surprise Asteroid Underlines Need for Early Detection System,” http://www.findingdulcinea.com/news/science/2008/December/Surprise-Asteroid-Underlines-Need-for-Early-Detection-System.html, CALLAHAN)

Astronomers are asking for additional funding to monitor asteroid activity with the hopes of detecting potentially devastating asteroids before it’s too late. Astronomers Call for Asteroid Warning Systems. In October, a small asteroid collided with the Earth’s atmosphere over Africa, surprising astronomers who never saw it coming. Although it caused no damage, had the piece of space debris been larger, it could have been “catastrophic for the planet,” wrote Australian paper Herald Sun. Space scientists believe the celestial commotion indicates that there is a need for funding geared toward surveying the skies to predict asteroid patterns, and to learn if any are headed toward the Earth. The asteroid measured two meters across, and was between one and five meters wide—about the “size of a bus,” claims Gareth Williams, associate director of the Minor Planet Center, confirming “something that small would not survive passage through the atmosphere intact.” Williams warned that had the asteroid been larger, however—such as 30 meters across—an entire city could have been taken out. An asteroid as large 300 meters across “could have ended all life on planet Earth.” According to astronomers, a 300-meter-wide asteroid, named Apophis, has a slim chance of hitting the Earth in 2036. The odds of a collision are 1/6250 according to astronomers, and although that’s only a minor chance, they believe “the stakes are too high to ignore.” Opinion & Analysis: More funding needed for asteroid detection Dr. Colin Keay, an associate professor of physics at the University of Newcastle who has studied asteroid activity for over 30 years, told ABC News that only about 10 percent of small and medium-sized asteroids have been mapped by scientists since the “hunt for unidentified near earth objects has begun.” He adds that the operation is small since there’s a lack of government funding. Keay asserts that while we were “lucky” the asteroid did not cause damage, mapping asteroids is extremely important, since “[o]n the small screen of a weapons early warning system, the flaring tail of an asteroid looks remarkably like an incoming ballistic weapon.” Related Topic: The case for early warning systems 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 finding Dulcinea article, an early detections system could provide up to 10 hours of warning so people can evacuate. Reference: What is an asteroid? Most people have seen meteor showers light up the night sky, or have at least heard about Halley’s Comet—which appears once every 75 years. Asteroids are less understood. According to the Hubble Site Reference Desk, asteroids are usually larger masses of rock that, when found in our solar system, often emerge from the asteroid belt located between Mars and Jupiter. The finding Dulcinea Web Guide to Astronomy has resources for finding the best sites to learn the basics, keep up-to-date on news and research, and much more.

## SOLVENCY EXTS – EARLY DETECTION KEY

**ASTEROID MAPPING KEY TO EARLY DETECTION, WHICH IS KEY TO EFFECTIVE DEFLECTION – MUST BE ABLE TO TRACK THE TRAJECTORY WITH PLENTY OF TIME TO PREVENT COLLISION**

Boyd, 09. (Robert S. Boyd is a correspondent for the Courier Mail, based in Australia. January 8, 2009, “Attack from space” lexis, CALLAHAN)

The race is on to stop the disastrous consequences of a large asteroid smashing into Earth, writes Robert S. Boyd. Finding them is one thing, but you have to know your enemy. A BLUE-ribbon panel of American scientists is trying to determine the best way to detect and ward off any wandering space rocks that might be on a collision course with Earth. We're looking for the killer asteroid,'' James Heasley of the University of Hawaii's Institute for Astronomy recently told the committee the National Academy of Sciences. The US Congress asked the academy to undertake the study after astronomers were unable to eliminate an extremely slight chance that an asteroid called Apophis will slam into Earth with devastating effect in 2036. Apophis was discovered in 2004 about 34 million kilometres from Earth on a course that would overlap our planet's orbit in 2029 and return seven years later. Observers said the asteroid -- a massive boulder left over from the birth of the solar system -- was about 300m wide and weighed at least 45 million tonnes. After further observations, astronomers reported the asteroid would harmlessly skim Earth in 2029, but it has a one-in-44,000 chance of slamming into our planet on Easter Sunday, April 13, 2036. Small deviations in Apophis's path could make the difference between a hit or a miss, according to Jon Giorgini, a planetary analyst at NASA's Jet Propulsion Laboratory in Pasadena, California. ``We have not eliminated the threat in 2036,'' Lindley Johnson, the manager of NASA's asteroid detection program, told the committee. The academy panel is headed by Irwin Shapiro, a former director of the Harvard-Smithsonian Centre for Astrophysics in Cambridge, Massachusetts. It has a two-part assignment from Congress: detect and deflect asteroids that might hit Earth. First, the Shapiro committee is supposed to propose the best way to detect and analyse 90 per cent of the so-called ``near Earth objects'' orbiting between Mars and Venus that are wider than 140m by 2020. About 20 per cent of these are identified as potentially hazardous objects because they might pass within 10 million miles of Earth (20 times the distance to the moon). More than 5000 near-Earth objects, including 789 potentially hazardous objects, have been identified so far. Johnson predicted future surveys would find at least 66,000 near-Earth objects and 18,000 potentially hazardous objects. A collision with one or more of these many objects littering the solar system was inevitable, Johnson said. ``Once every 100 years there might be something to worry about, but it could happen tomorrow,'' he said. For example, astronomers had only 24 hours' notice of a small asteroid that blew up over northern Africa on October 7. A larger, more dangerous object presumably would be spotted years ahead, giving us time to change its course before impact. The Shapiro panel's second task is to review various methods proposed to deflect or destroy an incoming object and recommend the best options. They include a nuclear weapon, conventional explosives or a spacecraft that would push or pull the asteroid clear. Offbeat ideas are painting the surface of the asteroid so the sun's rays would heat it differently and alter its direction, and a ``gravity tractor'', a satellite that would fly close to the asteroid, gently nudging it aside. The earlier a dangerous asteroid was found, and the farther it was from Earth, the easier it would be to change its trajectory, panel members were told. A relatively small force would be enough while the object was millions of kilometres away. The year 2029 could be crucial. When Apophis makes its first pass by Earth, its track can be more precisely determined. That will enable astronomers to judge whether Earth will escape with a near miss or will have to take swift action to avoid a collision that could devastate a region as large as Europe or the eastern US. To deflect an asteroid, scientists need to know its shape, weight and composition. A ball of loose rubble would be handled differently from a solid metallic rock. ``Finding them is one thing, but you have to know your enemy,'' NASA Planetary Science Division director James Green said. So far, NASA has spent $US41 million ($60 million) on asteroid detection and deflection, but the Near Earth Object Program is running out of money. ``It's just barely hanging on,'' Shapiro said. Two expensive telescopes to focus on dangerous asteroids have been proposed, but Congress and the incoming administration of Barack Obama must be persuaded to approve the money. ``Without new telescopes, we'd never get to 90 per cent (detection),'' Johnson said. After a lot of original scepticism, Congress now looks favourably on the asteroid project, according to Richard Obermann, the staff director of the House Subcommittee on Space and Aeronautics. ``There used to be a high giggle factor among members,'' Obermann said. ``But it's now a very respectable area of investigation.'' Johnson told the Shapiro committee the search for killer asteroids must have a high priority. ``The space program could provide humanity few greater legacies than to know the time and place of any cosmic destruction to allow ample time to prepare our response to that inevitable event,'' he said.

## SOLVENCY EXTS – EARLY DETECTION KEY

DEFLECTION TECHNOLOGY EXISTS NOW – WE JUST NEED EFFECTIVE EARLY WARNING – FAILURE TO HAVE ADEQUATE WARNING MEANS WE DEFAULT TO NUCLEAR DEFLECTION

Stone 08 (Richard, Asia News Editor of Science, the international weekly magazine, “The State of Our Planet’s Defense,” Science, vol. 319, no. 5868, p. 1329, 3/7/08, <http://www.sciencemag.org/content/319/5868/1329>) [Iuliano]

Experts can't say exactly when the next Earth-bound asteroid will heave into view, but they are confident that humanity has the tools to defend itself. There are several deflection scenarios; in most, the straightforward objective would be to change an asteroid's speed so that it arrives too early or too late to hit Earth. In 2005, former astronaut Edward Lu of Google and astronomer-astronaut Stanley Love, a mission specialist on the shuttle flight last month that delivered the Columbus Laboratory to the space station, proposed a “gravity tractor”: a spacecraft that hovers in front of or behind an asteroid, using its minuscule gravitational force to slightly accelerate it or slow it. The gravity tractor could divert an asteroid from a keyhole, a narrow swath of space where gravitational forces would yank an asteroid onto a trajectory in which it would hit Earth a few years later. Steering an asteroid clear of a keyhole would require less energy and thus is much easier to accomplish than diverting an asteroid on a direct course for Earth. A 1-ton gravity tractor would have to hover more than 3 years near a Tunguska-size, 45-meter-wide NEO on a collision course to change its orbit enough to bypass Earth, says Russell Schweickart, chair of the B612 Foundation. It would take less than 40 days to divert the much-larger Apophis from a keyhole on its close encounter with Earth in 2029, he says. Another way to fiddle with Apophis's speed would be to spray it with material that changes the amount of sunlight it absorbs or reflects. If such a mission were mounted by 2018, just a few-percent change in its energy balance over 18 years would assure that Apophis misses Earth, says Jonathan Giorgini, a senior analyst at NASA. Coaxing an asteroid to miss a keyhole won't necessarily eliminate the risk. Space is littered with keyholes and resonant return points that can sling an object back at Earth. To counter that possibility, scientists are devising ways to slap a transponder on a target asteroid or otherwise send back telemetry revealing whether a follow-up mission is necessary. Last week, The Planetary Society in Pasadena, California, announced the winners of a competition to design a mission that would tag a potentially hazardous near-Earth asteroid to better track its orbit. The top prize of $25,000 went to two companies—SpaceWorks Engineering Inc. in Atlanta, Georgia, and SpaceDev Inc. in Poway, California—for Foresight, a $137 million spacecraft that would shadow Apophis for almost a year, taking its measure with a multispectral imager and a laser altimeter. The European Space Agency (ESA) has a similar mission on the drawing board: Don Quijote, which for €150 million would send a spacecraft to rendezvous with Apophis and precisely measure its position, mass, and other parameters. But Don Quijote is on hold. “Without an imminent impact threat, ESA is focusing on other priorities,” says the agency's Ian Carnelli. A modest-sized asteroid spotted too late for subtle maneuvering could be rammed with a kinetic impactor—a missile, or a spacecraft similar to NASA's Deep Impact probe that crashed into comet 9P/Tempel in 2005. According to a report last year in the journal Science and Global Security, a single strike, with 5 years' lead time, should safely divert an asteroid up to 250 meters wide; many larger asteroids could be deflected with multiple strikes and longer lead times. A gravity tractor in place before the strike could both provide telemetry and give the asteroid an extra nudge, if necessary. Some scientists, meanwhile, favor a nuclear detonation, the force of which could obliterate smaller asteroids—with the hope that any fragments still on target for Earth would burn up in the atmosphere—or alter the trajectory of larger ones. Schweickart, for one, views nukes as a last resort. An asteroid for which other technologies would fail, he contends, comes along only once every 100,000 years or so. However, notes Harvard University astronomer Brian Marsden, “if the warning time is such that an object will hit us in a matter of months or even weeks, the nuclear option is the only one we really have. If the warning time is only days, I really don't know what we would do.”

## SOLVENCY EXTS – SPACE-BASED DETECTION KEY

**A telescope in a Venus-like orbit solves – infrared imaging easier in space**

David, 10. (Leonard is the senior space writer for Space.com and former editor for Ad Astra, the official magazine of the National Space Society and has been reporting on the space industry for more than 50 years. December 21, 2010, “Experts Push for a NASA Asteroid-Hunting Spacecraft,” http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?, CALLAHAN)

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. Moreover, a dedicated NEO-studying spacecraft could help humanity finally come up with a plan for how to thwart ominous NEOs on track to smack our fragile world. Census mandate NASA already has a congressional mandate to catalogue nearby space rocks. 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. 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. Detailed appraisal One concept that has already been fleshed out is dubbed the NEO Survey mission, a detailed appraisal done by Ball Aerospace & Technologies Corporation in Boulder, Colo. Results of a study by Ball Aerospace highlighted how best to meet the George E. Brown objectives for detecting NEOs. [5 reasons to care about asteroids.] As explained in a Ball Aerospace white paper review provided to SPACE.com, in only 1.6 years, a spacecraft could locate all of the roughly 165 feet (50 meter) diameter, and larger, nearby space rocks that are potentially accessible for human spaceflight, and within 7.5 years could catalogue 90 percent of all NEOs greater than 459 feet (140 meters) in diameter. "We have more work to do, but what we've created is a very high-quality existence proof. We have a point design based on real engineering with real parts," said Robert Arentz, a Ball Aerospace Advanced Systems Manager. Arentz told SPACE.com that the NEO survey spacecraft draws upon the firm's heritage of working on NASA's space-based observatories ? from the Hubble Space Telescope and the Kepler exo-planet hunter to the Spitzer infrared telescope and the Wide-field Infrared Survey Explorer, along with the company's comet-smacking Deep Impact spacecraft.

Space based infrared telescopes are more efficient than ground based systems

NAC 10 (NASA Advisory Council, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, 10-6-10, http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf )[JHegyi14]

2.1. NEO Search: To implement this recommendation, the Task Force recommends that NASA immediately initiate a space-based infrared telescopic NEO search project as the primary means of meeting the congressionally mandated George E. Brown NEO Survey goal. NASA was tasked to discover 90 percent of the NEOs larger than 140 meters by the end of 2020 as part of the NASA Authorization Act of 2005 (Public Law No. 109-155). Both ground- and space-based options for meeting the George E. Brown, Jr. NEO Survey goals have been investigated. Although NASA should continue to assist state-of -the-art ground-based optical surveys, including those coming on line or planned by other agencies (e.g., PanSTARRS, LSST), one or more space-based infrared (IR) telescopes in an orbit interior to Earth’s (e.g., a Venus-like orbit) offers several search efficiency advantages. Compared with ground-based optical systems, such space-based systems possess greater discovery efficiency and can more accurately determine the sizes and orbits of potentially threatening objects. The cost of such a survey asset is comparable to the multiple dedicated ground-based alternatives required, and will rapidly meet the legislated completion goal (probably within seven years). Additionally, a space-based survey, with its advantageous observing geometry and frequency, will enable prompt and precise orbit determination of newly discovered NEOs in collaboration with ground-based optical and radar systems, reducing the need for actual deflection campaigns. NASA should also examine the additional costs and observing advantages of a pair of such Venus-orbit survey telescopes, both to complete the overall survey more rapidly and aid in collapsing the error ellipse of worrisome NEOs. These enhanced capabilities may further reduce unnecessary launches of in situ tracking or deflection spacecraft. Although some NEOs are potentially hazardous, their periodic close approaches to Earth also make them among the most accessible objects in the solar system for robotic and human exploration. A space-based IR survey telescope would efficiently find both exploration targets and threatening NEOs currently inaccessible to observation by ground-based systems.

