# TOC R1 Neg vs Harker MK

# 1NC

### 1

#### Interpretation---“Appropriation of outer space” by private entities refers to the exercise of exclusive control of space.

TIMOTHY JUSTIN TRAPP, JD Candidate @ UIUC Law, ’13, TAKING UP SPACE BY ANY OTHER MEANS: COMING TO TERMS WITH THE NONAPPROPRIATION ARTICLE OF THE OUTER SPACE TREATY UNIVERSITY OF ILLINOIS LAW REVIEW [Vol. 2013 No. 4]

The issues presented in relation to the nonappropriation article of the Outer Space Treaty should be clear.214 The ITU has, quite blatantly, created something akin to “property interests in outer space.”215 It allows nations to exclude others from their orbital slots, even when the nation is not currently using that slot.216 This is directly in line with at least one definition of outer-space appropriation.217 [\*\*Start Footnote 217\*\*Id. at 236 (“Appropriation of outer space, therefore, is ‘the exercise of exclusive control or exclusive use’ with a sense of permanence, which limits other nations’ access to it.”) (quoting Milton L. Smith, The Role of the ITU in the Development of Space Law, 17 ANNALS AIR & SPACE L. 157, 165 (1992)). \*\*End Footnote 217\*\*]The ITU even allows nations with unused slots to devise them to other entities, creating a market for the property rights set up by this regulation.218 In some aspects, this seems to effect exactly what those signatory nations of the Bogotá Declaration were trying to accomplish, albeit through different means.219

#### Private appropriation for temporary usage or perusal is distinct from appropriation “of” outer space. Sovereign claims are still universally prohibited.

Abigail D. Pershing, J.D. Candidate @ Yale, B.A. UChicago,’19, "Interpreting the Outer Space Treaty's Non-Appropriation Principle: Customary International Law from 1967 to Today," Yale Journal of International Law 44, no. 1

II. THE FIRST SHIFT IN CUSTOMARY INTERNATIONAL LAW’S INTERPRETATION OF THE NON-APPROPRIATION PRINCIPLE Since the drafting of the Outer Space Treaty, several States have chosen to reinterpret the non-appropriation principle as narrower in scope than its drafters originally intended. This reinterpretation has gone largely unchallenged and has in fact been widely adopted by space-faring nations. In turn, this has had the effect of changing customary international law relating to the non-appropriation principle. Shifting away from its original blanket application in 1967, States have carved out an exception to the non-appropriation principle, allowing appropriation of extracted space resources.53 This Part examines this shift in the context of the two branches of the United Nation’s customary international law standard: State practice and opinio juris. A. State Practice The earliest hint of a change in customary international law relating to the interpretation of the non-appropriation clause came in 1969, when the United States first sent astronauts to the moon. As part of his historic journey, astronaut Neil Armstrong collected moonrocks that he brought back with him to Earth and promptly handed off to the National Aeronautics and Space Administration (NASA) as U.S. property.54 Later, the USSR similarly claimed lunar material as government property, some of which was eventually sold to private citizens. 55 These first instances of space resource appropriation did not draw much attention, but they presented a distinct shift marking the beginning of a new period in State practice. Having previously been limited by their technological capabilities, States could now establish new practices with respect to celestial bodies. This was the beginning of a pattern of appropriation that slowly unfolded over the next few decades and has since solidified into the general and consistent State practice necessary to establish the existence of customary international law. Currently, the U.S. government owns 842 pounds of lunar material.56 There is little question that NASA and the U.S. government consider this material, as well as other space materials collected by American astronauts, to be government property.57 In fact, NASA explicitly endorses U.S. property rights over these moon rocks, stating that “[l]unar material retrieved from the Moon during the Apollo Program is U.S. government property.”5 The U.S. delegation’s reaction to the language of the 1979 Moon Agreement further cemented this interpretation that appropriation of extracted resources is a permissible exception to the non-appropriation clause of Article II. Although the United States is not a party to the Moon Agreement, it did participate in the negotiations.59 The Moon Agreement states in relevant part: Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person.60 In response to this language, the U.S. delegation made a statement laying out the American view that the words “in place” imply that private property rights apply to extracted resources61—a comment that went completely unchallenged. That all States seemed to accept this point, even those bound by the Moon Agreement, is further evidence of a shift in customary international law.62 B. Opinio Juris: Domestic Legislation Domestic law, both in the United States and abroad, provides further evidence of the shift in customary international law surrounding the issue of nonappropriation as it relates to extracted space resources. Domestic U.S. space law is codified at Section 51 of the U.S. Code and has been regularly modified to expand private actors’ rights in space.63 Beginning in 1984, the Commercial Space Launch Act provided that “the United States should encourage private sector launches and associated services.”64 The goal of the 1984 Act was to support commercial space launches by private companies and individuals.65 It did not, however, specifically discuss commercial exploitation of space. The first such mention of commercial use of space appeared in 2004, with the Commercial Space Launch Amendments Act.66 This Act specifically aimed at regulating space tourism but did not explicitly guarantee any private rights in space.67 The most significant change in U.S. space law came with the passage of the Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act in 2015. As incorporated into Section 51 of the Code, this Act provides: A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.68 Whereas the idea that private corporations might go into space may have seemed far-fetched to the drafters of the Outer Space Treaty, the SPACE Act of 2015 was the first instance of a government recognizing such a trend and officially supporting private companies’ commercial rights to space resources under law. With the new 2015 amendment to Section 51 in place, U.S. companies can now rest assured that any profits they reap from space mining are firmly legal—at least within U.S. jurisdictions. Although the United States was the first country to officially reinterpret the non-appropriation principle, other countries are following suit. On July 20, 2017, Luxembourg passed a law entitled On the Exploration and Utilization of Space Resources with a vote of fifty-five to two.69 The law took effect on August 1, 2017.70 Article 1 of the new law states simply that “[s]pace resources can be appropriated,” and Article 3 expressly grants private companies permission to explore and use space resources for commercial purposes.71 Official commentary on the law establishes that its goal is to provide companies with legal certainty regarding ownership over space materials—a goal that the commentators regard as legal under the Outer Space Treaty despite the non-appropriation principle.72 The next country to enact similar legislation may be the United Arab Emirates (UAE). According to the UAE Space Agency director general, Mohammed Al Ahbabi, the UAE is currently in the process of drafting a space law covering both human space exploration and commercial activities such as mining.73 To further this goal, in 2017 the UAE set up the Space Agency Working Group on Space Policy and Law to specify the procedures, mechanisms, and other standards of the space sector, including an appropriate legal framework.74 C. Opinio Juris: Legal Scholarship Other major space powers are also considering similar laws in the future, including Japan, China, and Australia. 75 Senior officials within China’s space program have explicitly stated that the country’s goal is to explore outer space and to take advantage of outer space resources.76 The general international trend clearly points in this direction in anticipation of a potential “space gold rush.” 7 Mirroring the shift in State practice and domestic laws, the legal community has also changed its approach to the interpretation of the nonappropriation principle. Whereas at the time of the ratification of the Outer Space Treaty the majority of legal scholars tended to apply the non-appropriation principle broadly, most legal scholars now view appropriation of extracted materials as permissible.78 Brandon Gruner underscores that this new view is historically distinct from prior legal interpretation, noting that modern interpretations of the Outer Space Treaty’s non-appropriation principle differ from those of the Treaty’s authors.79 In contrast to earlier legal theory that denied the possibility of appropriation of any space resources, scholars now widely accept that extracting space resources from celestial bodies is a “use” permitted by the Outer Space Treaty and that extracted materials become the property of the entity that performed the extraction.80 Stressing the fact that the Treaty does not explicitly prohibit appropriating resources from outer space, other authors conclude that the use of extracted space resources is permitted, meaning that the new SPACE Act is a plausible interpretation of the Outer Space Treaty.81 However, scholars have been careful to cabin the extent to which they accept the legality of appropriation. For instance, although Thomas Gangale and Marilyn Dudley-Rowley acknowledge the legality of private appropriation of extracted space resources, they nonetheless emphasize that “[o]wnership of and the right to use extraterrestrial resources is distinct from ownership of real property” and that any such claim to real property is illegal.82 Lawrence Cooper is also careful to point out this distinction: “[t]he [Outer Space] Treaties recognize sovereignty over property placed into space, property produced in space, and resources removed from their place in space, but ban sovereignty claims by states; international law extends this ban to individuals.”83 Although there remain some scholars who still insist on the illegality of the 2015 U.S. law and State appropriation of space resources generally,84 their dominance has waned since the 1960s. These scholars are now a minority in the face of general acceptance among the legal community that minerals and other space resources, once extracted, may be legally claimed as property. 85 Taken together, the elements described above—statements made in the international arena, de facto appropriation of space resources in the form of moon rocks, the adoption of new national policies permitting appropriation of extracted space resources, and the weight of the international legal community’s opinion— indicate a fundamental shift in customary international law. The Outer Space Treaty’s non-appropriation clause has been redefined via customary international law norms from its broad application to now include a carve-out allowing appropriation of space resources once such resources have been extracted.