An infrared space based telescope in Venus- like orbit would allow better NEO observation

NAC 10 (NASA Advisory Council, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, 10-6-10, http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf )[JHegyi14]

8. To achieve the NEO search goals in a timely manner as directed by the 2005 George E. Brown NEO Survey legislation, the nation will likely require acquisition and operation of a space-based survey element in addition to ground-based systems. A spacecraft operating with sensors in the infrared band from an orbit sunward of Earth’s (e.g., a Venus-like orbit) offers great advantages in rapid search and repeat observation frequency. 9. When used in conjunction with ground-based optical observations, radar data can dramatically improve orbit knowledge of recently discovered NEOs. However, radars have limited sky coverage and can observe NEOs only at relatively close range. A modest-aperture, space-based infrared telescope with its advantageous orbital geometry (an observing location and direction different than Earth’s) could enable a much larger total of positional observations over much longer orbital tracks. Such tracking from 8 multiple solar system vantage points (e.g. Earth and a Venus-like orbit) will aid in quickly reducing orbit uncertainties when radar follow-up is unavailable. 10. While the search for the NEO population larger than 140 meters is underway and the necessary orbit precision is being obtained, there will be a transition period or window of perceived vulnerability, lasting at least two decades. Some NEOs will present worrisome probabilities of impact, and sufficient orbit precision to rule out an impact may not be obtained before a decision must be made to launch a deflection campaign. The more rapid search enabled by a space-based system will, by aiding early ground-based followup, shorten this window of vulnerability by several years. Impact threats will still appear as the catalog nears completion, but continuing observations will reduce uncertainty and increase warning time

## SOLVENCY EXTS – SPACE-BASED DETECTION KEY

**A SPACE-BASED APPROACH KEY – WE HAVE THE MEANS TO DEFLECT AN ASTEROID, BUT STATUS QUO CAN’T DETECT THEM EARLY ENOUGH**

**Atkinson, 10.** (Nancy is a senior editor for Universe Today, producer for Astronomy Cast, and NASA/JPL Solar System Ambassador. January 22, 2010. “Asteroid Detection, Deflection, Needs More Money, Report Says,” <http://www.universetoday.com/51811/asteroid-detection-deflection-needs-more-money-report-says/>, CALLAHAN)

Are we ready to act if an asteroid or comet were to pose a threat to our planet? No, says a new report from the National Research Council. Plus, we don’t have the resources in place to detect all the possible dangerous objects out there. The report lays out options NASA could follow to detect more near-Earth objects (NEOs) that could potentially cross Earth’s orbit, and says the $4 million the U.S. spends annually to search for NEOs is insufficient to meet a congressionally mandated requirement to detect NEOs that could threaten Earth. “To do what Congress mandated NASA to do is going to take new technology, bigger telescopes with wider fields,” said Don Yeomans, Manager of NASA’s Near Earth Object Program Office, speaking at the American Geophysical Union conference last month. However, Yeomans said work is being done to improve the quality and quantity of the search for potentially dangerous asteroids and comets. “We have a long term goal to have three more 1.8 meter telescopes,” he said, “and the Large Synoptic Survey Telescope with an 8.4 meter aperture in 2016. Once these new facilities are in place, the data input will be like drinking from a fire hose, and the rate of warnings will go up by a factor of 40.” But getting all these facilities, and more, online and running will take continued and additional funding. Congress mandated in 2005 that NASA discover 90 percent of NEOs whose diameter is 140 meters or greater by 2020, and asked the National Research Council in 2008 to form a committee to determine the optimum approach to doing so. In an interim report released last year, the committee concluded that it was impossible for NASA to meet that goal, since Congress has not appropriated new funds for the survey nor has the administration asked for them. But this issue isn’t and shouldn’t be strictly left to NASA, said former astronaut Rusty Schweickart, also speaking at the AGU conference. “There’s the geopolitical misconception that NASA is taking care of it,” he said. “They aren’t and this is an international issue.” Schweickart said making decisions on how to mitigate the threat once a space rock already on the way is too late, and that all the decisions of what will be done, and how, need to be made now. “The real issue here is getting international cooperation, so we can — in a coordinated way — decide what to do and act before it is too late,” he said. “If we procrastinate and argue about this, we’ll argue our way past the point of where it too late and we’ll take the hit.” But this report deals with NASA, and committee from the NRC lays out two approaches that would allow NASA to complete its goal soon after the 2020 deadline; the approach chosen would depend on the priority policymakers attach to spotting NEOs. If finishing NASA’s survey as close as possible to the original 2020 deadline is considered most important, a mission using a space-based telescope conducted in concert with observations from a suitable ground-based telescope is the best approach, the report says. If conserving costs is deemed most important, the use of a ground-based telescope only is preferable. The report also recommends that NASA monitor for smaller objects, and recommends that immediate action be taken to ensure the continued operation of the Arecibo Observatory in Puerto Rico, and support a program at the Goldstone Deep Space Communications Complex. Although these facilities cannot discover NEOs, they play an important role in accurately determining the orbits and characterizing the properties of NEOs. Schweikart quoted Don Yeomans as saying the three most important things about asteroid mitigation is to find them early, find them early and find them early. “We have the technology today to move an asteroid,” Schweikart said. “We just need time. It doesn’t take a huge spacecraft to do the job of altering an asteroid’s course. It just takes time. And the earlier we could send a spacecraft to either move or hit an asteroid, the less it will cost. We could spend a few hundred million dollars to avoid a $4 billion impact.”

**SPACE-BASED TELESCOPES ARE NECESSARY TO PROVIDE ENOUGH LEAD TIME TO PREVENT A COLLISION**

**Park et al 05 (**Daniel D. Mazanek, Carlos M. Roithmayr, and Jeffrey Antol Langley Research Center, Hampton, Virginia Sang-Young Park, Robert H. Koons, and James C. Bremer Swales Aerospace, Inc., Hampton, Virginia Douglas G. Murphy, James A. Hoffman, Renjith R. Kumar, and Hans Seywald Analytical Mechanics Associates, Inc., Hampton, Virginia Linda Kay-Bunnell and Martin R. Werner Joint Institute for Advancement of Flight Sciences (JIAFS) The George Washington University, Hampton, Virginia Matthew A. Hausman Colorado Center for Astrodynamics Research The University of Colorado, Boulder, Colorado Jana L. Stockum San Diego State University, San Diego, California, “Comet/Asteroid Protection System (CAPS): Preliminary Space-Based System Concept and Study Results” NASA, May 2005, <http://www.nss.org/resources/library/planetarydefense/2005-CometAsteroidProtectionSystem(CAPS)-NASA.pdf)> rory

Finally, any attempt to deflect an impacting NEO with reasonable lead time is likely to be accomplished only by using a space-based deflection system. Many deflection approaches are possible given sufficient warning time, particularly decades of advance notice. Immediate threats are extremely difficult to defend against, and likely require highly capable spacecraft that can quickly engage the target and provide large, rapid changes in the object’s orbital velocity to avert a collision. These requirements, plus the desire to modify the orbit in a controlled manner, considerably restrict the potential methods that could be used to alter an impactor’s trajectory. It is essential to understand that the issues associated with detection and deflection of an impactor are intimately connected, particularly if we are not afforded decades of warning time that would be necessary for large NEAs. The requirements for the detection system could be significantly reduced given an extremely robust deflection capability. However, due to the enormous amounts of energy required to move these massive bodies, any additional warning time is an extremely valuable asset.

## SOLVENCY EXTS – SPACE-BASED DETECTION KEY

**SPACE-BASED DETECTION BEST – IT CAN DETECT NEOs BY MEASURING ENERGY FIELDS**

**Arentza et al 2010** (Robert, Ball Aerospace & Technologies Corp; Harold Reitsema, Ball Aerospace & Technologies Corp; Jeffrey Van Cleve, SETI Institute, NASA Ames Research Center; and Roger Linfielda, Ball Aerospace & Technologies Corp, “NEO Survey: An Efficient Search for Near-Earth Objects by an IR Observatory in a Venus-like Orbit,” 1/28/10, <http://www.lpi.usra.edu/decadal/sbag/topical_wp/RobertFArentz.pdf>) [Iuliano]

Groundbased searches at visible wavelengths are nearing 90% completeness for NEOs of diameter >1km. Extending the effort down to diameters of 140 meters, and smaller, is challenging from the ground due to: visible albedos of ~20% or less; unfavorable phase functions in reflected light; and difficulties observing near the Sun. Using a dedicated mid-IR telescope in a Venus-like orbit greatly improves the search efficiency for several reasons including: NEOs in small orbits can be seen at larger solar elongation angles; most of the energy radiated by NEOs is in the thermal IR; and the phase function of thermal emission is more favorable than for reflection. Also, NEO Survey accesses a greatly expanded near-Earth region in its field of regard (FOR). Additionally, NEOs in roughly Earth-like orbits have Earth-like periods and usually reside in the daytime sky. For example, a NEO within 5% of an Earth-like orbit closely approaches the Earth every 20 years. Such a NEO resides in the daytime sky and is hard to find from the ground. From a Venus-like orbit all such objects are easily detectable on the scale of ~520 days.

The accuracy of a space based telescope would make up for the cost to build and launch it

Friend 11 (Tad, Staff Writer, “Vermin of the Sky”, New Yorker, Vol. 87 Issue 2, p22-29, 2/28/2011, EBSCO) [Iuliano]

On the second day of the conference, as the Task Force began to discuss its recommendations, Schweickart addressed Richard Binzel: "So your question, which got me thinking half the night, was 'How do we get the most precise orbits?' Because getting precision on these things turns out to be more important than finding more of them." The group had heard two proposals for placing a satellite equipped with an infrared telescope--the ideal tool for picking up NEOs, which are dim in the visible spectrum--in a Venus-like orbit. Such a satellite would enable NASA to meet the congressional requirement for spotting smaller NEOs in seven and a half years--rather than the twenty to forty allowed by ground-based telescopes--and also to track NEOs for longer periods and pin down their orbits. Schweickart, with the enthusiasm of a new convert, now suggested that such a telescope would "dramatically pay for itself," as it would obviate expensive false-alarm deflection missions. Surprised, Binzel said, "We're in violent agreement!" But then Brian Wilcox, the robotics expert, posed another challenge to Schweickart's plans. He questioned the need to test a deflection mission, pointing out that, even though the NASA survey has been seriously underfunded, "we've gone in the last dozen years from an estimate of 1,166 fatalities per year to ninety-one. And pretty soon we're going to be down to twenty-five per year--a number that derives from a twenty-five-thousand-fatality event that happens every thousand years, probably somewhere outside the United States. Just to play devil's advocate, we kill forty thousand people a year in America on the freeways. An intelligent person from the outside world is going to say, 'Why do we need to do anything more than keep looking as we have been?'" NASA's position is that its survey has pretty much ruled out our being hit by any planet- or country-killing NEOs in the next century; the agency's Jim Green told me, "We now know, to a high degree of probability,that we're not under imminent threat in our lifetimes." One well-placed government expert argues that NASA's confidence is unfounded: "We're not effectively safer; we're just better informed. If an asteroid heads for us, we still have no plan in place." Indeed, if an unknown comet or asteroid were to pop out from behind the sun, we'd have just three to six days' warning. And while long-period comets pose less than one per cent of the over-all threat, their sheer mass and force would make them almost invincible, even with years of warning. In 2005, Ball Aerospace banged a rocket into the comet Tempel-1 at twenty-three thousand miles per hour, basically to see what would happen. The comet was unfazed. What's more, recent work by the physicist Mark Boslough has shown that even asteroids well under Congress's hundred-and-forty-metre limit can cause significant damage.Boslough persuasively argued, using computer simulations, that the asteroid that flattened the Tunguska forest in 1908 was only thirty to fifty metres wide--about one-third as massive as had been thought. Boslough determined that the bolide actually blew up in the air, creating a violent downward shock wave. All of which means, as there are many more small asteroids than large ones, that we've been hit with airbursting asteroids--and will continue to get hit--much more than we'd thought, as often as every two hundred years. And small ones are the hardest to detect. "The actuarial argument is important," Chapman now told Wilcox. "But, unlike with Hurricane Katrina, we can do something about an asteroid. The question is whether we'd rather be wrong in overprotecting or underprotecting."

**2 Space based telescopes solves best --- detects 99% >140 m, and 80% >60 m**

Linfield et al 8 (Roger, Ball Aerospace & Technologies Corp; Jeffrey vanCleve; Harold J. Reitsema; and Robert Arentz, “Searching for Near Earth Objects from a Venus-like Orbit,” 1/7/08, <http://www.lpi.usra.edu/meetings/lpsc2008/pdf/1412.pdf>) [Iuliano]

Using larger telescopes improves the completeness only mildly, because of a phasing problem. The NEOs with the longest orbital periods (4 – 8 years) spend almost all their time far from the sun, where they are quite faint in both IR and visible bands when observed from Earth or Venus orbit. These NEOs only pass perihelion once during an observing program of ~7 years. If this passage happens when the spacecraft is on the other side of the sun, the NEO will be outside the telescope field of regard and not accessible. Attaining substantially better completeness requires a second telescope in a different orbital location, either in the same orbit but ~180 degrees away (an anti-correlated location), or else on the Earth (an uncorrelated location). With two 0.5 m diameter IR telescopes 180 degrees apart in the 0.60 × 0.80 A.U. orbit, we can get 99% completeness in seven years for >140 m diameter NEOs. With one 0.5 m diameter IR telescope in this orbit plus a 1.8 m diameter visible telescope on Earth (for example, Pan-STARRS 1), we can get 93% completeness on >140 m objects. With these two telescope combinations, we can achieve reasonable completeness on substantially smaller objects. For NEOs with diameter >60 m and the same seven year observing program, we can achieve 81% completeness with our twin telescopes in space, and 69% completeness with the combination of space IR and visible ground telescope.

## SOLVENCY EXTS – SPACE-BASED DETECTION KEY

**Space based solar telescopes are essential to detecting all NEO’s – land-based can’t detect during the day during to solar glare**

**Schweickart et al 08** (Russell - former astronaut and former co-chairman of the Task Force on Planetary Defense of the NASA Advisory Council, “Asteroid Threats: A Call For Global Response”, Association of Space Explorers International Panel on Asteroid Threat Mitigation Sept. 25, 2008, <http://www.space-explorers.org/ATACGR.pdf>) rory

From the daylight hemisphere, NEO detection and tracking are restricted to radar telescopes. Asteroid impacts occur on both the daylight and night sides of the Earth in roughly equal numbers. While there are exceptions, asteroids impacting on the sunlit hemisphere appear to approach the Earth from the direction of the Sun, while those impacting at night appear to approach from the anti-Sun direction. As a result, while ground-based optical telescopes can observe the approach of night impactors, they cannot (due to solar glare), be used to detect and track those close to impact on the day side. 7 6 Generally, any action reducing the consequences of a threatened NEO impact. It usually refers to those actions short of physical deflection of a NEO (e.g. evacuation). 7 A radio telescope which has the capability of active radio transmission, used to obtain precision tracking of NEOs. Radar tracking complements optical tracking and, when available, can significantly improve predictions of NEO orbits. , which are insensitive to the bright sky. Furthermore, while optical telescopes can detect and track the smallest NEOs of concern from 1 to 6 months before impact, radar systems with their limited range can only “see” objects this size within 3 to 6 days of impact, provided the operators know precisely where to look. Thus, for an impactor approaching from the sunlit side, there will be a maximum of 3-6 days of warning time for the evacuation of a potentially large target zone. Even that minimal warning would be available only for those asteroids detected on a previous close pass by the Earth; that earlier tracking would provide us with the predicted impact time and direction of approach necessary for aiming our radar telescopes. Because radar observatories have small fields of view and cannot view the entire sky, an undetected asteroid approaching Earth from the daylight side will give us little or no warning.

## SOLVENCY EXTS – GROUND-BASED DETECTION FAILS – SMALL NEOs

**THE STATUS QUO’S RELIANCE ON GROUND-BASED DETECTION FOR SMALLER NEOs FAILS - ALBEDOS ARE HARD TO DETECT FROM EARTH’S GROUND SURFACE**

**Arentza et al 2010** (Robert, Ball Aerospace & Technologies Corp; Harold Reitsema, Ball Aerospace & Technologies Corp; Jeffrey Van Cleve, SETI Institute, NASA Ames Research Center; and Roger Linfielda, Ball Aerospace & Technologies Corp, “NEO Survey: An Efficient Search for Near-Earth Objects by an IR Observatory in a Venus-like Orbit,” 1/28/10, <http://www.lpi.usra.edu/decadal/sbag/topical_wp/RobertFArentz.pdf>) [Iuliano]

Groundbased searches at visible wavelengths are nearing 90% completeness for NEOs of diameter >1km. Extending the effort down to diameters of 140 meters, and smaller, is challenging from the ground due to: visible albedos of ~20% or less; unfavorable phase functions in reflected light; and difficulties observing near the Sun. Using a dedicated mid-IR telescope in a Venus-like orbit greatly improves the search efficiency for several reasons including: NEOs in small orbits can be seen at larger solar elongation angles; most of the energy radiated by NEOs is in the thermal IR; and the phase function of thermal emission is more favorable than for reflection. Also, NEO Survey accesses a greatly expanded near-Earth region in its field of regard (FOR). Additionally, NEOs in roughly Earth-like orbits have Earth-like periods and usually reside in the daytime sky. For example, a NEO within 5% of an Earth-like orbit closely approaches the Earth every 20 years. Such a NEO resides in the daytime sky and is hard to find from the ground. From a Venus-like orbit all such objects are easily detectable on the scale of ~520 days. Recent work by Dr. Mark Boslough4 shows that the impact physics of NEOs in the 30-100 meter range has been misunderstood due to a process he calls a Low-Altitude Airburst (LAA), which is a newly recognized threat regime that has been previously underestimated. In an LAA event the main body of the NEO comes apart at high altitudes (~80 km to ~10 km), but the object’s mass and kinetic energy are conserved as a fast moving, loosely aggregated, collection of particles which entrain a column of air reaching the ground in what might be termed an “air hammer.” Dr. Boslough’s work shows that the “air hammer” from NEOs as small as 30 meters inflicts significant damage, as was seen in the 30-meter-class Tunguska event. Dr. Boslough has also shown that an LAA from a ~100 meter diameter NEO melted sand into glass across a region about 10 km in diameter during Libyan Desert Glass impact ~35 million years ago. During this event the LAA’s fireball settled onto parts of Egypt and Libya for about a minute with temperatures approaching 5,000K. It’s hypersonic blast wave extended radially for about 100 kilometers. Dr. Boslough has also shown that the interaction of the LAA with the ocean’s surface is much different from a large object’s strike, and that any ensuing tsunami is not yet well modeled. Therefore any survey instrument capable of searching well below 140 meters is quite valuable.

**Ground based telescopes fail – can’t see many asteroids**

Abell, 11 (Dr. Paul Abell, Astromaterials Research and Exploration Science, 2011 IAA Planetary Defense Conference, 7/18/11) Hou

Human accessibility of known objects larger than 30 m requires exposing astronauts to long duration missions and entails development of many advanced technologies and capabilities. Even if these capabilities are assumed, consideration of NEOs within the current database available for human exploration constrains program flexibility and increases budgetary risk. However, there is excellent evidence to suggest that the current number of known NEOs is only a small fraction of the total population**.** This evidence motivates discovery of additional mission targets among the NEO population to aid in the development of a robust and affordable exploration strategy. Improved knowledge of the NEO population is not only scientifically valuable, but is crucial for planetary defense since many of the accessible NEOs discovered would be potentially hazardous objects**.** Affordable mission scenarios involve NEOs that can be visited with the minimum practicable mass launched to low Earth orbit, short mission durations, and reasonable Earth re-entry speeds. The most suitable targets for human missions are NEOs in Earth-like orbits with long synodic periods, but these mission candidates are often not observable from Earth via ground-based telescopes until the timeframe of their most favorable human mission opportunities, and thus preclude appropriate time for mission development. These objects spend much of their orbital periods in day-time sky viewing geometries that are not conducive to their discovery from ground-based systems. However, this same phasing that places these objects in the daytime sky and makes them difficult to observe, also enables round-trip missions to these targets with minimal propulsion and duration requirements.

**Ground based observatories restricted by weather—space-based near-Earth and interplanetary observatories more effective Chapman et. al, 2001**, (Clark, Daniel Durda, Robert Gold, Senior Scientists of Southwest Research Institute and Johns Hopkins University, “THE COMET/ASTEROID IMPACT HAZARD: A SYSTEMS APPROACH”, February 24, 2001, <http://www.internationalspace.com/pdf/NEOwp_Chapman-Durda-Gold.pdf>) [Waxman]

There are three basic approaches to searching for potentially threatening objects: groundbased, spacebased near-Earth, and interplanetary. Groundbased searches have the enormous cost advantage of not having to be launched into space and maintained there. However, the duty cycle is restricted by daylight and cloudy weather, and the atmosphere degrades sensitivity in several ways. Earth-orbital observatories overcome some of these difficulties and might be of comparable cost if they could be piggy-backed onto some of the many other enterprises that operate Earth-orbiting satellites. Recently, there was reported to be a potential opportunity – for little more than the cost of building the instrument – to fly an NEA detector on a Canadian satellite (A. Hildebrand, 2000, personal communication). Interplanetary observatories are the most costly of all, but have the potential for enormous gains over Earthbased techniques in detectability of certain kinds of NEAs. Such gains are much more likely to be realized for objects like Atens, which are confined to the comparatively modest volume of the inner solar system and could be searched for advantageously from a location well inside the Earth’s orbit. The advantage of getting closer to outer solar system objects, like comets, is overwhelmed by the enormous volume of space that would have to be searched from a location like Jupiter’s orbit.

## SOLVENCY EXTS – GROUND-BASED DETECTION FAILS

**OUR GROUND-BASED TELESCOPES ARE MISSING THOUSANDS OF NEOs – NUMBERS WILL ONLY INCREASE**

**Haack et al 05** (H. Haack, Geological museum, University of Copenhagen, P.R. Bidstrup, Geological Museum University of Copenhagen, G. Grillmayer, Institute of Space Systems, University of Stuttgart, A.C. Andersen, Dark Cosmology Center, Niels Bohr Institute, University of Copenhagen, J.L. Jorgensen, Danish Technical University, “Automated Detection of Small Bodies By Space Based Observation”, Dec 27, 2005, <http://dark.dark-cosmology.dk/~anja/papers/Bidstrup_etal06.pdf>) rory

The number of known comets and asteroids is increasing every year. Up till now this number is including approximately 250,000 of the largest minor planets, as they are usually referred. These discoveries are due to the Earth-based observation which has intensiﬁed over the previous decades. Additionally larger telescopes and arrays of telescopes are being used for exploring our Solar System. It is believed that all near-Earth and Main-Belt asteroids of diameters above 10 to 30 km have been discovered, leaving these groups of objects as observationally complete. However, the cataloguing of smaller bodies is incomplete as only a very small fraction of the expected number has been discovered. It is estimated that approximately 10 10 main belt asteroids in the size range 1 m to 1 km are too faint to be observed using Earth-based telescopes. In order to observe these small bodies, space-based search must be initiated to remove atmospheric disturbances and to minimize the distance to the asteroids and thereby minimising the requirement for long camera integration times.

## AT: CAN’T ASSESS THE RISK

**WE CAN ASSESS THE RISK OF ASTEROIDS ENOUGH TO JUSTIFY POLICY ACTION – WE CAN NEVER KNOW 100% UNLESS WE FUND MORE NEO SEARCH EFFORTS**

Lloyd 2010 [Robin - responsible for editing and assigning stories for SCIENTIFIC AMERICAN’s Web site. She also manages SCIENTIFIC AMERICAN’s Twitter feed. Previously, she was a senior editor for LiveScience.com and SPACE.com. She has additional experience in print journalism, wire journalism (and network online journalism (CNN.com). She has a PhD in sociology from the University of California, Santa Barbara, and received a Knight Science Journalism Fellowship at the Massachusetts Institute of Technology, “Competing Catastrophes - Asteroid Impact or Climate Change?” *Scientific American* , <http://www.scientificamerican.com/article.cfm?id=asteroid-impact-climate-change>] ttate

Human risk assessments for asteroid impacts are confusing in part because there has never been an asteroid impact in historic times that has caused even a local disaster (setting aside the 1908 flattening of more than 2,000 square kilometers of sparsely populated taiga near the Tunguska River in Siberia), let alone a global catastrophe. Nevertheless, scientists can estimate the risk and the frequency of such events quite well, Harris says. Here is a rough outline of how it's done, he says: "In round numbers, [this risk] is dominated by very large events that would kill about a billion people, and happen about once in a million years—thus, in round numbers, about 1,000 per year. Present [NEO] surveys have found about 90 percent of that risk, and provided assurance that no such event will happen in the next century or so from the 90 percent we have found. So the leftover short-term risk is around 100 [per] year, as tabulated." Harris says he agrees with much of what Boslough wrote in Appendix D: "It was important as a matter of 'due process,' the scientific endeavor cannot tolerate suppression of dissent. On the other hand, it is also unfortunate because…it has distracted attention from the central messages of the report." The distraction is unfortunate, Boslough says, adding that he only insisted on the minority opinion because it was more important to include the climate change information than to avoid the potential for distraction. The report, which came out in January and with which Boslough otherwise fully agrees, reveals that the scientific inventory of Earth-threatening space objects (asteroids and comets), especially the smaller ones that are most likely to impact our planet, is far from complete and unlikely to improve significantly without a greatly increased funds for NEO search programs. And our preparedness, if scientists found a moderate to large asteroid with our name on it, is weak—it'd take at least a decade to mount a space mission to deflect the object. And that might not be soon enough.

## AT: WE CAN ADAPT

**AND, LIFE WAS NOT ABLE TO ADAPT TO THE LAST MAJOR ASTEROID COLLISION**

**Gale Encyclopedia of Science, no date**, (Gale Encycopedia of Science, “The Asteroid-Impact Theory” no date, [http://booklists.narod.ru/P\_Physics/PGe\_Encyclopaediae/Lerner\_K.L.\_\_Lerner\_B.W.\_\_eds.\_\_Vol.2.\_The\_Gale\_encyclopedia\_of\_science.\_Charge\_coupled\_device\_\_\_Eye\_\_Thompson\_Gale\_\_2004\_\_380dpi\_\_T\_\_C\_\_792s\_.20.htm)[Max](http://booklists.narod.ru/P_Physics/PGe_Encyclopaediae/Lerner_K.L.__Lerner_B.W.__eds.__Vol.2._The_Gale_encyclopedia_of_science._Charge_coupled_device___Eye__Thompson_Gale__2004__380dpi__T__C__792s_.20.htm)%5bMax) Waxman]

The primary cause of the Cretaceous [mass extinction](http://science.jrank.org/pages/4157/Mass-Extinction.html) was a mystery for decades, until geologists discovered a thin layer of rock that marks the boundary between the Cretaceous period and following Tertiary period; this layer of sediments is termed the K-T boundary, and gave rise to the asteroid-impact theory of the Cretaceous extinction. The asteroid-impact theory was first proposed in detail in 1978, by a team led by American geologist Walter Alvarez (1940–) and physicist Luis Alvarez (1911–). The Alvarez team analyzed sediment collected in the 1970s from the K-T layer near the town of Gubbio, Italy. The samples showed a high [concentration](http://science.jrank.org/pages/1706/Concentration.html) of the element iridium, a substance rare on [Earth](http://science.jrank.org/pages/2214/Earth.html) but relatively abundant in [meteorites](http://science.jrank.org/pages/2643/Extinction-asteroid-impact-theory.html). Other samples of K-T boundary [strata](http://science.jrank.org/pages/6533/Strata.html) from around the world were also analyzed; excess iridium was found in these samples as well. Using the average thickness of the sediment as a guide, they calculated that a meteorite about 6 mi (10 km) in diameter would be required to spread that much iridium over the whole Earth. If a meteorite that size had [hit Earth](http://science.jrank.org/pages/2643/Extinction-asteroid-impact-theory.html), the dust lofted into the air would have produced an enormous cloud of dust that would have encircled the world and blocked out the sunlight for months, possibly years. This climactic change would have severely depressed [photosynthesis](http://science.jrank.org/pages/5196/Photosynthesis.html), resulting in the death of many plants, subsequent deaths of herbivores, and finally the death of their predators as well. (This chain of events would have occurred so rapidly that there would have been no chance for evolutionary [adaptation](http://science.jrank.org/pages/67/Adaptation.html) to the new environment, which requires thousands of years at minimum.) A major problem with the theory, however, was that a 6-mi (10-km) meteorite would leave a very large crater, 93–124 mi (150–200 km) in diameter—and while Earth has many [impact craters](http://science.jrank.org/pages/2643/Extinction-asteroid-impact-theory.html) on its surface, few are even close to this size, and none of the right age was known.

## AT: TECH DOES NOT EXIST

**TECHNOLOGY FOR ASTEROID DETECTION IS FEASIBLE – IT IS MATTER OF DEDICATING MORE RESOURCES FOR DEVELOPMENT**

**URIAS ET AL 1996** [John M – colonel, “Planetary Defense: Catastrophic Health Insurance for Planet Earth”, A research paper presented to Air Force 2025, October, <http://csat.au.af.mil/2025/volume3/vol3ch16.pdf>] ttate

We should also realize that the technology required for a system to mitigate the most likely of impact scenarios is, with a little concerted effort, within our grasp. There are no current means for preventing many such natural disasters as earthquakes, tornadoes, and typhoons. Some of these disasters can not even be detected in time to give adequate warning to the affected population. Such is not the case with ECOs. Humanity certainly has the technology that, with a relatively modest investment, to warn of an impending catastrophe, maybe years or decades in advance. In most cases, an associated mitigation system could use the latest nuclear explosives, space propulsion, guidance, and sensing and targeting technologies, coupled with spacecraft technology. These technologies already are related to defense capabilities, but how they are developed for use in space (and what effects they have) will offer invaluable experience for defense efforts. We can maximize our investment by turning to the commercial world for technology development and highlight opportunities for dual-use possibilities.19 Space operations will continue to grow at a rapid rate as a factor in United States military capabilities limited primarily by affordable access.

## AT: THEY JUST CAN’T BE DETECTED

**Detection is feasible, but only with more funding and impetus**

Clark, 10. (Stephen is a senior reporter for SpaceFlightNow, January 22, 2010, “More funding needed to meet asteroid detection mandate,” http://spaceflightnow.com/news/n1001/22neo/index.html, CALLAHAN)

NASA is not doing enough to complete a mandated search for Earth-threatening asteroids and comets because the space agency is not receiving enough money for the problem, according to a National Research Council report. In a report released Friday, scientists said Congress and the administration have not requested or appropriated funding to complete a survey mandated in the NASA Authorization Act of 2005. Called the George E. Brown, Jr., Near-Earth Object Survey, the detection program was tasked with discovering 90 percent of Near-Earth Objects, or NEOs, larger than 140 meters, or 459 feet, by 2020. NEOs of that size would have regional or continental affects if they struck Earth. "You have this conflict between having a very small probability of anything bad happening, versus a terrific impact if there is a bad event," said Irwin Shapiro, chairman of the NEO committee from the Harvard-Smithsonian Center for Astrophysics. Congress asked the National Research Council in 2008 to determine the best way to achieve the George Brown survey. "If there were really a credible threat, money would flow like water, but it may be too late if we don't do anything preparing ahead of time," Shapiro told Spaceflight Now in a Friday interview. NASA currently spends about $4 million per year searching for NEOs, but accomplishing the George Brown survey by the 2020 deadline is now unattainable. "To complete the George Brown survey, you're probably talking about something like $50 million a year, at least to complete it in a reasonable time scale," said Michael A'Hearn, the research committee's vice chairman and an astronomy professor at the University of Maryland, College Park. Knowing where threatening objects are and developing viable mitigation strategies is like buying insurance on your house, Shapiro said. With current technologies, it may take up to a century to find the bulk of the 140-meter class asteroids, according to scientists. "There's no way to do it by 2020 now because there's been no funding for it since it was mandated," A'Hearn said. NASA is close to completing the Spaceguard project, another legislative mandate to find 90 percent of NEOs larger than 1 kilometer, or about 3,300 feet, in diameter. Such objects are large enough to have global affects if they impact Earth. More than 6,700 NEOs have been discovered to date, including more than 800 objects greater than 1 kilometer in size, according to a NASA Web site. A'Hearn said there are no known large objects that pose a credible threat to Earth within the next century, but there are plenty of smaller asteroids that still have not been detected. "If we were to discover one that is about to hit us, we wouldn't know what to do. In that sense, no one is doing enough," A'Hearn said in an interview Friday. The committee proposed two alternatives, one option that would relatively quickly detect NEOs larger than 140 meters, and another that limits costs but delays the survey. "If completion of the survey as close to the original 2020 deadline as possible is considered most important, a space mission conducted in concert with observations using a suitable ground-based telescope is the best approach," the report said. "This combination could complete the survey well before 2030, perhaps as early as 2022 if funding were appropriated quickly." A'Hearn said infrared telescopes tailored for asteroid and comet surveys have been proposed to be launched into Earth orbit or a solar orbit near Venus, but none have been selected by NASA. "There's nothing in the pipeline," A'Hearn said. The WISE telescope launched by NASA in December is capable of detecting new asteroids, but it won't come close to fulfilling the Brown survey requirements, according to A'Hearn. A cheaper option would be to utilize a large ground-based telescope such as the Large Survey Synoptic Telescope, a U.S.-led observatory to be built in Chile. "It would detect all moving objects in the solar systme, as well as transient objects in outer space," Shapiro said. When the LSST facility begins observations around 2016, it could single-handedly complete the George Brown survey. But it would cost about $125 million to modify the telescope for NEO detections, according to Shapiro. In its report, the panel analyzed hypothetical funding levels of $10 million, $50 million and $250 million annually. While $10 million would be insufficient to significantly improve NEO observations, greater funding would permit NASA to accomplish the George Brown survey, albeit up to 10 years late. $50 million per year is enough funding to mount an observation campaign with a ground-based telescope, and the $250 million funding level would allow NASA to develop a spacecraft to detect NEOs, or even pay for missions to demonstrate deflecting asteroids. "Whether you try to do it in space quickly, or on the ground somewhat more slowly, is a question of political will," A'Hearn said. Shapiro's team also recommended searching for objects as small as 30 meters, or about 100 feet. An object about that size was the culprit of the Tunguska event in 1908, which leveled a sizable chunk of the Siberian wilderness. "As we get down to these smaller objects, late discoveries are going to become more common," A'Hearn said. Congress also requested the National Research Council study mitigation techniques that could be employed after an object is found heading for Earth. Scientists say a major part of the problem is that asteroid impacts are not part of the U.S. defense framework.