#### Violation---they defend restricting private asteroid mining which isn’t absolute.

#### Standards:

#### 1] Limits—their interp means that affs about any outer space activity are topical: tourism, photography, sending rovers, collecting ice cores, launching satellites, deflecting debris, can’t sell rocks on EBAY, etc.

#### 2] Ground—they shift the controversy from sovereign domination to minute activity. The topic literature is grounded in a debate over sovereign control over space, which means core neg generics are space ownership bad, space democracy bad, not temporary resource extraction or expeditions. Their interp minimizes link uniqueness because our impacts will never be overcome the advantage.

#### Use competing interps – reasonability invites arbitrary britelines and judge intervention. CI is a prerequisite to reasonability because you have to use offense to determine if their interp is reasonable.

### 2

#### Plan: Private entities ought to restrict asteroid mining involving artificial asteroid capture except for asteroid mining for the purpose of space colonization.

#### CP Competes - Asteroid Mining is being used as a tool to support Space Colonization.

Williams ’17 [Matt Williams, Writer for Universe Today. Citing A. J. Berliner, UC Berkeley; C. P. McKay. Space Sciences Division, NASA Ames Research Center; Valeriy Yakovlev, an astrophysicist and hydrogeologist from Laboratory of Water Quality in Kharkov, Ukraine. 3/10/17, “The future of space colonization – terraforming or space habitats?” [https://phys.org/news/2017-03-future-space-colonization-terraforming-habitats.html Accessed 1/2/20](https://phys.org/news/2017-03-future-space-colonization-terraforming-habitats.html%20Accessed%201/2/20) \*edited for gendered language]

In light of this, Yakolev presents what he considers to be the most likely prospects for humanity's exit to space between now and 2030. This will include the creation of the first space biospheres with artificial gravity, which will lead to key developments in terms of materials technology, life support-systems, and the robotic systems and infrastructure needed to install and service habitats in Low Earth Orbit (LEO). These habitats could be serviced thanks to the creation of robotic spacecraft that could harvest resources from nearby bodies – such as the Moon and Near-Earth Objects (NEOs). This concept would not only remove the need for planetary protections – i.e. worries about contaminating Mars' biosphere (assuming the presence of bacterial life), it would also allow human beings to become accustomed to space more gradually. As Yakovlev told Universe Today via email, the advantages to space habitats can be broken down into four points: "1. This is a universal way of mastering the infinite spaces of the Cosmos, both in the Solar System and outside it. We do not need surfaces for installing houses, but resources that robots will deliver from planets and satellites. 2. The possibility of creating a habitat as close as possible to the earth's cradle allows one to escape from the inevitable physical degradation under a different gravity. It is easier to create a protective magnetic field. "3. The transfer between worlds and sources of resources will not be a dangerous expedition, but a normal life. Is it good for sailors without their families? 4. The probability of death or degradation of [hu]mankind as a result of the global catastrophe is significantly reduced, as the colonization of the planets includes reconnaissance, delivery of goods, shuttle transport of people – and this is much longer than the construction of the biosphere in the Moon's orbit. Dr. Stephen William Hawking is right, a person does not have much time." And with space habitats in place, some very crucial research could begin, including medical and biologic research which would involve the first children born in space. It would also facilitate the development of reliable space shuttles and resource extraction technologies, which will come in handy for the settlement of other bodies – like the Moon, Mars, and even exoplanets. Ultimately, Yakolev thinks that space biospheres could also be accomplished within a reasonable timeframe – i.e. between 2030 and 2050 – which is simply not possible with terraforming. Citing the growing presence and power of the commercial space sector, Yakolev also believed a lot of the infrastructure that is necessary is already in place (or under development). "After we overcome the inertia of thinking +20 years, the experimental biosphere (like the settlement in Antarctica with watches), in 50 years the first generation of children born in the Cosmos will grow and the Earth will decrease, because it will enter the legends as a whole… As a result, terraforming will be canceled. And the subsequent conference will open the way for real exploration of the Cosmos. I'm proud to be on the same planet as Elon Reeve Musk. His missiles will be useful to lift designs for the first biosphere from the lunar factories. This is a close and direct way to conquer the Cosmos." With NASA scientists and entrepreneurs like Elon Musk and Bas Landorp looking to colonize Mars in the near future, and other commercial aerospace companies developing LEO, the size and shape of humanity's future in space is difficult to predict. Perhaps we will jointly decide on a path that takes us to the Moon, Mars, and beyond. Perhaps we will see our best efforts directed into near-Earth space. Or perhaps we will see ourselves going off in multiple directions at once. Whereas some groups will advocate creating space habitats in LEO (and later, elsewhere in the Solar System) that rely on artificial gravity and robotic spaceships mining asteroids for materials, others will focus on establishing outposts on planetary bodies, with the goal of turning them into "new Earths". Between them, we can expect that humans will begin developing a degree of "space expertise" in this century, which will certainly come in handy when we start pushing the boundaries of exploration and colonization even further.

#### Solves the Aff – AAC is defined in 1AC Neenass as “bringing into orbit” – Space Colonization is explicitly defined as orbit of non-Earth planets – solves Debris and Astro-Terror risks since they wouldn’t be in Earth orbits.

NWE No Date "Space colonization" <https://www.newworldencyclopedia.org/entry/Space_colonization> //Elmer

Space colonization (also called space settlement, space humanization, or space habitation) is the concept of permanent, autonomous (self-sufficient) human habitation of locations outside Earth. It is a major theme in science fiction, as well as a long-term goal of various national space programs.

#### The Private Industry is the only avenue for Space Colonization – Governments have no incentive and are bound by I-Law.

Eure 16 (, J., 2016. Space… the final frontier. [online] Campbell Law Observer. Available at: <http://campbelllawobserver.com/space-the-final-frontier/> [Accessed 28 December 2021] Jonathan Eure is a 2017 graduate of Campbell Law School, winner of the 2017 J. Bryan Boyd Award for Excellence in Legal Journalism, and served as a senior staff writer for the Campbell Law Observer. He lived in Morganton, in the foothills of North Carolina, before moving to Raleigh for law school. He earned BA’s in Political Science and History from the University of North Carolina at Chapel Hill, graduating in 2014. The summer after his first year of law school, Jonathan worked as a legislative research intern with Representative Rob Bryan in the North Carolina General Assembly. Jonathan now interns with the Honorable Paul Newby at the North Carolina Supreme Court. Jonathan is the Secretary for the Campbell Public Interest Law Student Association (CPILSA).)-rahulpenu