## AT: THEY WILL JUST COLLIDE IN OCEAN

**AN ASTEROID COLLAPSE IN THE OCEAN COULD WIPE OUT OVER HALF OF THE OZONE LAYER**

**Hsu, 2010,** (Jeremy, senior writer for live science, “Asteroid Strike Could Force Humans into Twilight Existence”, October 26, 2010, <http://www.livescience.com/8825-asteroid-strike-force-humans-twilight-existence.html>) [Max Waxman]

An asteroid splashdown in one of Earth's oceans could trigger a destructive chemical cycle that would wipe out half the ozone layer, according to a new study. The massive loss of protection against the sun's ultraviolet (UV) radiation would likely force humans into a vampire-style existence of staying indoors during daylight hours. The worst scenario based on an asteroid 0.6 miles (1 kilometer) wide would re-create the [hole in the ozone layer](http://www.ouramazingplanet.com/the-downside-of-the-recovery-of-the-ozone-hole-0317/), which appeared over Antarctica during the 1990s, except this would be worldwide. UV levels in the study's simulation soared beyond anything measured so far on Earth by the UV Index's daily forecasts of overexposure to UV radiation, and remained that way for as long as two years. "An [asteroid impact in the ocean](http://www.livescience.com/10203-66-foot-waves-hit-york-ancient-asteroid-splashdown.html) is always dismissed as being a danger for coastal sites, but not much else has been discussed about it," said Elisabetta Pierazzo, a senior scientist at the Planetary Science Institute in Tucson, Ariz. "I was looking at the asteroid hazard from climatic effects."

**AN ASTEROID COLLISION IN THE OCEAN WOULD ACTUALLY DO MORE DAMAGE – TSUNAMIS**

Cowen 98(Ron, astronomy and physics writer at Science News in Washington, “Asteroid Impact: Beware the Tsunami,” Science News, Vol. 153, No. 6, pp. 88, 2/7/98, <http://elibrary.bigchalk.com/elibweb/elib/do/document?set=search&dictionary>

Click=&secondaryNav=advance&groupid=1&requestid=lib\_standard&resultid=9&edition=&ts=7AF20472F747CC7BAE0A6844F8D17AED\_1310523077944&start=1&publicationId=&urn=urn%3Abigchalk%3AUS%3BBCLib%3Bdocument%3B29553148) Ben I.

Pop quiz: Does an asteroid slamming into Earth do more damage if it lands on solid ground or if it plows into the middle of the ocean? Give yourself a Bronx cheer if you chose the first answer. Surprising as it may seem, a watery landing holds the greater potential for destruction, says Jack G. Hills of Los Alamos (N.M.) National Laboratory. An asteroid striking solid ground deposits its energy rapidly in a relatively small volume. A body striking the ocean creates waves that retain enormous energies as they travel great distances across the water's surface, Hills says. These waves, called tsunamis, can scour thousands of kilometers of coastline with debris and towering walls of water. In 1960, an earthquake-generated tsunami that originated in Chile spread halfway across the world, killing 200 people when it reached Japan. When a tsunami hits a continental shelf, it slows down but grows higher. Hills and Charles Mader, retired from Los Alamos, calculate that a 5-kilometer-wide asteroid striking the mid-Atlantic would swamp the upper East Coast of the United States. The tsunami would also drown the coasts of France and Portugal. Hills presented the findings last month at a meeting of the American Astronomical Society in Washington, D.C. A 5-km-wide asteroid is expected to hit Earth only once every 10 million years, but rocky bodies as little as 200 meters in diameter are much more common and can also spawn tsunamis. For example, an asteroid 400 m across would create a wall of water reaching 100 m high, Hills and Mader find. Earlier calculations by Hills and M. Patrick Goda, then at Los Alamos, had revealed that an asteroid slamming into the ocean can pack a wallop. After the researchers published their preliminary findings in the March 1993 ASTRONOMICAL JOURNAL, Hills enlisted Mader, an expert in tsunamis, to help with detailed computer simulations. Additional modeling over the next 3 years should reveal the damage caused by smaller asteroids, which is more difficult to calculate, Hills says. He notes that if an asteroid can be discovered before it strikes, a nuclear-powered rocket might be used to direct it away from Earth.

**Asteroids hitting the water would cause the most powerful tsunamis**

**Marusek, 2007,** (James, Retired U.S. Navy Physicist and Engineer, “Comet and Asteroid Threat Impact Analysis”, April 26, 2007, <http://www.aero.org/conferences/planetarydefense/2007papers/P4-3--Marusek-Paper.pdf>) [Waxman]

An ocean impact will create a compression wave in the water. The compression wave may be sufficient to implode deeply submerged objects, such as submarines. A large ocean impact will produce a large tsunami. Tsunami is Japanese for "harbor wave". Tsunami generally travel quickly across the ocean, typically at speeds of 380 mph (0.17 km/s).11 In deep water the impact tsunami height might be several thousand feet high for a Cretaceous/Tertiary (K/T) size impactor, but the height may increase dramatically as the waves reach the shoreline because the wave slows in shallow water and the energy becomes more concentrated. The impact tsunami may produce several mile high wave fronts that could travel several hundred miles inland.12 Tsunamis are of concern because they propagate over great distances and much of the world’s populations are located near coastal regions.

## AT: THEY WILL JUST COLLIDE IN OCEAN

**Asteroid impact with the ocean worse than on land Projects to Employ Resources of the Moon and Asteroids Near Earth in the Near Term, 2002**, (Projects to Employ Resources of the Moon and Asteroids Near Earth in the Near Term, 2002, “Earth Impact by an Asteroid: Prospects and Effects”, <http://permanent.com/a-impact.htm>) Waxman

At the other end of the spectrum are the 1 km asteroids. That kind of impact would wipe out life within proximity of the impact site. However, more serious is how it would affect the whole world in indirect ways. The dust and/or vapor cloud created by an impact to either the land or the ocean could be big enough to create a "nuclear winter" like mini-ice age, and disrupt climatological wind patterns, adversely affecting major food-growing regions of the world, thus straining world food supplies, prices, governments and civilization. However, such an impact is quite unlikely over the next thousand years, at least. (It is thought that the very massive asteroid Geographos, a cigar shaped asteroid of 5.1 kilometers by 1.8 kilometers (3.2 miles by 1.2 miles) which passed near Earth in 1969 and again in 1994, could collide with Earth in the not too distant future. It's probably an iron or stony iron asteroid. It would make the Tunguska meteorite look like a trivial impact. Geographos would cause a global ice age for several years from the dust it would kick up. But it won't impact in the next few hundred years, at least. We can't project Geographos' orbit in the far future with enough precision to determine if it will impact Earth or the Moon, or whether it will have a close encounter which will fling it elsewhere.) The most damaging kind of impact would be an asteroid that hits the ocean, not the land. An asteroid hitting land causes mainly localized damage. An asteroid hitting the ocean can cause a tsunami (i.e., huge wave) that would inflict catastropic damage to coastal cities and assets to great distances. The Earth is covered 70% by oceans, so an ocean impact is more likely.

**Ocean impacts cause more damage - airbursts**

**Projects to Employ Resources of the Moon and Asteroids Near Earth in the Near Term, 2002**, (Projects to Employ Resources of the Moon and Asteroids Near Earth in the Near Term, 2002, “Earth Impact by an Asteroid: Prospects and Effects”, <http://permanent.com/a-impact.htm>) Waxman

For an ocean impact, the destruction is much greater -- smaller objects can cause far more widespread damage. The effects of an ocean impact are felt much further away than the effects of an airburst due to the more effective propagation of water waves, and the fact that human populations and assets are largely concentrated in coastal cities which historically became established due to water transport (i.e., shipping and trade) and businesses near ports. For example, the earthquake-induced tsunami in Chile in 1960 produced waves in Hawaii 10,600 km away of height up to over 10 meters (30 feet), and up to 5 meters (15 feet) in Japan 17,000 km away with an average of 2 meters, causing heavy damages and loss of lives. What happens with a tsunami is that when a deep water wave of, say, a third of a meter hits a continental shelf its speed decreases but its height conversely rises. For example, the tsunami from the 1960 Chile earthquake created a deep water wave of only 20 cm (8 inches) above sea level, but when it hit the shore it had risen to a height an average of ten times its ocean size -- over 2 meters (6 feet), and in some places much higher. However, the size varies depending upon the coastal features, and was higher in many places. Understand, this is not just a narrow surfable wave that dies down when it approaches the shore, but is a wide body of water that grows into a wall that smashes into the land. (When the wave hits the shallow coast it slows down, and the water of the deep ocean wave behind it piles up on top to form a wall of water.)

## AT: WE WON’T BE ABLE TO DEFLECT

We have the technology to deflect asteroids but we need early detection

Atkinson 10(Nancy, senior analyst at Aite Group, “Asteroid Detection, Deflection Needs More Money, Report Says,” Universe Today, 1-22-10, http://www.universetoday.com/51811/asteroid-detection-deflection-needs-more-money-report-says/) [JHegyi14]

Schweikart quoted Don Yeomans as saying the three most important things about asteroid mitigation is to find them early, find them early and find them early. “We have the technology today to move an asteroid,” Schweikart said. “We just need time. It doesn’t take a huge spacecraft to do the job of altering an asteroid’s course. It just takes time. And the earlier we could send a spacecraft to either move or hit an asteroid, the less it will cost. We could spend a few hundred million dollars to avoid a $4 billion impact.” But the report put out by the NRC stresses the methods for asteroid/comet defense are new and still immature. The committee agreed that with sufficient warning, a suite of four types of mitigation is adequate to meet the threat from all NEOs, except the most energetic ones. Civil defense (evacuation, sheltering in place, providing emergency infrastructure) is a cost-effective mitigation measure for saving lives from the smallest NEO impact events and is a necessary part of mitigation for larger events. “Slow push” or “slow pull” methods use a spacecraft to exert force on the target object to gradually change its orbit to avoid collision with the Earth. This technique is practical only for small NEOs (tens of meters to roughly 100 meters in diameter) or possibly for medium-sized objects (hundreds of meters), but would likely require decades of warning. Of the slow push/pull techniques, the gravity tractor appears to be by far the closest to technological readiness. Kinetic methods, which fly a spacecraft into the NEO to change its orbit, could defend against moderately sized objects (many hundreds of meters to 1 kilometer in diameter), but also may require decades of warning time. Nuclear explosions are the only current, practical means for dealing with large NEOs (diameters greater than 1 kilometer) or as a backup for smaller ones if other methods were to fail. Although all of these methods are conceptually valid, none is now ready to implement on short notice, the report says. Civil defense and kinetic impactors are probably the closest to readiness, but even these require additional study prior to reliance on them.

**Deflection is possible now**

**Schweickart et al 08** (Russell - former astronaut and former co-chairman of the Task Force on Planetary Defense of the NASA Advisory Council, “Asteroid Threats: A Call For Global Response”, Association of Space Explorers International Panel on Asteroid Threat Mitigation Sept. 25, 2008, <http://www.space-explorers.org/ATACGR.pdf>) rory

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.

**WE HAVE THE TECHNOLOGY TO DEFLECT ASTEROIDS**

**CHOCRON AND WALKER 2008** [S. and JD – researchers at the Southwest Research Institute, “Near-Earth object deflection using conventional explosives” , *International Journal of Impact Engineering*, December] ttate

Due to the large number and distribution of asteroids and comets in the solar system, there is the distinct possibility of one of them striking Earth just as comet Shoemaker-Levy 9 struck Jupiter. A debate is ongoing in the scientific community as to how best to divert such a threat. In 2005 NASA was directed by Congress to provide a report on the detection of near-Earth objects (NEOs) and their mitigation if determined to be a threat. The report was delivered in March 2007; as input to that report, the work reported here provided information on conventional methods to divert a potentially hazardous object (PHO) including conventional explosives and direct impact with a rocket. Other slow push conventional approaches include propulsion systems attached to the asteroid or comet and the recently proposed gravitational tractor. Advantages of conventional explosives are that they can be delivered in small packages so that the asteroid or comet is in no danger of being broken up and it is possible to accurately compute the momentum transferred to the asteroid or comet through modern validated numerical techniques. This work demonstrates that conventional explosives can be an efficient conventional method to divert an asteroid or comet and computes the amounts of explosives needed.

## AT: SPACEGUARD SOLVES

**SPACEGUARD FAILS – ONLY ALLOCATED $4 MILLION ANNUALLY**

MORRISON 2006 [David – researcher for the Working Group on Near Earth Objects @ International Astronomical Union, “Asteroid and comet impacts: the ultimate environmental catastrophe”, <http://rsta.royalsocietypublishing.org/content/364/1845/2041.full>] ttate

The Spaceguard Survey is intended to identify any potential threat to the Earth with a warning time of at least several decades. Current searches are optimized for finding asteroids near 1 km diameter, which embraces the lower limit in size for a global catastrophe. (The nominal threshold is at 2 km, with an uncertainty of a about factor of 2 in size, or an order of magnitude in energy). The specific ‘Spaceguard Goal’ is to find 90 per cent of the NEAs larger than 1 km within 10 years, or by the end of 2008. Out of an estimated total of 1000–1100 (Bottke et al. 2004; Chesley & Spahr 2004; Harris 2004), 75 per cent had been found by the end of 2005. This is not as positive a result as might seem, however, since the rate of new discoveries falls off as the survey nears completeness. This survey is being carried out with approximately $4 million per year from NASA, plus voluntary and in-kind contributions—a tiny sum compared to the ongoing cost of mitigation for numerically comparable but better-known hazards such as earthquakes, severe storms, airplane crashes and terrorist activities.

## AT: WE CAN JUST NUKE THE ASTEROIDS

**Blowing up asteroids only creates more, smaller ones that do just as much damage**

Space Daily, 08. (Space Daily is an online news site for space industry professionals. December 5, 2008, “How to Destroy an Asteroid.” Lexis, CALLAHAN)

In the hit 1998 movie Armageddon, Bruce Willis and Ben Affleck blew up an asteroid to save the world. While the film was science fiction, the chances of an asteroid hitting the Earth one day are very real, and blowing up an asteroid in real life, says a Tel Aviv University researcher, will be more complicated than in the movies. Astrophysicists agree that the best method for avoiding a catastrophic collision would be to change the path of the asteroid heading toward our planet. "For that to work, we need to be able to predict what would happen if we attempt an explosion," says Tel Aviv University doctoral student David Polishook, who is studying asteroids with his supervisor Dr. Noah Brosch at the Department of Geophysics and Planetary Sciences. Polishook and Brosch are among the few scientists in the world researching the structure and composition of asteroids a critical first step in learning how to destroy them before they reach the Earth's atmosphere. Their research could prevent catastrophe: blowing up an asteroid may create many equally dangerous smaller asteroids of about 100 meters each in diameter, twice the size of the asteroid that created the famous Arizona crater. Looking on the Bright Sides "The information we are investigating can have a tremendous impact on future plans to alter the course of asteroids on a collision course with Earth," says Polishook. "Science needs to know whether asteroids are solid pieces of rock or piles of gravel, what forces are holding them together, and how they will break apart if bombed." By observing the waxing and waning brightness of far-away asteroids, Polishook is able to examine the shape, spin period and surface composition of these flying rocks. "This is a good way of evaluating what asteroids are made of," says Polishook, who takes measurements on an almost daily basis at Tel Aviv University's Wise Observatory. As part of their observations, the researchers used the fact that small asteroids change their rotation rate, accelerating or slowing down during short periods, as often as every 100,000 years. Compared to the age of the solar system 4.5 billion years that is an extremely fast change, says Polishook. The most recent results of their research were presented at the 2008 meeting of Asteroids, Comets and Meteors, sponsored by the Johns Hopkins University Applied Physics Laboratory in Baltimore. Size Matters An asteroid's rotation and acceleration are influenced by sunlight the "YORP Effect." If the YORP effect causes an asteroid to rotate faster than one revolution in 2.2 hours, it will break apart. To understand how the YORP Effect works on asteroids, Tel Aviv University researchers examined several variables relating to these asteroids, including size and location. They concluded that size is the most important factor in determining how an asteroid's rotation rate accelerates according to the YORP Effect. "We think this adds an important clue to how asteroids will behave should a space agency need to knock one off-course to prevent a collision with earth," Polishook notes.

**Blowing them up just creates more – new spacecraft tech being developed**

Gray, 07. (Richard is a science correspondent for the Sunday Telegraph who cites several scientists and professors. February 27, 2007, “Hollywood got it wrong, this is how you stop an apocalyptic asteroid” lexis, CALLAHAN)

ATTEMPTS to save mankind by smashing asteroids as they head towards Earth may do more harm than good, scientists believe. Rather than Hollywood's preferred option, engineers are trying to develop unmanned rockets that can land on space rocks and use the asteroids' own material to propel them into a safer orbit. The plan will be detailed at a conference, sponsored by Nasa next month, at which its scientists will reveal their estimate that 100,000 asteroids orbiting near Earth are large enough to destroy a city. So far the agency has only been able to identify and track 4,000 of them. Just one football pitch-sized asteroid smashing into the planet would create destruction on a terrifying scale, wiping out any area it hit, sending flaming debris into the atmosphere and causing tidal waves. Scientists claim that it is only a matter of time before one is found on a collision course. Research to be unveiled at the three-day Planetary Defence Conference in Washington DC will reveal that defending the Earth may not be as simple as suggested by films such as Armageddon in which Bruce Willis's character destroys a giant asteroid using a nuclear bomb. Gianmarco Radice of Glasgow University will be one of more than 200 scientists at the conference. He said: "A nuclear blast may cause it to fragment. So instead of having one large object on an impact course, you have five largish objects. "Also, we do not know a huge amount about the composition of these asteroids. Some are made of rock, others are ice while others are just piles of rubble. If you smash something into a pile of rubble, it will just break up and then reform by gravity.'' Nasa has already tested the approach by smashing a spacecraft into an asteroid in its Deep Impact mission last year. The European Space Agency is planning a similar test, sending a craft to smash into a 500-yard wide asteroid while another spacecraft monitors the results. Now an engineering firm in Atlanta, Georgia, has been commissioned by Nasa to develop a new kind of mission to land on an asteroid, drill through the surface and pump the debris into space. Anchoring several unmanned spacecraft, nicknamed Madmen, to an asteroid and ejecting material, would produce enough force in the opposite direction to push an asteroid slowly off its dangerous course. "It is like throwing rocks out of a rowing boat on a lake. The rocks go in one direction and the boat is slowly pushed in the other under the laws of physics,'' said John Olds, the chief executive of SpaceWorks, the firm behind the scheme. "Over several months we think we can make the difference between a hit and a miss.'' Astronomers fear that a 400-yard wide asteroid will pass dangerously close to the Earth within 30 years. Typically, one the size of a football pitch strikes every 100 years or so, and it is also almost 100 years since the last major impact which caused an explosion equivalent to a 15 megaton nuclear bomb in Tunguska, Siberia on June 30, 1908. Fears were heightened in 2004 by the discovery of a 45 million-ton rock orbiting the Sun called Apophis, which will pass just 22,000 miles from the Earth in April 2029. In 2036, it will have a close encounter. Some scientists calculate it may even hit the planet. Nasa believes that it has managed to identify nearly 90per cent of all asteroids larger than 1,000 yards. These are capable of causing a global disaster, throwing huge amounts of debris into the air and have historically caused widespread extinction.

## AT: WE CAN JUST NUKE THE ASTEROIDS

**JUST NUKING THE ASTEROID WILL FAIL – TOO MUCH FRAGMENTATION**

**Gray 1994**  [Alison – editor of THE SCOTSMAN, “ASTEROIDS MAY PROVE HARD TO DIVERT, SAY SCIENTISTS”, *The Scotsman and Scotland on Sunday*, June 4, 1998, LexisNexis Academic] [Max Waxman]

USING explosions to deflect or destroy Earth-bound asteroids will be far more difficult than scientists originally expected. It had previously been thought that nuclear tipped projectiles could be used to deflect or break up asteroids on collision course with the Earth. However, scientists at the University of California have found that some types of asteroid could soak up a powerful nuclear explosion with little or no effect. For 24 hours earlier this year, the world believed that it would be hit by an asteroid in the year 2028. The very next day the story changed and it was revealed that the chances of asteroid 1997 XF11 having a direct hit on the planet were zero. Despite the short time available for panic before the all-clear was sounded, dozens of plans to save the world were hatched, the most viable being a scheme to prevent the asteroid coming anywhere near Earth by destroying it or knocking it off course. An astronomer and research associate at the University of California, Erik Asphaug, has used computer simulations to study the effects of powerful impacts on asteroids with different internal structures. His team has found that the outcome of blasting an asteroid depends entirely on its structure. Many asteroids are not single rocks, but are aggregates of debris left over from previous collisions. They might consist of a few large fragments held together by gravity or "rubble piles" consisting of numerous smaller pieces.

**NUCLEAR DEFLECTION NOT EFFECTIVE – MASS DRIVER ENGINE MORE TECHNOLOGICALLY VIABLE AND BENEFICIAL**

**SPACE STUDIES INSTITUTE NO DATE** (Space Studies Institute, “Asteroid Deflection”, WordPress, no date, <http://ssi.org/reading/papers/asteroid-deflection/>) [Max Waxman]

SSI funded studies of asteroid detection, asteroid tracking, and mining of asteroids. We also studied the concept of assembling a mass driver engine in orbit, sending it to an Earth-approaching asteroid, and then using the mass driver to modify the asteroid’s orbit. This research was conducted with the goal of guiding the asteroid into a High Earth Orbit where it could be mined for its minerals. But such a technological capability, once developed, has obvious applications should we ever need to divert an asteroid from an Earth-intercepting course. For a long while, the conventional wisdom on this issue was that one would use nuclear explosives for this purpose. But according to a paper published in the June 4th, 1998 issue of Nature, this may not be as easy as previously thought. It points out that many asteroids are multi-lobed. A nuclear detonation might be largely absorbed by one lobe, with little course deflection resulting in the whole. The paper theorizes that the average asteroid may not be so much like a solid rock as an aggregate of fragments loosely held together by fine dust. If this “flying gravel pile” theory is correct, a nuclear detonation might pulverize an approaching asteroid, converting one big problem into many little ones. A mass driver engine, by contrast, could provide the low, steady, continuous thrust needed to change an asteroid’s course gradually, using the asteroid’s own material for reaction mass. The ability to modify an asteroid’s course via mass driver certainly promises to usher in a new era where space resources are freely available for construction projects in High Earth Orbit, and holds out promise for obtaining resources in a way which is not damaging to the environment of Earth. But it is just barely conceivable that this same technology might also help to avert a catastrophe of major proportions. In any event, a major program of asteroid mining can only make the Earth safer as the centuries pass. As it happens, those asteroids which cross the orbit of the Earth (and thus pose the greatest hazard) are also the ones most economically attractive for space-resource use. It is good that humanity is becoming more aware of the threat posed by Earth-crossing asteroids. But at the same time we should also become more aware of their vast economic potential.

## AT: ASTEROID STRIKE GOOD

**FALSE – THERE IS NO CHANCE FOR FUTURE DEVELOPMENT OR EVOLUTION IF WE ALL DIE**

**VERSCHUUR 1996** [Gerrit – adjunct professor of physics @ University of Memphis, *Impact: The Threat of Comets and Asteroids*, page 216] ttate

Recognition of the fundamental role of both comet and asteroid collisions in shaping evolutionary change means that the notion of survival of the fittest may have to be reconsidered. Survivors of essentially random impact catastrophes—cosmic accidents—were those creatures who just happened to be "lucky\* enough to find themselves alive after the dust settled. No matter how well a creature may have been able to survive in a particular environment before the event, being thumped on the head by a large object from space is not conducive to a long and happy existence.

## “SUBSTANTIALLY INCREASE” TOPICALITY HELPERS – BASELINE

**THE BASELINE FOR OUR INCREASE IS ONLY $4 MILLION**

**Atkinson 10** (Nancy, Staff writer for Universetoday, “Asteroid Detection, Deflection Needs More Money, Report Says”, 1/22/10, http://www.universetoday.com/51811/asteroid-detection-deflection-needs-more-money-report-says/)

Are we ready to act if an asteroid or comet were to pose a threat to our planet? No, says [a new report](http://www.nap.edu/catalog.php?record_id=12842)from the National Research Council. Plus, we don’t have the resources in place to detect all the possible dangerous objects out there. The report lays out options NASA could follow to detect more near-Earth objects (NEOs) that could potentially cross Earth’s orbit, and says the $4 million the U.S. spends annually to search for NEOs is insufficient to meet a congressionally mandated requirement to detect NEOs that could threaten Earth. “To do what Congress mandated NASA to do is going to take new technology, bigger telescopes with wider fields,” said Don Yeomans, Manager of NASA’s Near Earth Object Program Office, speaking at the American Geophysical Union conference last month. However, Yeomans said work is being done to improve the quality and quantity of the search for potentially dangerous [asteroids](http://www.universetoday.com/32459/asteroids/) and [comets](http://www.universetoday.com/40186/comets/). “We have a long term goal to have three more 1.8 meter telescopes,” he said, “and the Large Synoptic Survey [Telescope](http://www.universetoday.com/14424/telescopes/) with an 8.4 meter aperture in 2016. Once these new facilities are in place, the data input will be like drinking from a fire hose, and the rate of warnings will go up by a factor of 40. But getting all these facilities, and more, online and running will take continued and additional funding. Congress mandated in 2005 that NASA discover 90 percent of NEOs whose diameter is 140 meters or greater by 2020, and asked the National Research Council in 2008 to form a committee to determine the optimum approach to doing so. In an interim report released last year, the committee concluded that it was impossible for NASA to meet that goal, since Congress has not appropriated new funds for the survey nor has the administration asked for them.

## 2AC DA THUMPERS – ERR AFF

**THE LARGE SCALE IMPACT OF ASTEROIDS DEVASTATES TYPICAL RISK ANALYSIS – VOTE AFF EVEN IF THE PROBABILITY OF OUR IMPACT IS LOW**

**Posner 04 (**Richard, judge on the U.S. Court of Appeals for the Seventh Circuit and a senior lecturer at the University of Chicago Law School, “Catastrophe: Risk and Response”, 2004) [Iuliano]

Even if our insouciant reaction to small probabilities of great losses is accepted as an authentic basis for estimating the value of life in most such situations, the reaction may not generalize to ones in which the loss, should it materialize, would be the near or total extinction of the human race. If the annual probability of an asteroid collision that would kill 6 billion people is only 1 in 75 million, the expected number of deaths worldwide is only 80 per year, which may not seem a large enough number to justify the expense of an effective defense against an asteroid collision. (This of course ignores smaller but still lethal collisions; but read on.) But if there is a minute chance that the entire human race, both current and future, would be wiped out, together with all or most of the world's animal population, we (the ambiguous "we" of policy analysis, but here it may represent dominant public opinion) may think that something should be done to eliminate or reduce the risk, slight as it is, beyond what a standard cost-benefit analysis would imply; may be willing, if the risk and the possible responses are explained carefully, to incur some cost in higher taxes or otherwise to reduce the risk. So there is a conundrum. We don't know how to value life for purposes of conducting a cost-benefit analysis of asteroid defense because we don't know whether we should be discounting or escalating the conventional value of life estimates or, if we should be doing both, whether the adjustments would be offsetting. But what we can do is generate a range of estimates of the expected costs of asteroid collisions to human life and compare it with the amount of money currently being spent on asteroid defense. If that amount is below the lowest point on the range, we know that we're spending too little—which appears to be the case, as we saw in chapter 3—We can also, as we did there as well, divide the amount being spent on asteroid defense by the range of estimates of the expected costs of asteroid collisions to obtain the probability range that would make the expenditure optimal. When we did this, we discovered that the risk is being underestimated. (This is an application of what I have called "inverse cost- benefit analysis.")

## POLITICS ANSWERS – PLAN BIPARTISAN

**Bipartisan support for asteroid detection**

Physics Today, 10. (Physics Today is the flagship publication of the American Institute of Physics, July 20, 2010, “Congress moves toward protecting Earth against asteroid attacks,” http://blogs.physicstoday.org/newspicks/2010/07/congress-moves-toward-protecti.html, CALLAHAN)

Last month, Rep. Dana Rohrabacher (R–CA) introduced a bill, HR 5587, "to establish a United States Commission on Planetary Defense and for other purposes." The bill springs from the concern of Rohrabacher and others that a so-called near-Earth object could strike Earth with catastrophic results. The bill, which has bipartisan support, is currently being considered by the House Committee on Science and Technology.

**Asteroid detection is bipartisan – bill proves**

David, 10. (Leonard is a veteran aerospace reporter for the Christian Science Monitor, July 20, 2010, “Asteroid threat: Don't worry, Congress is looking into it,” http://www.csmonitor.com/Science/2010/0720/Asteroid-threat-Don-t-worry-Congress-is-looking-into-it, CALLAHAN)

Lawmakers are paying new attention to how best to shield Earth from a bad day — getting whacked by an asteroid or comet that has our planet in its cross-hairs. A new bill introduced to Congress proposes establishing a government-sponsored commission to study the threat of a major space rock collision with Earth and how prepared we are — as a country and a planet — to face such a danger. There is a growing choir of concern regarding Near Earth Objects, or NEOs – spotting them and dealing with any Earth-threatening gatecrashers. While the annual probability of the Earth being struck by a huge asteroid or comet is small, the consequences of such a collision are so calamitous that it is prudent to appraise the nature of the threat and prepare to deal with it, experts say. Last month, Representative Dana Rohrabacher (R – CA) introduced the new bill before Congress, H.R. 5587, titled: "To establish a United States Commission on Planetary Defense and for other purposes." The bill has been referred to the Committee on Science and Technology, on which Rohrabacher serves as a member. Both sides of the aisle are now looking at the commission idea. Planetary readiness "We need to take the next step," Rohrabacher told SPACE.com. "Our NEO search and tracking program continues to move forward, but nobody is taking responsibility for protection. I am more confident than ever in our ability to identify potential threats from asteroids and comets, but it is critical to the future of humanity that we develop the capabilities to protect ourselves from those threats." Rohrabacher said that the Commission on Planetary Defense that he is proposing will review our planetary readiness for an impact event and make recommendations on how to develop an adequate response system to those threats.