Space… the final frontier With the recent discovery of a new earth-like planet, many countries are beginning serious talks about inhabiting and colonizing a planet in outer space. We very soon might turn on the news and hear stories of interstellar exploration and colonization. We might even hear about voyages of a starship named Enterprise. This probably sounds like wild speculation, or the contents of a cheesy science fiction novel. However, after a European research team announced the discovery of an earth-like planet circling the inhabitable zone of Proxima Centauri in August, 2016, we may soon see more discussions of the logistics and technology required to reach out into the stars. The part of that discussion we ultimately must address is the legal ramifications of colonization, essentially what are the laws to which nations and private individuals must adhere, when claiming portions of a new planet, moon, or asteroid. Proxima Centauri is the closest star to our own, lying a mere 4.54 light years from the Sun. In interstellar terms, that is a stone’s throw away, though clearly still an impossible journey for a civilization who has yet to visit another planet in our own Solar System. Still, Proxima Centauri’s vicinity to Earth has garnered a fair amount of interest from parties who hope to discover an inhabitable, one day reachable, planet. Guillem Anglada-Escudé led a research team of 31 scientists from eight different countries for months studying Proxima Centauri through the European Southern Observatory’s HARPS spectrograph and 3.6 meter telescope in La Silla, Chile. While investigating a tiny wobble Proxima Centauri experiences, the team discovered that the cause of the wobble is an Earthlike planet, promptly named “Proxima b.” “…overall, Proxima b is the best opportunity we have ever had for an inhabitable planet that may be reachable in the foreseeable future.” To be classified as “Earthlike,” Proxima b was studied based on likely mass, position, and orbit around Proxima Centauri, and the effects of Proxima Centauri on Proxima b. The researchers believe Proxima b has a similar mass to Earth, possibly indicating a similar, rocky makeup. Though Proxima Centauri, as a red dwarf star, releases less energy than our Sun, Proxima b is located in the so-called “goldilocks zone” of Proxima Centauri; in other words, not too hot, not too cold. Therefore, the researchers believe the basic elements for human life, heat, oxygen, and water could exist on Proxima b. There is some concern that the amount of solar radiation expelled by Proxima Centauri could make Proxima b uninhabitable, but overall, Proxima b is the best opportunity we have ever had for an inhabitable planet that may be reachable in the foreseeable future. “A ratified treaty is then given the full force of domestic law in the U.S., and the U.S. government would generally be bound to uphold the tenets of that treaty. Being bound to a treaty in this case means the U.S. could not claim any portion of Proxima b as U.S. property.” Obviously we have to get there first, and at this very moment, some of the most brilliant minds on Earth are attempting to develop interstellar travel. Ideas such as asteroid mining and economic incentives of resources available in space are already pushing us toward the day when we might visit another planet. Once we do, our current legal framework may make colonization difficult, at least on a national level. The best starting place for understanding space law is the “Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies,” better known as the “Outer Space Treaty.” Signed in 1967 by the member nations of the UN, including space race powerhouses the U.S. and U.S.S.R., the Outer Space Treaty created a series of broad principles controlling the manner in which nations would explore space. These principles include provisions that exploration is permitted in all states, that no celestial bodies may be appropriated by individual states, that nations take responsibility for the environments of space and celestial bodies, and that non-governmental space activities must be authorized and continually supervised by the states which have jurisdiction over such activities. In order to have ratified such a treaty in the U.S., the President would have sent the treaty to Congress for their “advice and consent,” and the treaty would have to be approved by a two-thirds majority. The treaty would then be sent back to the President to be ratified, as described in Article II, Section 2 of the U.S. Constitution. A ratified treaty is then given the full force of domestic law in the U.S., and the U.S. government would generally be bound to uphold the tenets of that treaty. Being bound to a treaty in this case means the U.S. could not claim any portion of Proxima b as U.S. property. Fortunately, this is also true for Russia and China, the U.S.’s primary competitors in space, and none of these nations can violate the treaty without risking adverse reactions from the others. The Outer Space Treaty is the only one of the U.N.’s treaties on outer space to which the U.S. or any other major space-faring nation belongs, and is therefore the only treaty that really matters, though the U.N. has passed other resolutions on the issue. “**Private** **exploration** of space **becomes** **more** of a **reality** each day, with private corporations such as SpaceX, Blue Origin, and Virgin Galactic testing **new** **platforms** for space travel.” As a policy matter, though the **O**uter **S**pace **T**reaty uses lofty ideals to **bind** **nations** into mutual respect and perhaps even unity of purpose, focusing solely on those ideals discounts a key ingredient of the original space race. Promulgation of national ideology was the original motivator of the space race between the U.S. and the U.S.S.R. Without national ideology, prestige, or power as a motivating factor, there is really **no** **incentive** **for** the **governments** of major spacefaring nations **to** **spend** massive amounts of money over long periods of time **on** such risky endeavors as space **colonization**. For this reason, the **colonization** of Proxima b would more likely **fall** **to** private **corporations** with much to gain from the resources other worlds might offer. Private exploration of space becomes more of a reality each day, with private corporations such as SpaceX, Blue Origin, and Virgin Galactic testing new platforms for space travel. A **movement** has **grown** **up** **alongside** these private spacefaring **companies** **claiming** planets such as Proxima b might become a **new** **frontier**, where private citizens can stake their own personal claims. This movement has even **proposed** **legislation** in Congress. The “Space Settlement Prize Act,” which would **ultimately** **guarantee** that **any** **settlement** built privately on other planets, moons, asteroids, etc., would be **owned** **by** the private citizens or **corporations** **who** **claim** **them**. This act would likely function similarly to the Homestead Acts, which allowed settlers who worked unclaimed land, to buy that land at very little cost. Furthermore, these groups claim that they are **not** **subject** **to** the **O**uter **S**pace **T**reaty, as the treaty’s provisions only govern nations. “The language of the Outer Space Treaty does not forbid private claims on and settlement of celestial bodies, only national appropriations. Furthermore, nations themselves are answerable in case of any environmental damages.” It is an interesting theory, and these 21st century frontiersmen and women might be correct. The Outer Space Treaty does not only govern nations themselves, but national oversight of non-governmental organizations as well. As all private attempts at space colonization on Proxima b and any other celestial body would be through corporate entities. These corporate entities would certainly fall under the national mandate to authorize and continually supervise the operation of such groups. But just because governments must have some form of oversight in place to manage private space exploration corporations, does not mean there is a mandate to control the legal operation of such corporations. The language of the Outer Space Treaty does not forbid private claims on and settlement of celestial bodies, only national appropriations. Furthermore, nations themselves are answerable in case of any environmental damages. Nations can certainly pass laws regulating the actions of private corporations consistent with the Outer Space Treaty’s mandate, and in fact the U.S. is already considering and attempting to create policies governing private space craft and travel. The problem is that none of this law has become official yet. The reality behind this entire discussion is that it will not become truly important until either nations or private corporations prove they can travel to another planet. Until then, the laws of space colonization are nothing more than an academic exercise. However, they have been proven important in one sense: protection of our moon. Prohibitions on national appropriation, military use, or exploitation have certainly been effective in keeping the moon unmolested (though technological and financial constraints also played a major role). So perhaps there is a reasonable groundwork for the future laws of space colonization. Proxima b may not be the first place they are exercised, but the discovery of a relatively nearby Earthlike planet is sure to hasten the need for such laws to be in place before we land. The law now needs to boldly go where no law has gone before.

#### Concede that Mining democratizes AAC tech – that’s necessary for Space Colonization to occur.

NASA 14 National Aeronautics and Space Administration 6-27-2014 “How Will NASA's Asteroid Redirect Mission Help Humans Reach Mars?” <https://www.nasa.gov/content/how-will-nasas-asteroid-redirect-mission-help-humans-reach-mars/> //Elmer

Trajectory and Navigation As we learn to maneuver a large mass like an asteroid using low-thrust propulsion and the gravity fields of Earth and the moon, we’ll prove valuable technologies for the future Mars missions. Human missions to Mars will require far more cargo at a long distance from Earth—much greater than the amount of cargo we currently send to the space station, which takes about one to three days to arrive. The ARM mission will help perfect techniques for sending those large masses to Mars by requiring a precise set of maneuvers to intercept the asteroid at a distance with large time delays. Reaching the Earth-moon system also requires precision very similar to that required for Mars orbit. Very careful power balancing and attitude control will be required to execute this portion of the ARM mission, which will parallel the work needed to pre-position cargo at Mars. Additionally, the crewed mission aboard Orion to the asteroid in cis-lunar space calls for a complex set of maneuvers to rendezvous and dock with the robotic spacecraft. Both the out-bound legs and in-bound legs of the journey require a critical lunar gravity assist burn, which is executed about 62 miles (100 km) above the lunar surface. The insertion and departure from the distant retrograde orbit also require very precise maneuvers that are comparable to the Mars orbit insertion and Mars departure burns.

#### Earth is dying

Arora 19 (Naveen Kumar Arora, Professor in the Department of Environmental Science, Ex-Head Department of Env. Microbiology, Babasaheb Bhimrao Ambedkar University.)(“Earth: 50 years challenge”, Environmental Sustainability, March 2019, Volume 2, [Issue 1](https://link.springer.com/journal/42398/2/1/page/1), pp 1–3)//ASMITH