## POLITICS/ELECTIONS LINK TURN HELPERS - PLAN POPULAR (PUBLIC)

**TURN – PLAN POPULAR WITH THE PUBLIC – PLAN WILL BE SPUN TO GET THE PUBLIC ON BOARD IN REGARDS TO AVERTING A NATURAL DISASTER**

Planetary Defense Conference, 07(“Summary and Recommendations from the 2007 Planetary Defense Conference”, held March 5-8 2007, published April 25, 2007, 7/13/11, <http://www.aero.org/conferences/planetarydefense/2007papers/WhitePaperFinal.pdf>) stephanie

Low probabilitydisasterscome to the attention of policy makers and become part of the national and international agenda as the result of focusing events. These are infrequent**,** sudden and harmful eventsthat become known to the public and to the government simultaneously. As attention-grabbers, they initiate a push to “do something” about redressing the situation and preventing its recurrence.Ahurricane, earthquake, major oil spill or technologicalcatastrophe can generate a “spike” in interest that typically peaks in a few weeks in the media and in a few months in governmental deliberationsand then dissipates as other issues come to the fore. Typically it produces a two-year window of opportunity for preparing for similar disasters,a window that closes slowly in the absence of another focusing event.Progress occurs when there is an organized community of scientists and policy experts who push for new legislation during the window of opportunity. Such “policy entrepreneurs” have been highly successful promoting useful legislation following earthquakes, with the result that construction standards have improved consistently over the past hundred years**.** For example, earthquake policy entrepreneurs were instrumental in the drafting of the National Earthquake Hazard Reduction Act (NEHRA) of 1977. The key is a motivated and organized group of policy advocates that presses for efforts to mitigate the hazard and not just speed the flow of post-disaster relief**.** While no NEO impact disastrous to society has occurred yet, significant NEO detections and even low-level threat warnings provide windows of opportunity for educating the public and decision makers on the nature of thisrecently recognizedproblem**.** Additionally, major projects, such asdeveloping a new NEO warning or mitigation system, may have focusing effects and further ourmitigationefforts**.10** In presenting risk,we must treat the threat seriously and act through established protocols that are understandable by the public.

## SPENDING DA ANSWERS – PLAN INEXPENSIVE

**No link – a complete planetary defense system would only cost $102 million**

Kaupa and Nici, 97. (Lt. Col. Rosario Nici, USAF, and 1ST Lt. Douglas Kaupa, USAF. “PLANETARY DEFENSE: Department of Defense Cost for the Detection, Exploration, and Rendezvous Mission of Near-Earth Objects,” Airpower Journal, Summer 1997, http://www.airpower.au.af.mil/airchronicles/apj/apj97/sum97/nici.html, CALLAHAN)

Currently planetary defense is not itemized in the DOD budget. As with any organization, priorities set the budget. The apprehension from those not in DOD may be that any planetary defense could be just another excuse for an arms race since the cold war is over. The reality from the congressional perspective is that the money for any efforts specifically itemized for planetary defense should come out of DOD’s current budget.31 Given that the funding is from DOD, support should be given to those academic research programs that are currently conducting NEO detection, research, and technology development and to the Air Force Space Command, which has spent over $100 million on the technology to improve the current space surveillance mission of the ground based electrical-optical deep space system (GEODSS). Space Command’s relentless efforts of quality and continuous improvement should be lauded. Not only is there an improvement in the accuracy of detecting man-made debris in Earth orbit, but also the enhanced tracking of NEOs for a planetary defense is now feasible. Clearly, the humanitarian search for NEOs would be a hallmark for efforts to transform military assets into civilian endeavors. Furthermore, current improvements in the GEODSS can be utilized to improve environment, weather, and remote sensing, as well as to create smaller, faster, more intelligent hardware. However, tracking NEOs is not the only solution for protection. We need to learn more about NEOs and be prepared to avoid a future collision. Over the next 20 years, NEO detection, exploration, and rendezvous missions need to take place. In a recent Air Command and Staff College study, Larry D. Bell and others provided an excellent in-depth look at search systems, their advantages and disadvantages, a system architecture, and cost.32 Detection includes searching for NEOs, maintaining a NEO catalog, estimating populations of NEOs, and recurring operations and support. Exploration consists of determining the NEO origins, understanding how their orbits change due to the planets or collisions, and resolving the composition and density of NEOs. Are they solid or rubble objects orbiting together? Flybys or ground-based research will be the vanguards. Missions like Galileo, Clementine 1 and 2, NASA’s near-Earth asteroid rendezvous (NEAR) system, and use of the Arecibo and Goldstone radar systems will increase our knowledge of NEOs. Finally, rendezvous missions practice the meeting of NEOs beyond the Earth’s orbit, testing methods to deflect or destroy an NEO. These are the practice, small-scale mitigation missions in case we need to perturb or destroy a NEO months or even years before an Earth collision occurs. The science missions may require observations from Earth or flybys of the target, whereas rendezvous missions require the interceptor to orbit the target NEO. The bottom line is that the estimated cost for a planetary defense is near $14 million per year for detection, $23 million per year for exploration, and $75 million per year for rendezvous missions averaged over the next 20 years. Figure 12 reflects the breakdown of the budget each year if we begin today. These estimated costs were finalized with comments from Mr Nick Fuhrman, science advisor to the Committee on Science, US House of Representatives, and Dr. Bill Tedeschi of the Sandia National Laboratory. A limited mitigation system that would cost approximately $1 billion over three years is not included above.33 A different estimate sets costs at $120 to $150 million per year for two mitigation missions to either destroy or deflect non-Earth impacting NEOs over a 10-year period.34 The United States will perhaps need an impact scare to push Congress to approve a mitigation program because any system with the capability to deflect or destroy NEOs might be viewed as a weapon.

**NO LINK – PLAN IS A DROP IN THE BUCKET OF FEDERAL BUDGET SPENDING**

Schweickart, 10. (Rusty is a former astronaut and former co-chairman of the Task Force on Planetary Defense of the NASA Advisory Council. October 26, 2010, “Humans to Asteroids: Watch Out!” Lexis, CALLAHAN)

A FEW weeks ago, an asteroid almost 30 feet across and zipping along at 38,000 miles per hour flew 28,000 miles above Singapore. Why, you might reasonably ask, should non-astronomy buffs care about a near miss from such a tiny rock? Well, I can give you one very good reason: asteroids don't always miss. If even a relatively little object was to strike a city, millions of people could be wiped out. Thanks to telescopes that can see ever smaller objects at ever greater distances, we can now predict dangerous asteroid impacts decades ahead of time. We can even use current space technology and fairly simple spacecraft to alter an asteroid's orbit enough to avoid a collision. We simply need to get this detection-and-deflection program up and running. President Obama has already announced a goal of landing astronauts on an asteroid by 2025 as a precursor to a human mission to Mars. Asteroids are deep-space bodies, orbiting the Sun, not the Earth, and traveling to one would mean sending humans into solar orbit for the very first time. Facing those challenges of radiation, navigation and life support on a months-long trip millions of miles from home would be a perfect learning journey before a Mars trip. Near-Earth objects like asteroids and comets -- mineral-rich bodies bathed in a continuous flood of sunlight -- may also be the ultimate resource depots for the long-term exploration of space. It is fantastic to think that one day we may be able to access fuel, materials and even water in space instead of digging deeper and deeper into our planet for what we need and then dragging it all up into orbit, against Earth's gravity. Most important, our asteroid efforts may be the key to the survival of millions, if not our species. That's why planetary defense has occupied my work with two nonprofits over the past decade. To be fair, no one has ever seen the sort of impact that would destroy a city. The most instructive incident took place in 1908 in the remote Tunguska region of Siberia, when a 120-foot-diameter asteroid exploded early one morning. It probably killed nothing except reindeer but it flattened 800 square miles of forest. Statistically, that kind of event occurs every 200 to 300 years. Luckily, larger asteroids are even fewer and farther between -- but they are much, much more destructive. Just think of the asteroid seven to eight miles across that annihilated the dinosaurs (and 75 percent of all species) 65 million years ago. With a readily achievable detection and deflection system we can avoid their same fate. Professional (and a few amateur) telescopes and radar already function as a nascent early warning system, working every night to discover and track those planet-killers. Happily, none of the 903 we've found so far seriously threaten an impact in the next 100 years. Although catastrophic hits are rare, enough of these objects appear to be or are heading our way to require us to make deflection decisions every decade of so. Certainly, when it comes to the far more numerous Tunguska-sized objects, to date we think we've discovered less than a half of 1 percent of the million or so that cross Earth's orbit every year. We need to pinpoint many more of these objects and predict whether they will hit us before it's too late to do anything other than evacuate ground zero and try to save as many lives as we can. So, how do we turn a hit into a miss? While there are technical details galore, the most sensible approach involves rear-ending the asteroid. A decade or so ahead of an expected impact, we would need to ram a hunk of copper or lead into an asteroid in order to slightly change its velocity. In July 2005, we crashed the Deep Impact spacecraft into comet Tempel 1 to learn more about comets' chemical composition, and this proved to be a crude but effective method. It may be necessary to make a further refinement to the object's course. In that case, we could use a gravity tractor -- an ordinary spacecraft that simply hovers in front of the asteroid and employs the ship's weak gravitational attraction as a tow-rope. But we don't want to wait to test this scheme when potentially millions of lives are at stake. Let's rehearse, at least once, before performing at the Met! The White House Office of Science and Technology Policy has just recommended to Congress that NASA begin preparing a deflection capacity. In parallel, my fellow astronaut Tom Jones and I led the Task Force on Planetary Defense of the NASA Advisory Council. We released our report a couple of weeks ago, strongly urging that the financing required for this public safety issue be added to NASA's budget. This is, surprisingly, not an expensive undertaking. Adding just $250 million to $300 million to NASA's budget would, over the next 10 years, allow for a full inventory of the near-Earth asteroids that could do us harm, and the development and testing of a deflection capacity. Then all we'd need would be an annual maintenance budget of $50 million to $75 million. By preventing dangerous asteroid strikes, we can save millions of people, or even our entire species. And, as human beings, we can take responsibility for preserving this amazing evolutionary experiment of which we and all life on Earth are a part.

## SPENDING DA ANSWERS – PLAN INEXPENSIVE

**THE PRICETAG FOR THE PLAN COULD BE AS LOW AS $10 MILLION**

Borchers, 09 (Brent W. Borchers, USAF Major, “Should the US be involved in Planetary Defense?” http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA539693&Location=U2&doc=GetTRDoc.pdf, 7/17/11)

A simple investment increase of tens of millions of dollars per year or even in the single digits would give the U.S. and the world a much higher awareness of the space surrounding our planet and our potential dangers associated with impacting objects. If the four million dollars spent per year so far as part of the Spaceguard survey has allowed us to increase our knowledge from basically zero to now almost 75% of the objects that might impact our planet and cause catastrophic damage, think of the increase in knowledge we’d have of NEOs from a slight increase in a few million dollars. In the government budget millions of dollars easily drop off the radar scope of most legislators. Most “big ticket” items cost in the hundreds of millions or billions of dollars. Most people who are aware of the problem would agree that we can afford the extra expense, even in today’s economy and in these times of shrinking government budgets. In fact, most people aware of the threat would say that we can’t afford not to increase efforts with the stakes so high**.** For example, the entire budget of NASA is approximately $20 billion dollars in fiscal year 2009. For the same period the U.S. Air Force’s budget for space as the Department of Defense (DOD) executive agent for space is around $18 billion dollars. Adding $10 million dollars per yearto either of these budgets to track NEOs that are capable of causing a regional catastrophe or the extinction of the human race is drop in the bucket compared to the value. Even if Congress directs NASA or the Air Force through DOD to fund this ten million out of their own pocket, it would only account for .05% of their total space budgets**.** In some cases we probably have spent more government money in study the mating habits of the fruit fly that we have to ensure our own species’ survivability on this planet.

**NO LINK – PLAN COSTS $300 MILLION**

Lewis, ’96 (John S. Lewis is a professor of planetary science at the University of Arizona’s Lunar and Planetary Laboratory, “Rain of Iron and Ice,” Chapter 15, 7/14/11, Northwestern Library) Hou  
Now it is definitely technically feasible to detect objects of this size: the Spacewatch program has found a number of near-Earth asteroids with diameters less than 10 meters. The problem is not one of sensitivity; it is one of numbers. To get thorough sky coverage requires a sizeable array of telescopes**.** Suppose thatwe have a computer-driver telescope that is capable of discovering ten 250-meter asteroids per month. The cost of each such telescope is about $2 million. In order to achieve a nearly complete census of the population of near-Earth 250-meter bodies in twenty years, we need an average discover rate of 10,000 per year**,** or 850 a month. Thuswe require the full-time services of a network of 85 such telescopes spread around the world, or about 150 if reasonable allowance was made for observational downtime caused by cloudiness and other problems. The installation cost of the system is thus about $300 million. We should perhaps double or tripe this amount to include the cost of twenty years of operations (more highly computerized observatories have lower operational costs, but cost more to install). This is still not a terrible expense: a single major unmanned space-craft such as the US Air Force Lacrosse radar surveillance satellite or the Voyager outer-planet flyby commonly costs $1 billion.

## SPENDING DA ANSWERS – PLAN INEXPENSIVE

**NO LINK – PLAN CHEAP**

David, 10. (Leonard is the senior space writer for Space.com and former editor for Ad Astra, the official magazine of the National Space Society, and has been reporting on the space industry for more than 50 years. December 21, 2010, “Experts Push for a NASA Asteroid-Hunting Spacecraft,” http://www.space.com/10526-experts-push-nasa-asteroid-hunting-spacecraft.html?, CALLAHAN)

The internally funded Ball Aerospace concept has not yet been given a green light by NASA, noted Kevin Miller, a Ball Advanced Systems Manager, but the point design does showcase proven capabilities and an affordable approach, he said. The work uses a recipe "to establish confidence that, yes, this really is a very tractable problem," Miller said. In order to meet the George E. Brown requirements to find 90 percent of all NEOs larger than some 460 feet (140 meters) within 7 years, the NEO Survey mission would cost roughly $638 million. The catalog it would yield is a superset of the targets that NASA human spaceflight planners would find of interest for piloted excursions to selected space rocks. Given a go, the NEO hunter from start to launch should take around 42 months to develop, Arentz added. But there are technological challenges in building the NEO survey spacecraft. Dealing with solar radiation is one. The heat load from a location so near the sun means the spacecraft would need a large thermal shield and cryocooler hardware. Also, the telescope's photon-gathering array requires highly advanced engineering. The key is to prevent the intense solar radiation at Venus from reaching the telescope. This is done by careful design of the spacecraft's solar array and use of two thermal shields between the main array and the telescope. The spacecraft design, Arentz said, is based largely on the Kepler planet-hunting spacecraft design to reduce cost and risk. And, if two NEO-hunting spacecraft were placed in roughly opposite locales in a Venus-like orbit, this would allow a binocular view of space rocks, and scientists could chart them with an even greater degree of tracking accuracy .

**NO LINK – PLAN IS INEXPENSIVE IN COMPARISON WITH THE OVERALL NASA BUDGET**

**Streiber 1**0 (ANNE, Editor in chief for unknown country, “Saving Us from Asteroids is CHEAP”)

It's not even expensive: Adding just $250 million to $300 million to NASA's budget over the next decade would allow them to do a complete inventory of incoming asteroids, as well as develop and test methods of deflecting them. After that, $50 to $70 million per year would keep the program up and running. This isn't a lot of money in government terms--in fact, it's a drop in the bucket compared to the trillions of dollars we are spending right now to fight two wars. Schweickart says, "By preventing dangerous asteroid strikes, we can save millions of people, or even our entire species. And, as human beings, we can take responsibility for preserving this amazing evolutionary experiment of which we and all life on Earth are a part."