The life of earth is estimated to be 4.54 billion years with an error range of 50 million years. Life appeared on earth around 3.5 billion years ago. Around 200,000 years ago, Homo sapiens evolved and started the great civilizations on the planet. Study suggests that human population is only 0.01% of all the life forms on Earth. This shows how existence of humans is just a miniscule part if we compare it with the existence of our planet or of the presence of life on earth. But if we go through the events particularly in last 10,000 years (of recorded history of mankind), it becomes clear that the presence of humans on earth brought several changes in both the biological and non-biological components. Most of the striking changes have appeared in last 50 years or so. According to reports, humans have destroyed about 83% of wild mammals and half the species of plants till date. On the whole, humans have consumed 30% of the known resources resulting into scarcer ecosystem services for future generations. If these trends continue, the Earth will soon be experiencing mass extinctions and we will be left with an even more degraded planet. Humans in last 50 years, because of ever-increasing population associated with pollution and destruction of natural ecosystems have completely changed the face of the Earth. The exponential increase in human population in last few decades brought about many drastic changes on Earth making it look much degraded and bruised. One such phenomenon is Earth’s present carbon dioxide (a potent green house gas) level in the atmosphere which has exceeded 411 parts per million (ppm), much higher as compared to about 323 ppm about 50 years ago, resulting in major environmental issues such as global warming and climate change. According to the Fifth Assessment Report of Intergovernmental Panel on Climate Change, anthropogenic activities have been described as the main cause of increased green house gases level, of which 2/3rd come from burning of fossil fuels and 1/3rd is from land use changes. The increased clearing of forests and vegetated lands, due to overgrazing and industrial transformation, in the 1970s showed disturbed albedo and evapotranspiration leading to warming of earth, change in carbon cycle and global catastrophic events of biodiversity extinction. NASA’s Goddard Institute for Space Studies (GISS) analyzed that the average global temperature of earth has increased by about 0.8 °C since 1880 and two-thirds of this warming has been reported since 1975. The nexus of responses and catastrophic events also point towards the accelerated rate of melting of glaciers with the loss of 226 gigatons/year of ice between 1971 and 2009. The highest impacted glacier loss was reported from Greenland Ice Sheet (about sixfold higher) and Antarctic ice (almost quadrupled) in merely 20 years. Correspondingly, the sea level rise has almost doubled in last 20 years, with increment being 3.1 mm/year since 1993. Chemical and pesticide pollution is another menace to the ecosystems. According to reports, more than 1,40,000 chemicals including pesticides, plastics, etc. have been synthesized till date since 1950 and each year 10 millions tons of toxic compounds are being dumped into the environment leading to land degradation, soil salinization and contamination of water resources. This has resulted in the problem of safe drinking water around the globe. As per reports of CNN, about 500 million tons of heavy metals, toxic sludge and hazardous solvents were estimated to be released in global water supply in 2007 making it unsafe to consume. Plastic pollution is also a big nuisance caused by humans on Earth. The stats show that annual production of plastics during 1970s was about 50 million metric tons and it has increased to over 348 million metric tons at present. In terms of biodiversity losses, WWF’s Living Planet Report highlights that humans have eradicated 60% of the Earth’s wildlife in less than 50 years. About 20% of Amazon forests are lost in the last half century. A recent study revealed that of total global tree cover loss between 2001 and 2015, 27% depreciation came from commodity driven deforestation i.e. conversion of forests permanently in order to expand commodities such as meat, minerals, oils and gas. Other drivers are forestry i.e. loss within the managed forests or tree plantations (26%), shifting agricultural practices (24%), wildfires (23%), and urbanization (0.6%). Half of the shallow-water corals have also been leached out by anthropogenic activities polluting the oceans and seas in last 30 years. The recent analysis shows that the population of freshwater animals has plummeted by 75% since 1970s. Reports say that the damage done is so rapid that even if we end it now, it will take centuries to replenish the natural world. The global human footprints over the past 50 years are so dominating that even the view of the planet from space shows the modification of various critical ecosystems and the demography. The complementing series of aerial pictures taken through satellites show that many hotspot ecosystems and areas have been tremendously degraded. Focusing on what all we have lost over the past half century, the red list is so long that it cannot be confined in few pages. The Great Barrier Reef visible even from space has shown 50% loss due to severe bleaching by increased temperature of the oceans in just 30 years and is predicted that up to 90% may die within next century. Shrinking of the Dead Sea has shown an alarming rate of around four feet a year and the sea has already lost one-third of its surface area. The increasing temperature has caused high rate of snow melting in the European mountain range The Alps, and the most unsettling event reported in 2017 was that the winter season was 38 days shorter in comparison to that in 1960. The human oriented massive irrigation project over past 50 years has shrunk the fourth largest lake Aral Sea, to only 10% and it will soon be a thing of the past. NASA’s monitoring of Arctic Sea ice since 1978 have detected a steep decline in overall ice content. The polar ice thawing stories over the past half centuries have been highly alarming and Antarctic alone has lost 40 billion tons of ice each year from 1979 to 1989 and this trend rose to 252 billion tons per year in 2009 and today Antarctic has already lost 6 times the ice it had 40 years ago. The ‘Third Pole’ i.e. The Himalayan- Hindu Kush mountain range and the Tibetan Plateau in Central Asia is also impacted by the negative trends of global warming and in the past 50 years this remote region has lost 509 glaciers resulting in the local temperature rise by 1.5 °C. Recently in 2018, a huge chunk of ice in Helheim Glacier in Greenland, about the size of Manhattan, with 10 billion tons of ice, split out and tumbled into sea; this loss was indicated as the most disturbing irreversible loss. The record breaking heat waves in Australia and Europe are already the hard and fast evidences to how much humans have changed the face of Earth. Australia witnessed the hottest summer in the recorded history in the year 2018–2019. The high melting of glaciers and warming of the poles led to the extreme freezing of Chicago, which became colder than Mount Everest, Siberia and the poles. The summers in Iran shockingly changed the size and color of Lake Urmia from green to brown due to blooming of algae and bacteria. Similarly, there are numerous reports which show the decline of fertile lands, increased soil salinity, loss of forests and so on, clearly visible by the satellite images. A team of researchers’ from several countries including Sweden, Australia, Denmark, USA, England, Canada, Germany and Holland declared climate change and biodiversity loss as the “core boundaries” which if breached can transform Earth to inhabitable state. Stephen Hawking in his recently published book “Brief Answers to the Big Questions” stated that the biggest threat to mankind on Earth is the human induced climate change. Although the technology has advanced at an unprecedented rate and this has improved the living standards a lot but the cost of this development in terms of damage to the planet as a whole is also extraordinary. We share the planet with millions of other species but have almost single handedly exploited it to the extent that every specie is affected one way or the other. The industrial, agricultural and the infrastructural revolution have resulted in over exploitation of resources and pollution of every nook and corner of the planet. The technologies which were developed to adorn and ease our routines has brought antonymic effect threatening the survival and has made it very clear that no human science can replace “nature’s perfect systems” which have been carving the environment and ecosystems of earth to balance it in the zone of habitability.

#### Space colonization is key to ensure human survival – pursuing it as soon as possible is crucial

Kovic 18 (Marko Kovic, co-founder and president of the thinktank [ZIPAR](https://kovic.ch/zipar/), the Zurich Institute of Public Affairs Research. He is also co-founder and CEO of the consulting firm [ars cognitionis](https://kovic.ch/consulting-ars-cognitionis/),. He has a PhD in political communication, University of Zurich.)(“Why space colonization is so important”, Nov 10, 2018, https://medium.com/@marko\_kovic/space-colonization-why-nothing-else-matters-a877723f77d4)//ASMITH

Should humankind exist in the future? Should the future existence of humankind be as good as possible in as many ways as possible? If your answer to these two questions is Yes, then there is a topic that you should care about a lot: Space colonization. Why, you might wonder, does space colonization matter, possibly more than anything else, as the title of this article claims? Because the future of humankind directly and completely dependent on whether and how we manage to colonize space. Space colonization is a double-edged sword. On one hand, the creation of permanent and self-sustainable human habitats beyond Earth is unavoidable if humankind is to exist in the long-term future. On the other hand, however, space colonization could bring about a catastrophically bad future if we colonize space in a bad way. That future that might be worse than one in which humankind does not exist. Space or bust: Why we must reach for the stars Why should we pursue space colonization in the first place? Don’t we have more pressing problems today, on Earth? Yes, we do have many problems on Earth today, and we should try to solve them. But space colonization is just that: A strategy for dealing with certain problems. An the problems that space colonization would be dealing with are, arguably, among the greatest problems of them all: Existential risks; risks that might lead to the extinction of humankind [1]. Currently, all of our proverbial existential eggs are in the same basket. If a natural existential risk strikes (for example, a large asteroid colliding with Earth) or if a man-made existential risk results in a catastrophic outcome (for example, runaway global warming [2, 3]), all of humankind is at risk because humankind is currently limited to planet Earth. If, however, there are self-sustainable human habitats beyond Earth, then the probability of an irreversibly catastrophic outcome for all of humankind is drastically reduced. Investing in space colonization today could therefore have immense future benefits. Using resources today in order to make space colonization possible in the medium-term future is not a waste, but a very profitable investment. If humankind stays limited to Earth and if we go extinct as a consequence of doing so, then we will all the billions of life years and billions of humans who might have come to exist — and who would have experienced happiness and contributed to humankind’s continued epistemic and moral progress. Taking space colonization more seriously today does not, of course, mean that we should only pursue space colonization and ignore everything else that is bad in the world. We should continue dealing with current global problems and, at the same time, invest greater resources into space colonization. At this point in our history and our technological development, even modest amounts of resources directed at space colonization would go a long way, such as public funding of basic research. Additionally, it is very likely that technological advances in the domain of space colonization would improve our lives in other ways as well thanks to technology transfer [4] — investing in space colonization today would probably be a win-win situation.

## Case

#### Public Sector Thumps Deflection Technology:

#### a] NASA

Koren 21 Marina Koren 11-30-2021 "NASA Is Practicing Asteroid Deflection. You Know, Just in Case." <https://www.govexec.com/technology/2021/11/nasa-practicing-asteroid-deflection-you-know-just-case/187120/> (a staff writer at The Atlantic. She covers space, including astronaut missions, robotic explorers, and the solar system and has reported from Cape Canaveral, SpaceX's launch site in south Texas, and NASA headquarters in Washington, DC. Previously, Koren was senior associate editor for The Atlantic.)//Elmer