## SPENDING DA ANSWERS – SOLVES FUTURE COSTS – FALSE ALARMS

Early detection avoids wasting resources on false alarms- turns spending

NAC 10 (NASA Advisory Council, “Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense”, 10-6-10, http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf )[JHegyi14]

5. 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 followup tracking of hazardous NEOs eliminates any need for a standing defense capability by mission-ready deflection spacecraft with their high attendant costs. 6. Accurate orbital predictions based on an adequate and credible search and tracking capability will eliminate many ambiguous impact threats from NEOs, ruling out a collision long before an expensive deflection solution becomes necessary. This requires reducing the uncertainty in any NEO’s observed and predicted position. The Task Force refers to this strategy as “reducing the error ellipse” as rapidly as possible. 7. A relatively low-cost, early investment in search, track, and follow-up observations through ground- and space-based systems (including radar) **is a powerful cost-saving strategy**. Such a capability will pay off handsomely by enabling more accurate orbit determination; eliminating many predictions of NEOs with a worrisome probability of impact (an uncomfortably high, but uncertain, probability of Earth collision); and avoiding the launch of a deflection or even a transponder tracking spacecraft, each costing hundreds of millions of dollars.

## SPENDING DA ANSWERS – COST-BENEFIT ANALYSIS – COST JUSTIFIED

**ECONOMIC COSTS SHOULD NOT BE A CONCERN – IMPACT OF AFF JUSTIFIES THE SPENDING**

New Zealand Herald, 08. (Just because it’s a newspaper with no author given doesn’t mean it’s not credible – the whole article is about an international panel of scientists saying these things. December 8, 2008, “Scientists: We need to combat asteroid threat,” lexis, CALLAHAN)

A group of the world's leading scientists has urged the United Nations to establish an international network to search the skies for asteroids on a collision course with Earth. The spaceguard system would also be responsible for deploying spacecraft that could destroy or deflect incoming objects. The group - which includes the London-based Royal Society president Lord Rees and environmentalist Crispin Tickell - said that the UN needed to act as a matter of urgency. Although an asteroid collision with the planet is a relatively remote risk, the consequences of a strike would be devastating. An asteroid that struck the Earth 65 million years ago wiped out the dinosaurs and 70 per cent of the species then living on the planet. The destruction of the Tunguska region of Siberia in 1908 is known to have been caused by the impact of a large extraterrestrial object. "The international community must begin work now on forging three impact prevention elements - warning, deflection technology and a decision-making process - into an effective defence against a future collision," said the International Panel on Asteroid Threat Mitigation, which is chaired by former American astronaut Russell Schweickart. The panel made its presentation at the UN's building in Vienna. The risk of a significantly-sized asteroid - defined by the panel as being more than 45m in diameter - striking the Earth has been calculated at two or three such events every 1000 years, a rare occurrence, though such a collision would dwarf all other natural disasters in recent history. The panel added that developments in telescope design mean that by 2020 it should be possible to pinpoint about 500,000 asteroids in orbit round the Sun and study their movements. Of these, several dozen will be revealed to pose threats to Earth, the panel added. However, the group warned it would be impossible to predict exactly which of these "at-risk" asteroids would actually strike until it was very close to our planet. By then, it would be too late to take action. As a result, the panel said it would be necessary to launch missions to deflect or destroy asteroids that have only a one in 10, or even a one in 100, risk of hitting our planet. "Over the next 10 to 15 years, the process of discovering asteroids will likely identify dozens of new objects threatening enough that they will require proactive decisions by the UN," the report added. In addition, such missions will have to be launched well ahead of a predicted impact, so that slight deflections by spaceships can induce major changes in an asteroid's paths years later. The world will not be able to rely on Bruce Willis saving it from an asteroid at the last minute as he does in the movie Armageddon, in other words. Considerable planning and forethought will be needed. Funding such missions will therefore require far greater investment than is currently being made by international authorities. At present, about $4US million ($7.5 million) a year is spent by Nasa on asteroid detection, while the European Space Agency's planned mission to study the asteroid Apophis - which astronomers calculate has a 1 in 45,000 chance of striking the Earth this century - is likely to be a modest project costing only a few tens of millions of dollars. By contrast, any effective protection system will require funding of about $100US million ($187 million) a year to provide a full survey of the skies, combined with investment in spacecraft that can reach an asteroid and then deflect it. This would be achieved either by crashing the spacecraft on to the asteroid or by triggering a nuclear explosion in space. However, the cost of such missions should not be used as an excuse for failing to act, added the panel. "We are no longer passive victims of the impact process. We cannot shirk the responsibility." - OBSERVER

## SPENDING DA ANSWERS – COST-BENEFIT ANALYSIS –

**IF COSTS IS THE DECISION-MAKING FRAMEWORK, VOTE AFF – STATISTICAL LIFE VALUATIONS JUTIFY SPENDING $32 BILLION IN ASTEROID DEFENSE, WHICH IS MUCH MORE THAN THE AFFIRMATIVE PLAN**

**Matheny 07** (Jason, Department of Health Policy and Management, Bloomberg School of Public Health, Johns Hopkins, “Reducing the Risk of Human Extinction”, May 27, 2007, http://www.paforge.com/files/articles/Reducing%20the%20Risk%20of%20Human%20Extinction.pdf)

Although the usual justifications for discounting do not apply to extinction, we might accept discounting and still conclude that delaying human extinction is cost effective. In the tabular display below I estimate the cost effectiveness of asteroid defense under different discounting schemes. As above, these estimates assume asteroid defense will save an expected 8 billion life-years. However, now the value of future life-years is discounted, relative to the value of a life-year lived now. The cost of asteroid detection and deflection is still assumed to be $20 billion, paid in the present. The cost per life-year saved is $2.50 in the undiscounted case and $140 in the declining discounted case. Under constant discounting, the cost per life-year saved ranges from $40,000 to $200,000. Because the value of future life-years declines rapidly under constant discounting, these costs change by less than $1 if one pessimistically assumes a human duration of 1,000 years. Thus, even with discounting, and even assuming a 1,000-year human duration, asteroid defense could be more cost effective than much existing health spending. Even if we expected humanity to become extinct within a generation, traditional statistical life valuations would warrant a $16 billion to $32 billion annual investment in asteroid defense (Gerrard & Barber, 1997 ). Yet the United States spends only $4 million per year on asteroid detection and there is no direct spending on mitigation. 1

## NASA TRADE-OFF DA ANSWERS

**NO LINK – NO TRADE-OFF – NORMAL MEANS WOULD BE THAT THE FUNDING WOULD COME FROM EXTERNAL SOURCES**

**NAC 2010** [“Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense,” Oct 6, <http://www.nss.org/resources/library/planetarydefense/2010-NASAAdvisoryCouncilOnPlanetaryDefense.pdf>] ttate

12. The Task Force 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.

## SPACE MILITARIZATION DA ANSWERS – NO LINK

**NO LINK – ASTEROID DETECTION DEVICES ARE NOT DUAL-USE – THEY ARE PEACEFUL OBSERVING TECHNOLOGY**

Petras, 02 (Major Christopher M. Petras is Chief of Operations Law in United States Space Command, “Space Force Alpha: Military Use of the International Space Station and the Concept of Peaceful Purposes,” Air Force Law Review, 7/14/11, Academic Search Premiere) Hou

Giventhat the type of objects of greatest concern(largeasteroids, meteors, and comets**)** would approach Earth from space at very high speeds from very great distances, the tools of detection and trackingtend tofall into the already es-tablished fields of astronomy and to a limited extent, early warning/air defense,although the latter is currently focused on the detection of missiles and would require significant modification in order to be of use against objects from outer space. ... Thus**,** a planetary defense system, having as its only target entirely naturalistic forces of nature utterly devoid of human genesis or control, is not a weapon and is not prohibited by the Outer Space Treaty**.** As with other non-weapons such as a shovel or chisel, some of the components ofa planetary defense system, particularly those that could deflect or destroy an asteroid, have a peaceful purpose**.** ... In building the case for the legality of aplanetary defense system**, it** would beimportant to emphasize itspeacefulpurpose and world-savingintent at every opportunity. ... A fair reading ofthe Outer Space Treaty finds that it would not prohibit any of the likely components (detection, tracking or mitigation) of an operational planetary defense system**.** Because even non-aggressive military uses of outer space are legal, a fortiori a non-weapon, world-saving, peaceful-purpose system such as planetary defense is legal. ... It does not ban the testing of weapons in outer space (as opposed to on the moon or other celestial bodies), and thereforedoes not ban the testing of non-weapons such as a planetary defense system in outer space either.

## COUNTERPLAN THUMPER

**ANY SOLVENCY DEFICIT TO THE COUNTERPLAN WILL OUTWEIGH – THE THREAT OF ASTEROID COLLISION IS CONSTANT – WE CAN’T BE WRONG EVEN ONCE**

**Barbee, 9.** (Brent is working as an Aerospace Engineer and Planetary Defense Scientist and teaches Astrodynamics at the University of Maryland. Apr 1, 2009, “Planetary Defense: Near-Earth Object Deflection Strategies,” http://www.airpower.au.af.mil/apjinternational/apj-s/2009/1tri09/barbeeeng.htm, CALLAHAN)

It is generally accepted that statistics and probability theory is the best way to handle partial information problems. Gamblers and insurance companies employ it extensively. However, one of the underlying premises is that it is acceptable to be wrong sometimes. If a gambler makes a bad play, the hope is that the gambler has made more good plays than bad ones and still comes out ahead. This however is not applicable to planetary defense against NEOs. Being wrong just once may prove fatal to millions of people or to our entire species. If we trust our statistical estimates of the NEO population and our perceived collision probabilities too much, we risk horrific damage or even extinction. This is how we must define the limit for how useful probability theory is in the decision-making process for defense against NEOs.

## INTERNATIONAL ACTOR COUNTERPLAN ANSWERS – US MUST ACT

**THE CASE IS A DA TO THE COUNTERPLAN – THE US DOES NOT WANT TO RELY ON OTHER NATIONS TO PREVENT AN IMPACT WITH SUCH GRAVE CONSEQUENCES FOR THE US PUBLIC – A POLICYMAKER SHOULD NOT PASS ON THE RESPONSIBILITY TO AN OUTSIDE ACTOR – THE TECHNOLOGY DEVELOPMENT IS ALSO KEY TO OUR DEFENSE READINESS AND HEGEMONY**

**Barbee, 9.** (Brent is working as an Aerospace Engineer and Planetary Defense Scientist and teaches Astrodynamics at the University of Maryland. Apr 1, 2009, “Planetary Defense: Near-Earth Object Deflection Strategies,” http://www.airpower.au.af.mil/apjinternational/apj-s/2009/1tri09/barbeeeng.htm, CALLAHAN)

A variety of observatories around the world scan the skies to provide observations (when available) of known NEOs and to discover NEOs we have not seen yet. The Jet Propulsion Laboratories (JPL) here in the US and The University of Pisa in Italy both use observation data to determine the orbits (and associated uncertainties) of all known NEOs and assess Earth collision probabilities. However, no agency anywhere in the world is currently responsible for carrying out the deflection of an incoming NEO should it be required. The development of a global political and organizational framework for responding to a threatening NEO through the United Nations (UN) will be discussed at a UN meeting in February 2009.27The Association of Space Explorers (ASE) has written a report28 outlining their conclusions regarding the scope of the NEO threat and issues relevant to threat response in terms of organization, politics, and legalities. Their fundamental concern is that an effective response framework be established prior to needing it during an emergency. The wisdom of being properly prepared to act before being required to act is certainly indisputable, as is the fact that NEO impact is generally a global problem that warrants an international response. But not all NEOs are created equal. In fact, the majority of the known and predicted NEO population consists of NEOs several hundred meters in mean diameter or smaller. This size class of NEO is capable of causing devastation on local or regional levels, whereas impacts by NEOs one kilometer or larger in size would have global effects and impacts by NEOs several kilometers in size or larger constitute extinction-level events. This raises of the possibility of one nation being targeted by an incoming NEO that is small enough to localize the devastation to that particular nation or small region of that nation. If the US ever finds itself in such a situation, it does not want to be dependent on other nations to defend US citizens from the incoming NEO. If a large NEO is discovered to be on a course to impact any part of the world and the NEO is large enough to cause adverse effects on a global scale, the US does not want to be at the mercy of the decisions and capabilities of other nations when it comes to deflecting such a NEO. The NASA Authorization Act of 200529 included that NASA has responsibility for detecting, tracking, cataloging, and characterizing NEOs in order to provide warning and mitigation of the threat they pose to Earth. NASA was also directed to discover 90 percent of the NEO population consisting of NEOs 140 meters in size and larger by the end of 2020. However, no specific funding has been provided for these tasks and NASA is not officially responsible for defending the US from NEO impacts. Nevertheless, the key to our response strategy is to find incoming NEOs as early as possible. This requires that discovery and accurate threat assessment of NEOs happens far enough in advance of the predicted times of Earth impact for us to take effective action. A small community of scientists and engineers interested in the NEO deflection problem has steadily grown in recent years. In April of 2008 the Asteroid Deflection Research Center (ADRC) was founded at Iowa State University with the goal of creating an interdisciplinary research program aimed at developing both impulsive and low-thrust NEO deflection techniques.30 While interest is increasing and there is a growing body of technical work created largely by small independent groups of researchers, most of the work is either unfunded or has only a small amount of funding behind it. Thus a possible threat to our national security is that other spacefaring nations will develop NEO deflection technologies before the US or that their deflection technologies will be superior to ours due to either a head start in development or their allocation of more resources. The collisions of NEOs with Earth ought to be viewed and treated as a natural disaster that poses a legitimate threat to US national security, and one that can be prevented with appropriate technology development and preparation. However, it is important to note that the required technology development and deployment itself has national security implications, particularly if nuclear explosives are involved. It is difficult to speculate as to the costs of a NEO defense program, but the costs to date of NASA missions to NEOs can serve as a starting point. The main cost driver is the need to design, launch, and test deflection systems on harmless NEOs in order to verify and calibrate our associated physics models, ensuring that we can reliably alter the orbits of NEOs in a predictable, controlled, and timely manner. It is important to note that the technologies and expertise developed along the way would be widely applicable to the spectrum of space technology areas and the data gathered would be intrinsically scientifically valuable in its own right. This is highly encouraging since we already spend hundreds of millions of dollars on purely scientific missions to NEOs. The logical next step is to incorporate deflection system testing into NEO science missions.

## INTERNATIONAL ACTOR COUNTERPLAN ANS – INTERNATIONAL COOPERATION BAD

**INTERNATIONAL COOPERATION TO SOLVE ASTEROID THREAT LEADS TO POLICY PARALYSIS – UNILATERAL ACTION BEST**

**SEAMONE 2004** [Evan – JD @ University of Iowa Law and Judge Advocate General for the US Army, 17 Geo. Int'l Envtl. L. Rev. 1, lexis] ttate

Natural impact threats raise a crucial point involving cooperation within and among different nations -- unrestrained cooperation and interdisciplinary involvement can produce chaos rather than effectiveness. **[93](http://www.lexis.com/research/retrieve?y=&dom1=&dom2=&dom3=&dom4=&dom5=&crnPrh=&crnSah=&crnSch=&crnLgh=&crnSumm=&crnCt=&cc=&crnCh=&crnGc=&shepSummary=&crnFmt=&shepStateKey=&pushme=1&tmpFBSel=all&totaldocs=&taggedDocs=&toggleValue=&numDocsChked=0&prefFBSel=0&delformat=XCITE&fpDocs=&fpNodeId=&fpCiteReq=&_m=29883116b111aab2782c3966e91afae6&docnum=8&_fmtstr=FULL&_startdoc=1&wchp=dGLbVlb-zSkAb&_md5=167211df7d54cf708b11004a0b5470a7&focBudTerms=nuclear+w%2F10+%28asteroid+or+%22near+earth+object%22%29&focBudSel=all" \l "n93" \t "_self)** On a continuum from short-notice threats to long-term ones, as the magnitude of a natural impact threat increases or the response time grows shorter, more agencies will petition for involvement in the decision-making process. While space and military agencies might dominate the initial stages of decision-making, law enforcement, health, environmental, and fiscal agencies will merge into the decision-making framework over time. The influx of agency involvement can, of course, offer alternative perspectives. However, disruption, dilution, or ignorance of established frameworks will, no doubt, limit the overall effectiveness of joint efforts. The solution to this problem of coordination is not necessarily to give the lead to one agency and then prevent other agencies from meaningful modification of existing standards; nor is the answer carving out limited areas in which different agencies should legislate. Instead, the answer is to draw on the experience of all the agencies that could potentially become involved, identify their needs, exchange views, and then incorporate joint considerations into a single set of coordinating instructions. The National Response Plan incorporates many of these lessons.

## INTERNATIONAL ACTOR COUNTERPLAN ANS – PERM = BEST SOLVENCY

**US leadership of the international community is key to detection**

Science Daily, 10. (Science Daily is a news website for topical science articles. Jan 25, 2010. “Detecting and Countering Near-Earth Objects That Could Threaten Earth Underfunded, According to Report” http://www.sciencedaily.com/releases/2010/01/100122114436.htm, CALLAHAN)

In its final report, the committee lays out two approaches that would allow NASA to complete its goal soon after the 2020 deadline; the approach chosen would depend on the priority policymakers attach to spotting NEOs. If finishing NASA's survey as close as possible to the original 2020 deadline is considered most important, a mission using a space-based telescope conducted in concert with observations from a suitable ground-based telescope is the best approach, the report says. If conserving costs is deemed most important, the use of a ground-based telescope only is preferable. The report also recommends that NASA monitor for smaller objects -- those down to 30 to 50 meters in diameter -- which recent research suggests can be highly destructive. However, the report stresses that searching for smaller objects should not interfere with first fulfilling the mandate from Congress. Beyond completion of that mandate, the report notes the need for constant vigilance in monitoring the skies, so as to detect all dangerous NEOs. In addition, the nation should undertake a peer-reviewed research program to better investigate the many unknown aspects connected with detecting NEOs and countering those that could be a threat. The U.S. should also take the lead in organizing an international entity to develop a detailed plan for dealing with hazards from these objects. In addition, the report recommends that immediate action be taken to ensure the continued operation of the Arecibo Observatory in Puerto Rico. NASA and NSF should support a vigorous program of NEO observations at Arecibo, and NASA should also support such a program at the Goldstone Deep Space Communications Complex. Although these facilities cannot discover NEOs, they play an important role in accurately determining the orbits and characterizing the properties of NEOs within radar range.

## DEPARTMENT OF DEFENSE COUNTERPLAN ANSWERS – NO SOLVENCY

**DEPARTMENT OF DEFENSE ACTION WILL GUT INTERNATIONAL COOPERATION – JURISDICTION ISSUES WILL KILL CLASSIFICATION**

**NATIONAL RESEARCH COUNCIL 2010** [“National and International Coordination and Collaboration”, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies Space Studies Board,

<http://www.nap.edu/openbook.php?record_id=12842&page=93>] ttate

An effective, comprehensive approach to the NEO hazard will require significant planning, coordination, and cooperation within the U.S. government. It seems sensible to assign responsibility for this NEO hazards program to an existing governmental administrative structure, especially in view of the likely relatively small size of the undertaking. It also seems more efficient to place the program under the control of a single entity in coordination with other relevant government organizations. The coordination could be implemented by way of a standing committee or an interagency task force of the appropriate agencies to organize and lead the effort to plan and coordinate any action to be taken by the United States individually, or in concert with other nations. This committee or task force would have membership from each of the relevant national agencies (NASA and the National Science Foundation [NSF]) and executive departments (Defense, Energy, Homeland Security, Justice, and State), with the chair from the lead entity. (Other relevant agencies and departments might include the Departments of Transportation and of Health and Human Services, the Environmental Protection Agency, the General Services Administration, and the Department of Agriculture.) The first step of the standing committee or interagency task force would be to define the necessary roles and responsibilities of each member agency in addressing the various aspects of the threat, from surveying the sky through civil defense. The lead responsibility for a given task would be assigned to the appropriate agency or department. In view of the intrinsic international nature of the program, a civilian rather than a military agency would have advantages for housing it. Otherwise, one could envision continual internal conflict over military security and classification issues. Of course, any group will have such issues from time to time, but a civilian group could have far fewer such conflicts and also would likely be more acceptable to its counterparts in other nations. In an emergency, the military could be enlisted or appointed by the president to help; the military would maintain currency with the issues through membership in the standing committee or interagency task force. 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 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.

## KRITIK ANSWERS – PLAN = CONSTRUCTION OF NEW ENEMY

**PLAN ALLOWS FOR A REFRAMING OF WHO WE DEFINE AS AN “ENEMY” – ALLOWS US TO RECONCEPTUALIZE INTERNATIONAL RELATIONS – PLAN IS A SPRINGBOARD FOR INTERNATIONAL COOPERATION THAT ALLOWS US TO START DEFINING THE ASTEROID, NOT THE NATION-STATE, AS A COMMON ENEMY**

**Mellor 07** (Felicity, Professor of MSc in Science Communication at Imperial College London, Social Studies of Science, “Colliding Worlds : Asteroid Research and the Legitimization of War in Space”, published by SAGE, 2007, http://sss.sagepub.com/content/37/4/499.full.pdf) rory

Through such claims, the issue of planetary defence became a moral frame through which other threats of more human origin could also be addressed. Increased knowledge and surveillance of asteroids, the scientists insisted, would help stop mistakes by the military decision-makers by preventing the misidentification of asteroid airbursts as enemy nuclear warheads (Chapman & Morrison, 1994: 39). At the same time, destroying asteroids would provide us with a way of using up those unwanted bombs. As John Lewis (1997: 215) put it: ‘The net result of the asteroid deflection is really a twofold benefit to Earth: a devastating impact would be avoided and there would be one less nuclear warhead on Earth.’ Similarly, Duncan Steel saw the use of SDI technologies in asteroid missions such as Clementine II as ‘a prime example of beating swords into ploughshares’ (quoted in Matthews, 1997). Furthermore, the international tensions that led to the proliferation of nuclear weapons in the first place, would also be resolved by uniting against the common enemy of the asteroid. Thus Carl Sagan and Steve Ostro, although largely critical of the promotion of the impact threat, suggested that: In an indirect way the threat of interplanetary collision may have a political silver lining. They represent a common enemy to all nations and ethnic groups. By posing two different classes of danger to the human species, one natural and the other of our own making, Earth-approaching objects may provide a new and potent motivation for maturing international relations, ultimately helping to unify the human species. (Sagan & Ostro, 1994b: 72; see also Gehrels, 1988: 303) Even for Sagan and Ostro, then, as for the other civilian scientists, the impact threat offered hope of salvation.

## REPS KRITIK ANSWERS

**OUR REPRESENTATIONS ARE JUSTIFIED – ASTEROID ADVOCACY IS KEY TO EDUCATING POLICYMAKERS ABOUT THE NEO THREAT**

**MORRISON ET AL 2002** [David – researcher @ NASA Ames Research Center, “Dealing with the Impact Hazard”,

<http://www.disastersrus.org/emtools/spacewx/NEO_Chapter_1.pdf>] ttate

It is only during the past two decades that scientists have become aware of the scope of the asteroid impact hazard. This topic was broadly reviewed in 1993, leading to publication of a thousand-page book Hazards Due to Comets and Asteroids (Gehrels, 1994) that remains the primary reference in this field. With surprising speed, this concern has been communicated to governments and the public (e.g., Morrison et al., 1994). Due to the advocacy of NEA researchers (with timely publicity from the collision of Comet Shoemaker-Levy 9 with Jupiter and two feature movies), policy makers and their constituents are aware that impacts are possible. It is less clear, however, that decision-makers are convinced that any major action needs to be taken to deal with the impact hazard. The advocacy role of the science community is pivotal, because the abstract nature of the low-probability threat diminishes the likelihood of a response by either policy makers or their constituents. In this chapter we discuss both the "facts" of the impact hazard and the associated issues of public perception and governmental response.

## ZIZEK KRITIK ANSWERS

**ZIZEK VOTES AFFIRMATIVE – HE EVEN AGREES THAT NEOs ARE REAL THREATS AND CAN’T BE CONSTRUCTED**

**ZIZEK 2009** [Slavoj – philosopher, Interview posted on the web, “Zizek! – Full Transcript”, <http://beanhu.wordpress.com/2009/12/07/zizek/>] ttate

Let’s show them all, huh? Okay, philosophy. This, I can do it, at least traditionally, in two lines, no? Philosophy does not solve problems. The duty of philosophy is not to solve problems but to redefine problems, to show how what we experience as a problem is a false problem. If what we experience as a problem is a true problem, then you don’t need philosophy. For example, let’s say that now there would be a deadly virus coming from out there in space, so not in any way mediated through our human history, and it would threaten all of us. We don’t need, basically, philosophy there. We simply need good science desperately to find… We would desperately need good science to find the solution, to stop this virus. We don’t need philosophy there,because the threat is a real threat, directly. You cannot play philosophical tricks and say “No, this is not the”… You know what I mean. It’s simply our life would be… or okay, the more vulgar, even, simpler science fiction scenario. It’s kind of “Armageddon” or whatever. No, “Deep Impact.” A big comet threatening to hit Earth. You don’t need philosophy here. You need… I don’t know. To be a little bit naive, I don’t know. Strong atomic bombs to explode, maybe. I think it’s maybe too utopian. But you know what I mean. I mean the threat is there, you see. In such a situation, you don’t need philosophy. I don’t think that philosophers ever provided answers, but I think this was the greatness of philosophy, not in this common sense that philosophers just ask questions and so on.

## ????LASERS SOLVENCY

**The Statesman 04** (“Doomsday Calculations,” 5-11-2004 http://www.lexisnexis.com.turing.library.northwestern.edu/hottopics/lnacademic/?)[JHegyi14]

The programme calculates maximum pressures and wind velocities based on test results from pre-1960s nuclear blasts. Researchers at those blasts erected brick structures at the Nevada Test Site to study blast wave effects on buildings. Incoming objects can be catastrophic and wipe out our technologically advanced civilisation in an instant. That's why scientists are incessantly finding and tracking asteroids. Dan Mazanek, a scientist at Nasa's Langley Research Center, is developing a Comet/Asteroid Protection System (CAPS) that would employ lasers to discover asteroids. As powerful lasers that are required to do the job don't exist yet, Mazanek predicts CAPS could be developed within the next 20 to 40 years. A powerful laser will score better as a credible deterrent over other techniques, such as solar sails or chemical rockets, because it acts almost instantly. Jonathan W. Campbell, a scientist at Nasa's National Space Science and Technology Center, is working on a Moon-based Laser Earth Defense System (Leds), consisting of an array of lasers. Guided by a laser tracking system, the Leds would fire laser pulses at the Earth-bound asteroid. Each pulse would raise the temperature of asteroid's surface, creating a hot gas that would push the object a little. It would take millions of pulses to create sufficient push that would be needed to guide the asteroid away from the Earth. An alternate way to save the Earth is to slow down the incoming asteroid a bit so that the Earth has chance to move away from asteroid's trajectory. The Earth revolves around the Sun at 30 km per second. It can travel 12,760 km - the distance equivalent to Earth's diameter - in just seven minutes. In essence, we live in a technologically advanced world but we are still vulnerable. Scientists say that if a doomsday asteroid hits the Earth, 25 per cent of the world's population could die. "If an extinction-type impact is inevitable, then ignorance for the populace is bliss," Geoffrey Sommer, a scientific advisor to the US Government, said at the American Association for the Advancement of Science 2003 meeting in Denver. Sommer was of the view that citizens should not be informed of an extinct-type event in which we all are doomed to die.

## ????CAPS SOLVENCY

**Park et al 05 (**Daniel D. Mazanek, Carlos M. Roithmayr, and Jeffrey Antol Langley Research Center, Hampton, Virginia Sang-Young Park, Robert H. Koons, and James C. Bremer Swales Aerospace, Inc., Hampton, Virginia Douglas G. Murphy, James A. Hoffman, Renjith R. Kumar, and Hans Seywald Analytical Mechanics Associates, Inc., Hampton, Virginia Linda Kay-Bunnell and Martin R. Werner Joint Institute for Advancement of Flight Sciences (JIAFS) The George Washington University, Hampton, Virginia Matthew A. Hausman Colorado Center for Astrodynamics Research The University of Colorado, Boulder, Colorado Jana L. Stockum San Diego State University, San Diego, California, “Comet/Asteroid Protection System (CAPS): Preliminary Space-Based System Concept and Study Results” NASA, May 2005, http://www.nss.org/resources/library/planetarydefense/2005-CometAsteroidProtectionSystem(CAPS)-NASA.pdf)

CAPS is a future (25 or more years from now) space-based system concept designed to detect and protect against the entire range of threatening comets and asteroids. The initial focus is to determine the feasibility of protecting against 1-km class long-period comets, including inactive nuclei. The system is designed also to protect against smaller LPCs, as well as NEAs and SPCs capable of regional destruction. Although the primary motivation for CAPS is to provide protection against impacting comets and asteroids, it is anticipated that the system and technologies developed would have many additional benefits extending to governments (U.S. and international), the commercial sector, the scientific community, and academia. The CAPS detection system would provide an astronomical asset that could observe extremely faint or small targets (both planetary bodies and extrasolar objects), allowing an unprecedented level of scientific observations while surveying the entire celestial sky on a regular basis. The CAPS orbit modification system could enable exploitation of the vast economic resources available from NEOs and promote synergistic technologies for other future space missions. Technologies that will permit the future exploration and colonization of the solar system (e.g., high power and thermal management systems, high thrust and specific impulse propulsion, and power beaming) are also applicable to the deflection of Earth impacting comets and asteroids. Additionally, there is tremendous benefit in “practicing” how to move these objects from a threat mitigation standpoint; developing the capability to alter the orbits of comets and asteroids routinely for nondefensive purposes could greatly increase the probability that we can successfully divert a future impactor.

## ???AT: NEG SAYS THERE IS NO THREAT

**Humans biologically have difficulty taking the threat of collision seriously albeit the enormous consequences**

**Posner 04** (Richard, judge on the U.S. Court of Appeals for the Seventh Circuit and a senior lecturer at the University of Chicago Law School, “Catastrophe: Risk and Response”, 2004) [Iuliano]

Nuclear threats are familiar and feared, like the threat of pandemics. It is otherwise when attention shifts to the second natural catastrophe that I emphasized—a major asteroid collision. The number of expected human deaths from asteroid collisions follows a catastrophic risk distribution, meaning that the most serious collision in the range of possibilities considered would account for most of the deaths. Although a collision of that magnitude is highly' unlikely if its probability is computed over the span of a few decades (a probability is greater the longer the interval being considered—the probability that one will be involved in an automobile accident is greater in the next 10 years than in the next month), its expected cost is not negligible, because a very low probability is being multiplied by a very great loss if the risk materializes. That conjunction defines "catastrophic risk" as I am using the term, but with the further proviso that the loss must be cataclysmic. The very low probability associated with a catastrophic risk distribution causes two problems from the point of view of rational policy responses. The first is that for reasons evolutionary biology illuminates, most people have, as I have already noted, difficulty in thinking sensibly either about probabilities in the abstract, as distinct from experienced frequencies, or, the same point viewed differently, about events that could occur but haven't yet. In economic terms, they incur a high imagination cost when they try to think about new situations—situations that have no history—especially if the new situation is unlike any found in the environment to which the ancestors of modern human beings became adapted tens of thousands of years ago as a result of the operation of natural selection. Being able to cope with very-low-probability events would not have had survival value in that environment; hence the difficulty most of us have working with statistics. People tend either to ignore very small probabilities altogether or to exaggerate them. It is not just small probabilities that people have difficulty with; it is also unmemorable events. A remarkable fact is how unafraid people are of influenza, even though the 1918-1919 pandemic killed upwards of 20 million people in a short period of time, a similar pandemic could recur, there is still no cure for the disease, and flu vaccines are unreliable because of the mutability of the virus. Because influenza is not disfiguring and even in the 1918-1919 pandemic the mortality rate was low, although total mortality can be very great and was then, and most curiously of all because no famous people died in the pandemic, its victims being almost all young adults, the pandemic has faded from our historical memory. This doesn't show that people are dopes or are irrational, only that human mental capacity is limited and the mind uses various triggers to direct its attention. At present those triggers are lacking not only for influenza but also for asteroid collisions, even though many people are fearful of much lesser threats, such as low-level radiation and ambient cigarette smoke. There is no historical memory of asteroids colliding with the earth and so we find it hard to take the threat of such collisions seriously even if we accept that it exists. This is an example of the distinction that I pointed out in the introduction between notional and motivational beliefs.