The last thing anyone needs to think about right now is a catastrophic asteroid impact. And, thankfully, most of us don’t have to! Earth is not in immediate threat of a space rock. The chance that a known asteroid big enough to really do damage—or, you know, imperil our entire existence—will strike the planet in the next 100 years is insignificant. (If you want to worry about extinction, consider the extinctions brought on by climate change and other negative repercussions of our presence here on Earth.) But it helps to be prepared for these kinds of scenarios, and luckily there are people for whom thinking about them is a full-time job. So this week, just before Thanksgiving, NASA launched a space mission to test technology that could, someday, help humanity deflect a dangerous asteroid barreling its way. The spacecraft will now spend months zooming toward an asteroid several hundred million miles from Earth. (What did this particular asteroid ever do to us? Nothing—but NASA needs a test subject.) In September 2022, with the asteroid in its sights, the probe will line itself up and then—bam!—smash right into the unsuspecting rock at nearly 15,000 miles an hour. The impact is expected to change the orbit of the asteroid ever so slightly. Afterward, scientists will observe the shift with telescopes on Earth to determine whether this technique could work to protect our planet from a real cosmic threat. [Read: A handful of asteroid could help decipher our entire existence ] This would not be the first time a NASA spacecraft has bumped into an asteroid just minding its own business. Last year, a probe touched down on an asteroid’s surface and blasted it with nitrogen gas to stir up rocks. That mission was designed to collect some of those rocks and return them to Earth so that scientists might better understand how nature shaped the solar system and gave our planet its oceans. NASA punched that asteroid for the sake of science. This new mission is about survival. The Double Asteroid Redirection Test, or DART for short, marks humanity’s first-ever attempt to change the orbit of an asteroid. In some ways, it’s kind of rude? A bunch of “star stuff,” as Carl Sagan called us, has become sentient and smart enough to interfere with orbital mechanics and change, on a small scale, the nature of its solar system. It’s a weirdly godlike power move—you know, shifting heaven and earth for our own purposes. But here we are, throwing a spacecraft the size of a vending machine at an asteroid as big as Egypt’s Great Pyramid. The series of events that brought us to this particular point in human history can be traced back to 1998, when an astronomy institute issued an alert about a recently discovered asteroid that looked like it could hit in 2028. In astronomy time, that’s basically tomorrow, so if the asteroid was indeed a threat, we needed to do something about it soon. Scientists at NASA quickly found that this rock wasn’t going to collide with Earth, but the agency did establish a center devoted to estimating the probability of asteroids and comets hitting Earth, so that we might have a chance at actually stopping them. [Read: We’re heading straight for a demi-armageddon] The DART mission is aiming for Dimorphos, a small asteroid that orbits a bigger asteroid, Didymos, like a moon. If the mission works as intended, DART will carve a crater into the surface of Dimorphos and fling out a bunch of rocky debris, known as ejecta, esxplains Angela Stickle, a planetary scientist at the John Hopkins University Applied Physics Laboratory who leads the team that does impact simulations. “As that ejecta leaves the asteroid, it acts kind of like a rocket engine and pushes the asteroid,” Stickle told me. “You’re creating sort of a natural engine on the asteroid that then slows down its velocity.” Stickle and her team predict that the impact will shrink Dimorphos’s 12-hour orbit by about 10 minutes or so. A change in an object’s velocity translates into a change in its orbital path; if an asteroid were heading toward Earth, a version of this technique might shift an asteroid’s trajectory enough to turn a certain disaster into a near miss. In case you, like I, a person who usually assumes the worst, are wondering whether NASA could flub this mission and accidentally shove the asteroid toward Earth—don’t worry. A vending machine–size spacecraft isn’t capable of knocking Dimorphos out of its orbit around Didymos, or even inflicting serious damage. “This isn’t going to destroy the asteroid,” Nancy Chabot, the mission’s coordination lead at the Applied Physics Laboratory, told reporters earlier this month. “It’s just going to give it a small nudge.” The DART mission faces some unknowns. Astronomers think Dimorphos is probably a common kind of rocky asteroid. But asteroids have surprised them before. The asteroid that NASA touched down on last year, Bennu, turned out to be squishier than expected. And squishy asteroids would be more difficult to deflect, Cristina Thomas, a planetary scientist at Northern Arizona University who leads an observations team on DART, told me. “It’s a much simpler physics experiment if you take one hard thing and you smash it into another hard thing,” she said. [Read: How to get an asteroid named after you] In 2024, another planetary-defense mission, operated by the European Space Agency, will leave Earth for Didymos and Dimorphos to survey the scene and provide a close-up look of the aftermath of humanity’s attempt to mess with an asteroid. Meanwhile, on Earth, NASA will continue to search for and monitor near-Earth objects of a certain size. In 2005, Congress directed NASA to find at least 90 percent of the potentially hazardous asteroids that are statistically likely to exist out there. Remember when I said that no known asteroids have a significant chance of crashing into Earth in the next century? Well, NASA was supposed to meet that 90 percent goal as of 2020, but so far scientists have managed to find only 40 percent. Objects like Dimorphos appear fainter to telescopes than larger asteroids, which are easier to study and rule out as a hazard, Thomas said. “But an object of this size would actually pose a hazard to the planet,” she told me. Let’s say that someday astronomers identify a new asteroid that, unlike the 1998 discovery, could really be perilous. Scientists have practiced this scenario every year for nearly a decade in a NASA-run event about planetary defense. This year astronomers pretended that they had discovered an asteroid with a slight probability of hitting Earth in just six months. After a month of observations in this hypothetical scenario, that likelihood jumped to 100 percent. Astronomers needed more than a year to determine where exactly a hazardous asteroid would strike Earth, and they didn’t have that kind of time. Within days of impact, astronomers had only predictions about the regions at risk, including the places deemed “unsurvivable.” This particular exercise ended with a bleak conclusion: With a more powerful telescope scanning the skies, astronomers would have spotted this asteroid sooner, and space agencies would have had time to mount a mission like DART to attempt to deflect it away from Earth. And that telescope would have needed to be in place back in 2014. A starter mission such as DART is an important step in giving Earth a chance in this future. Despite what pop culture (or, more specifically, Armageddon) has led us to believe, space agencies won’t rely on a group of brave oil-rig workers but on spacecraft with good GPS to save us. (NASA actually invited Bruce Willis to attend the launch in California; the actor declined.) Any nuclear weapons—another option for destroying an asteroid headed our way—would likely be delivered by autonomous spacecraft, not astronauts. A future asteroid-redirect mission might be informed by the designs of previous spacecraft that destroyed themselves in the name of planetary defense, and guided by telescopes that have kept a watchful eye on the night sky, logging every new asteroid. When it comes to Earth-threatening asteroids, to paraphrase Aerosmith, you “don’t want to miss a thing.”

#### b] ESA

ESA 20 European Space Agency October 2020 "Value created by ESA's planetary defence initiative and Hera asteroid deflection mission" <https://space-economy.esa.int/article/85/value-created-by-esas-planetary-defence-initiative-and-hera-asteroid-deflection-mission> //Elmer

Value created by ESA's planetary defence initiative and Hera asteroid deflection mission [Oct/2020] In view of preparing Space 19+ and in order to inform decision makers on the impact of their investment on the European economy and society, ESA has conducted several studies to assess the socio-economic benefits of its programmes. One of these assessments evaluates the socio-economic benefits enabled by the Planetary Defence Programme, part of ESA’s Space Safety Programme and in particular the Hera asteroid deflection mission. With the objective to develop capabilities and technologies to detect, assess and deflect objects on collision route to Earth, ESA’s Planetary Defence roadmap foresees key tasks in the following areas: Threat detection and risk analysis; and Prevention, mitigation and protection (including Hera mission). Hera is the European component of the Asteroid Impact and Deflection Assessment (AIDA) collaboration with NASA. Its main objective is to characterise the outcome of a kinetic impactor test system (performed by NASA’s Double Asteroid Redirection Test DART mission to be launched in 2021 on a SpaceX launcher) on the smaller companion (Didymoon) of the Didymos binary asteroid and to provide the necessary physical and dynamical data to fully validate the kinetic impactor asteroid deflection technique (so as to be applicable to other asteroid targets). In addition, Hera will investigate relevant future in-situ resources utilisation activities, as well as gather scientific insights on the evolution processes of our solar system. In summary, Hera combines a broad range of objectives, both technical and scientific. In terms of economic impacts, investing 290 Million Euros into the Hera mission will support the European industry by strengthening their technology advantage, and thus, their competitiveness to target promising adjacent space markets with a total addressable opportunity ranging between 12 and 16 billion Euros by 2038. Considering the indirect and induced impacts on the economy, this would result in a GDP impact (value-added for the industry and the overall economy) of ca. 620 million Euro cumulatively, and a Hera mission’s Value-Added to Cost ratio of 2.0. This means that for every Euro invested in ESA’s Hera mission, the society will benefit from ca. 2 Euros in value-added. This study was conducted by SpaceTec Partners and was completed in May 2020. To access the document and more detailed information, please click here or login to access the restricted area.

#### That thumps the Aff – your 1AC U/Q is about Governments NOT Private Actors – if the 1AR pivots the I/L to “Size of Link” then Technology existing proves Pandora’s Box has been opened whether or not Asteroid Mining uses it or not.

#### No Astro-terror – no one will use deflection technology.

Wall 11 Mike Wall 11-4-2011 “Why Asteroids Make Lousy Space Weapons” <https://www.space.com/13515-asteroid-deflection-space-weapons.html> (Ph.D. in evolutionary biology from the University of Sydney, Australia)//Elmer

If you lie awake at night worrying about some supervillain steering giant asteroids toward your hometown, you really should relax, experts say. It's not going to happen anytime soon. Humanity does indeed have the technical skills to move space rocks around, and we may employ this know-how at some point to avoid a catastrophic impact like the one that killed the dinosaurs 65 million years ago. But the odds of any rogue state using asteroids to rain death down on its enemies are minuscule, experts say. "It's a lousy weapon," said former astronaut Rusty Schweickart, chairman of the B612 Foundation, a group dedicated to predicting and preventing cataclysmic asteroid impacts on Earth. "You get a chance to use one once every several hundred years," Schweickart said during a recent panel discussion called "Moving an Asteroid" at the California Institute of Technology in Pasadena. "And even then, you can only deflect it to hit someplace along a sort of arbitrary line across the Earth." [Top 10 Space Weapons] Serious spaceflight skills Changing the orbit of a massive asteroid hurtling through deep space sounds like a daunting task, but our species knows how to do it. For example, we could launch a spacecraft that would rendezvous with an asteroid, then travel alongside it for months or years. Over time, the probe's modest gravity would tug on the space rock, pulling it into a different orbit, Schweickart said. Given enough time to act, this so-called "gravity tractor" method could work in quite precise and predictable ways. And we've demonstrated the skills necessary to make it happen. Multiple missions have met up with asteroids in deep space. For example, NASA's Dawn spacecraft is currently in orbit around Vesta, the second-largest object in the main asteroid belt between Mars and Jupiter. And in 2005, Japan's Hayabusa probe rendezvoused with a space rock called Itokawa. The craft even scraped some samples off Itokawa and sent them back to Earth for analysis. It's a good thing we possess these potential asteroid-moving skills, Schweickart said, for they may save our bacon someday. Earth has been pummeled by many dangerous asteroids throughout its history, and there's no reason to think the barrage will stop in the future. Space rocks big enough to cause major damage and disruption to the global economy and society (were they to strike a populated area today) have hit Earth, on average, every 200 or 300 years, Schweickart said. Firing a weapon once every 300 years That bombardment rate is scarily frequent to anyone worried about the long-term survival of human civilization. But it's not nearly frequent enough to make asteroids good weapons of mass destruction, according to Schweickart. [5 Reasons to Care About Asteroids] "You're going to have an opportunity once every two or three hundred years to go up and have a weapon to hit Baghdad," Schweickart said. "Of course, the problem is that by that time, the Zambian space program is the world's premier space program, and Baghdad is a buddy of yours." Potential asteroid wranglers also wouldn't be able to direct a space rock just anywhere on Earth, he added. For the foreseeable future, we'll be able only to speed up or slow down an asteroid, moving it in an "east-west" direction along its trajectory. Moving it in the "north-south" plane is not an option. "If you do anything other than speed up or slow down the asteroid, it has almost no effect," Schweickart said. "You've got to go along that line; it's the only way physics lets you do it." So anyone wishing to asteroid-bomb the United States would have to manipulate a space rock whose trajectory already crossed American territory. The trick would be tweaking its velocity enough to ensure an impact on American soil. In practice, therefore, the wait for a suitable asteroid weapon could be considerably longer than 200 or 300 years. Protecting Earth Schweickart and other panelists argued that humanity will need to deflect a killer asteroid away from Earth someday. It would be a shame, they said, if unfounded fears about possible nefarious uses of asteroid-moving technology impeded its development. "The public perception of asteroids can be pretty scary," Schweickart said. "There's going to be a lot of scare stuff. It's already out there, it's going to get worse and that is going to be a very serious challenge that we on the technical side will have to deal with." People worried about death from above should focus their anxiety elsewhere, fellow panelist Bill Nye said. There are plenty of much more viable space weapons than asteroids already up there. "Space is already pretty weaponized," said Nye, executive director of the Planetary Society and former host of the science-themed TV show "Bill Nye the Science Guy." "The global positioning system that we all know and love was designed to guide weapons. So using an asteroid as a weapon is sort of coming late to the party."

#### “Useful Asteroids” come around every 1000 years – must meet size requirements that make it unfeasible.

Schweickart 4, Russell. "The real deflection dilema." 2004 Planetary Defense Conference: Protecting Earth from Asteroids. 2004. (an American aeronautical engineer, and a former NASA astronaut, research scientist, U.S. Air Force fighter pilot, as well as a former business executive and government executive. Schweickart was selected in 1963 for NASA's third astronaut group.)//Elmer

THE “ORIGINAL” DEFLECTION DILEMMA While counter arguments can certainly be made the risk or threat level posed by the original deflection dilemma can be put into perspective by considering the specifics of the opportunity for malicious use of a realistic asteroid deflection capability. An operational deflection mission would likely be launched with only enough propulsive capability to deflect the incoming asteroid to a safe miss distance above the atmosphere, accounting for various uncertainties. While different deflection concepts will have greater or lesser precision in applying the required delta V to the asteroid, it would be a wasteful expense if the targeted miss distance beyond the atmosphere were to exceed 1600 miles or so. In other words a reasonable mission capability would be to deflect an asteroid bound for a vertical impact to a miss distance of 1.4 earth radii. In all likelihood most systems that would be considered for operational use would permit a much smaller miss distance while still accounting for all uncertainties and necessary safety criteria. By way of illustration then, using this specific conservative example the deflection system would be able to deflect either a vertically impacting asteroid out to 1.4 Earth radii, or conversely, if used for nefarious purpose, deflect an asteroid which would otherwise have missed impacting the Earth by 1.4 Earth radii or less to an impact at the “center of the Earth”. How often might a “useful” asteroid of opportunity appear within this radius for someone with malicious intent to take advantage of it? In this example, precisely twice the frequency at which such an asteroid would have impacted the Earth on its own. I.e., the cross sectional area of concern here is double the cross sectional area of the Earth itself (1.4 squared). If then, a “useful” asteroid were to be defined as one between 75 and 150 meters in diameter, such an opportunity might present itself for nefarious use once every 1000 years or so. This is hardly the kind of opportunity that comprises a serious national security threat, or military opportunity.

#### AT Howe – 1] Proves they can’t no link out of Mining Good – AAC is irreparably tied technically to PD – separating the two ensures failure of the other and 2] Not reverse causal – yes its part of Mining BUT Mining isn’t the make-it-break-it for the development of that tech since they develop separately – banning it hurts Mining but banning Mining wouldn’t spill-over.

#### AT Mares – 1] More mining doesn’t make it more accessible – price, technical, and motive barriers still apply, 2] If they have enough technical capacity to implement, then they can just make the tech themselves thumping the unique I/L, 3] 3] Technical error solved by robust planning/detection, and 4] Even if Mares independently assumes a different Deflection Dilemma – NONE of your other cards that just cite Sagan’s original card do – proves Public Sector thumps – technology already exists.

#### AT Deudney – Mistakes capacity with ability – no U/Q for asteroids coming that are large enough with enough accuracy to make it likely.

#### AT Dello-Ivaco – 1] C/A our U/Q about Asteroids existing and 2] About state actors – thumps INCLUDING state sponsored mining operations.

#### AT Lovett – Response to a Private Company vs a Country is far different – the plan doesn’t ban Countries from just blasting NEOs or using them for Planetary Defense OFFENSIVELY.

#### AT Miller – Literally not about Deflection – its about “jamming” and “kinetic attacks” that simply don’t use propulsion tech from AAC – they also simply lack a U/Q about technical capacity – these are the same terrorists that can’t really build currently known technology like bioweapons – getting into Space is literally impossible.

#### View this Scenario as near zero – 1AC Byers says that Mining informed by astrodynamics and international rules solves – countries have no incentives since changing trajectory to kill Earth would hurt their profits – safety is intrinsic to generating high revenues – this is a question posed not a true risk.

#### Earth is prepared for an Asteroid Collision.

Powell 21 Corey Powell 12-20-2021 "How prepared is Earth for an asteroid collision?" <https://astronomy.com/news/2021/12/how-prepared-is-earth-for-an-asteroid-collision> (an American science writer and journalist, particularly known for his writing for Discover magazine, of which he became Editor-in-Chief in 2012, and his longstanding collaboration with Bill Nye. Powell co-authored three books with Nye, and as of 2019 co-hosted a podcast with Nye as well.)//Elmer

How prepared is Earth for an asteroid collision? NASA and other world space agencies have been studying this possibility and the forecast for near-earth celestial objects for years. Their efforts helped inform the new film 'Don't Look Up!' Contrary to what you may have read, Earth will not be devastated by the asteroid Apophis on April 13, 2029. Neither will Bennu, a 1/3-mile-wide pile of flying space rubble, strike us on Sept. 24, 2182. Every single scare story out there warning of an impending celestial collision is just that, a scary tale. At the same time, it is inevitable that such an impact will eventually occur — and when it does, the event could generate vast firestorms, tsunamis and extinctions. That is the asteroid paradox, explains Amy Mainzer, a planetary-defense expert at the University of Arizona’s Lunar and Planetary Laboratory: The odds of a major impact in any given year are minuscule, but the potential consequences are enormous. Further confounding things, the smaller the impact, the more likely it is to occur and the more difficult it is to predict. All those variables make it intensely challenging for scientists like Mainzer to assess asteroid risks in a useful way, and then to communicate that risk to the public. “You don't need to run out and buy asteroid insurance,” she says. “But you don't want to completely ignore the problem either.” Mainzer has been pondering these issues a lot lately in her role as the science advisor for Don’t Look Up!, a new film directed by Adam McKay (Vice, The Big Short, Anchor Man). The dark-satire film portrays a chaotic, confused global response to news that a comet is on a collision course with our planet. (Comets and asteroids pose similar hazards, but the filmmakers chose a comet for its greater drama.) The movie skewers, in wincingly believable ways, the powerful human desire not to believe in invisible dangers until they are right upon us. McKay conceived Don’t Look Up! as a metaphor for climate change, but it also literally depicts the asteroid-detection problems that Mainzer has spent her career attempting to solve. “The first thing I want to tell people is that we don't know of anything that's headed on a collision course. This is a science-fiction movie,” she says. Full disclosure is built into the way space-science works. The Center for Near-Earth Object (NEO) Studies at NASA’s Jet Propulsion Laboratory uses orbit-simulation software called Sentry II to assess the danger posed by any newfound asteroid. In less than one hour, it can calculate an object’s exact odds of impact within the next hundred years — down to the sliver of 1 in 10 million. The resulting database is openly accessible. You can see for yourself that no large objects have any significant probability of landing on our heads within a human lifetime. That reassurance comes with a significant caveat, though, because current asteroid surveys are far from complete. Mainzer has been working to remedy that as the principal investigator on NEOWISE, a repurposed NASA infrared space telescope that now scans the sky for previously unknown space rocks. For years, asteroid hunters have campaigned for a modern successor to complete the job. This past June, NASA formally authorized the much more powerful NEO Surveyor, with Mainzer reprising her role as head surveyor. “March 26, 2026 is our target date on the launch pad,” she says. By the mid 2030s, NEO Surveyor should have found 90 percent of the potentially hazardous asteroid more than 140 meters (460 feet) in diameter; astronomers focus on that size cutoff because such objects are small enough to slip through current surveys but large enough to cause significant regional damage. For even bigger asteroids, capable of causing global destruction on Earth, the coverage should approach 100 percent. Plug all of those newfound asteroids through the Sentry II software, and we will have a near-complete database of every large object that could potentially menace our planet over the next century. That will be a huge step beyond where we are now. Simulating an impact Scientists today run into their own asteroid paradox. There is no objective formula showing what level of risk requires action, nor what action would be desirable. A critical part of unwinding the paradox is the complicated, unsexy process of analysis: If NEO Survey or one of the other asteroid surveys uncovers a potentially hazardous object, scientists need to crunch a lot of data to figure out exactly how big and how dangerous the object is. And they need to do the job as quickly as possible, so we have maximum time to prepare a response. To hone that process, NASA has sponsored a series of planetary-defense simulations in which scientists pretend they have discovered a new Earth-threatening asteroid. A 2021 exercise, coordinated last spring by Vishnu Reddy at the University of Arizona, imagined that an asteroid similar to Apophis really was on a collision course with us, and then set the participants loose trying to understand what was happening. The simulation culminated with a deadly impact in the Czech Republic, and was scary enough that the associated website and press releases are plastered with “EXERCISE” and “FICTIONAL” warnings. People focus on the Armageddon-style heroics of sending a mission to blow the asteroid to bits, “but if you don't have the analysis tools in place, it's all kind of a moot point,” Mainzer says. “Are you looking at a situation where the only thing you can do is move people out of the way? Or do you have enough flexibility to mitigate the risk?” Asteroid deflection scheduled Fortunately, the world’s space agencies are stepping up their efforts to learn how to move a dangerous asteroid out of the way. Next year, NASA’s DART spacecraft (Double Asteroid Redirection Test) will ram headlong into a 500-foot (160-meter) asteroid called Dimorphos, the first test of asteroid deflection. About four years later, the European Space Agency’s Hera spacecraft will swing by to make a close study of DART’s effect on Dimorphos. The joint missions will vastly improve our knowledge of what asteroids are like on the inside and what it will take to move a risky one out of the way.

#### Chance of asteroids is tiny and no extinction

Robert **Walker 16**. Software Developer of Tune Smithy, Wolfson College, Oxford. 12-14-2016. "Why Resilient Humans Would Survive Giant Asteroid Impact." Science 2.0. https://www.science20.com/robert\_inventor/we\_wont\_go\_extinct\_after\_a\_major\_asteroid\_impact\_even\_96\_of\_species\_extinct\_0\_chance\_of\_humans\_extinct-187383

This is something you hear said so often - that we risk being hit by an asteroid that could make humans extinct. But do we really? This is the article I’m commenting on, a recently breaking news story: Earth woefully unprepared for surprise comet or asteroid, Nasa scientist warns. Some are already worrying that it means that we are all due to die in the near future from an asteroid impact. Well, no, it doesn't mean that. So, what is the truth behind it? The source of all this is a comment by Dr Joseph Nuth who warns: “But on the other hand they are the extinction-level events, things like dinosaur killers, they’re 50 to 60 million years apart, essentially. You could say, of course, we’re due, but it’s a random course at that point.” Photograph of comet Siding Spring by Hubble - right hand image is more processed. This comet did a close flyby of Mars and at one point was predicted to have a tiny chance of hitting Mars. In the end it missed Mars by more than a quarter of the distance from Earth to the Moon If you read the rest of the article, it’s a worthy goal, to prepare us for asteroid impacts of all sizes from the small Chelyabinsk one up to really large 10 km ones. There are a number of things potentially confusing about this statement however, if you read it as a non scientist. Although there is a risk of “mass extinction” if a large asteroid hit Earth, “mass extinction” there doesn’t mean “extinction of humans”, we are such a resilient species that we would certainly survive a giant asteroid impact. We are not “due” an extinction at all. Next giant impact is most likely to happen many millions of years into the future. As we'll see, there is almost zero chance of a giant impact in the next century. There is however much we can do to protect ourselves from smaller asteroids. As a result of extensive asteroid surveys over the last couple of decades: We can be pretty sure (as in perhaps 99.999999% sure) that there isn’t an extinction level asteroid headed our way in the next century. We know the orbits of all the Near Earth Asteroids that could do this and none will hit Earth over that timescale. That leaves comets, and the chance of that is something like 1 in 100 million per century, as a very rough guess (since 99% of the impacts are thought to be from asteroids). This risk has been pretty much retired due to the automated asteroid searches by the likes of Pan STARRS. But the chance of a smaller asteroid impact is still high enough to make it worth working on it, especially since this is the one natural hazard we can not only predict to the minute, decades in advance, with enough information but also prevent also, given a long enough timeline. We are already close to completing the survey of 1 km asteroids (90% done). With a bit more funding we could also find most of the asteroids down to 45 meters in diameter. As a result of new developments in the science of asteroid detection, this could be done for a cost of only $50 million to protect the entire Earth. We would then be able to deflect asteroids decades before they are due to hit, which is a far easier task than a last minute deflection. First when he said "You could say, of course, we’re due, but it’s a random course at that point.”" - that is a scientist speaking as a scientist. But of course people sharing this on social media, retweeting, writing new stories about it, pick up the “we are due” and omit the scientific qualification “but it’s a random course at that point”. To say that we are “due” a mass extinction is a bit like saying that after you throw nine heads, you are due to throw a tail. Not true. The chance that the next coin toss is a tail is always going to be 50/50 for a fair coin no matter how many heads you throw. It's the same with extinctions. So long as it is a random process, then an extinction that happens every 60 million years could happen tomorrow or it could be 60 million years or 120 million years before it happens. On average we would still expect to wait 60 million years for the next such mass extinction even if the last one happened hundreds of millions of years ago. It’s just as for the coin toss. Same for an extinction event of a size that happens every 100 million years. If you look at the diagram the big five are irregularly spaced. The last one happened 66 million years ago. But they are irregularly spaced so we can't conclude either that we need to wait 44 million years for the next big extinction either. Some scientists have tried to discern a periodicity in the extinctions of perhaps 26 to 30 million years. If they are right then we are due the next extinction perhaps 15 million years or so from now. But that is very controversial and if true, it wouldn’t cover all mass extinctions. At any rate that's so far into the future it makes no difference to us now, if they are right or wrong. We could get a mass extinction in the next few millions of years. But it is nearly impossibly unlikely in the next century.

#### AT Davis: 1] even if acquired by oligopolies there’s a profit incentive to see terrestrially 2] market competition solves – internal link in Xu is premised on a litany of actors competing for resources 3] costs go down – increase comp go downcard is vague posturing – prefer neg empirics

#### AAC is the most effective and feasible method of Asteroid Mining – other methods can’t fill-in.

Sutter 21 Paul Sutter 8-20-2021 "What can we do with a captured asteroid?" <https://www.space.com/asteroid-mining-bring-space-rocks-to-earth> (an astrophysicist at SUNY Stony Brook and the Flatiron Institute in New York City. Paul received his PhD in Physics from the University of Illinois at Urbana-Champaign in 2011, and spent three years at the Paris Institute of Astrophysics, followed by a research fellowship in Trieste, Italy)//Elmer

Far, far away But the main problem with asteroids is that they are far away. Not just in space (tens of millions of miles for even the "near"-Earth asteroids), but also in speed. To launch from Earth's surface and go into orbit, a rocket needs to change its velocity from zero to 5 miles per second (8 kilometers per second). To rendezvous with an average asteroid, the rocket has to change its velocity by another 3.4 miles per second (5.5 km/s). That requires almost as much fuel as the launch itself, which the rocket would just have to carry as dead weight, thus adding to the already-obscene cost of trying to set up a remote mining operation in the first place. And once the asteroid were mined, asteroid prospectors would be faced with a difficult choice: They could try to refine the ore right there on the asteroid, which would entail setting up an entire refining facility, or ship the raw ore back to Earth, with all the waste that would involve. Bringing home the bacon So instead of trying to mine a distant asteroid, how about we bring the asteroid back to Earth? NASA's ill-fated Asteroid Redirect Mission (ARM) was an attempt to do just that. The goal of the mission was to grab a 13-foot (4 meters) boulder from a nearby asteroid and return it to cislunar space (between the orbits of Earth and the moon), where we could then study it at our leisure. To move the boulder, ARM would use solar electric propulsion, with solar panels absorbing sunlight and converting it into electricity. That electricity would, in turn, power an ion engine. It wouldn't be fast, but it would be efficient — and it would eventually get the job done. Related: How it works: NASA asteroid-capture mission in pictures Unfortunately, in 2017, NASA canceled ARM. Some of the critical technologies wound up in other projects, like the OSIRIS-REx mission to the asteroid Bennu, and NASA continues to investigate and use ion engines. When properly scaled up, a future version of ARM could potentially send large chunks of asteroids — if not entire small asteroids — into nearby outer space. In fact, a recent study found a dozen potential asteroids, ranging from 6.6 to 66 feet (2 to 20 meters) across, that could be brought into near-Earth orbit with a change in velocity of less than 1,640 feet per second (500 m/s). And the solar electric propulsion schemes cooked up for ARM would be perfectly capable of that, although it would take a while. Once an asteroid is in near-Earth space, many of the difficulties of asteroid mining are significantly reduced. Just compare the ease of getting to low Earth orbit, or even to the moon, versus reaching Mars. The Red Planet's extreme distance from Earth presents enormous logistical, engineering and technical challenges that we are still trying to solve, all while we've maintained a continuous human presence in low Earth orbit for over two decades. A cislunar asteroid would be much easier to study and much easier to test different mining strategies on. In addition, its resources would be much easier to bring back to Earth. As a bonus, any asteroid redirect mission meant for mining would also automatically become an asteroid redirect mission for saving Earth: If we can successfully change the speed and orbit of a harmless asteroid, we can potentially do it for a dangerous Earth-crossing one. The solar electric propulsion drive, for example, might be humanity's best chance to avoid calamity.

#### Resource scarcity coming now and causes extinction—asteroid mining is the only way to solve

Crombrugghe 18 – Guerric, Business Development Manager Brussels, Brussels Capital Region, “Asteroid mining as a necessary answer to mineral scarcity”, LinkedIn, 1/11/2018, <https://www.linkedin.com/pulse/asteroid-mining-necessary-answer-mineral-scarcity-de-crombrugghe>

We need minerals, and we always will. Yet, our reserves are finite and a 100% end-of-life recycling rate is impossible to achieve. Eventually, new entrants will therefore be required to sustain our system. While the business case for asteroid mining can obviously not be closed with current technologies, it will someday become a necessity. We may as well start preparing ourselves. Scarcity of resources, the challenge of the 21st century According to the World Bank, in 2016 humanity's growth rate was of 1.18% in terms of population, and 2.50% in terms of GDP. Both of these, in turn, drive our staggering resource consumption: there are more of us, and each of us needs more. On the other, the Earth is a closed system, and resources are only available in a finite amount. We all know by now that there is only this much oil & gas, but the same can actually be said for water, arable land, minerals, etc. These two simple observations have sparkled the debate around the scarcity of resources. Even with the best intentions, mathematics teaches us that it is impossible to indefinitely extract resources from a given finite supply [1]. The problem arising in the short-term is the exhaustion of the existing supply. That limit is actually coming in fast. In a paper published in 2007, Stephen Kessler demonstrates that the global mineral reserves are only sufficient for the next 50 years. The figure on the right shows the ratio of known global reserve to global annual consumption, given a rough indication of adequacy in years. It dates from an earlier paper, published in 1994. Since then, the development of environmental-friendly technologies (e.g. batteries, electric engines, etc.) has drastically increased the consumption rate of high-tech metals such as cobalt, platinum, rare earths, or titanium. On the other hand, exploration programs have allowed to discover new deposits, notably of gold and diamond. We will certainly be able to continue to increase - or at least sustain - our reserves, but only temporarily. Recycling and other temporary fixes An obvious solution is recycling, i.e. rejuvenating our stocks. A popular concept to illustrate this idea is that of urban mining: retrieving the ores present in smartphones and other electronic devices. It may prove to be not only more environmental-friendly, be also safer and more cost-effective. Nevertheless, every solution based on recycling is, again, nothing more than a temporary fix, buying us a finite amount of time. The United Nations Environment Programme studied in a report the current recycling rate of 60 metals. More than half of them have an end-of-life recycling rate below 1%, and less than one-third are above 50%. Nickel, for example, is relatively easy to retrieve, with and end-of-life recycling rate of up to 63% under the best conditions. At that rate, less than 1% of the initial stock is available after only 10 cycle. Even with a staggering 99% efficiency, the same 1% limit is achieved in less than 460 cycles. Not bad, of course, but still not enough. Should our hunger for resources continue, and even with the most optimised recycling techniques, a second problem will arise in the longer term: the amount of resources needed at a given time will simply exceed the total available stock. Unless we manage to find growth vectors that do not require raw materials, that tipping point is an impassable limit. Its proximity obviously depends on our consumption rate. Asteroid mining? No matter which way we look at it, we will thus be short on resources, either through sheer exhaustion (i.e. transformation in an unrecoverable form) or because the demand will exceed the total reserves. We can - and should - talk about recycling, dematerialisation, and other more ethically questionable solutions such as bio-engineering. Nonetheless, no matter how good they are, these are only temporary fixes. If we don't radically change our lifestyle, we will sooner or later have to address the elephant in the room: the Earth is a closed system, we need new entrants. How can space help? Short answer: all these minerals can be found in space. Some are difficult to obtain, others are even more difficult, none are straightforward. The most accessible destination is near-Earth asteroids, a reservoir of over 17,000 known - and counting - giant rocks that regularly cross the orbit of our planet. They are commonly classified in three main families. The most interesting one, for our case, is that of the S-type asteroids. These are metallic bodies, containing first and foremost nickel, iron and cobalt, but also gold, ores from the platinum group. But the list doesn't stop there, many other minerals can be found in smaller amounts: iridium, silver, osmium, palladium, rhenium, rhodium, ruthenium, manganese, molybdenum, aluminium, titanium, etc. How do we get there? Let's take an example: Ryugu, formerly known as 1999 JU3. It's a C-type asteroid measured to be approximately one kilometre in size [2]. In addition to nickel, iron and cobalt, it also contains a fair share of water, nitrogen, hydrogen, and ammonia. Its total value is estimated to be approximately 80 billion USD. Fantastic! But how do we get there and, most importantly, how much does it cost? Well, we may have the start of an answer to these questions. Reaching Ryugu is a technological challenge, but it is feasible. In December 2014, the Japanese space agency has launched a spacecraft, Hayabusa2, heading to the asteroid. Its mission includes the collection of a small sample which will be sent back to the Earth, with a landing planned for December 2020. The target for the sample size is at least 100 µg. The total cost of the mission was projected to be around 200 million USD. That's 2 trillion USD per gram. Let's be optimistic and assume that the sample retrieved is pure gold. At today's rate, it is worth 42.5 USD per gram. That's a difference of over 10 orders of magnitude. Some may argue that Hayabusa2 has many other objectives that retrieving a sample. The mission does indeed include multiple landers, thorough scientific investigations, etc. There is actually another asteroid sample return mission underway, which we could you as a second point of comparison: OSIRIS-Rex, from NASA. It's heading for Bennu, also a C-type asteroid, which it will reach in August 2018. Total cost of the mission: 980 million USD. Target sample size: at least 60 g. We achieve thus roughly speaking 16 million USD per gram. Better, but still 6 orders of magnitude off compared to pure gold. It's pretty much as good as it gets with existing state-of-the-art technologies. Not much of a business case. Should we forget about it? Referring back to our earlier conclusion on resource scarcity, we had two options. Either we drastically reduce our resource consumption, to such a degree that reserves can last for longer than humanity itself, or we extend our closed system, the Earth, to nearby asteroids. In the current state of affairs, I am honestly not sure which course of action is the easiest. As they get increasingly rare, the cost of minerals will go up. On the other hand, as explained in a previous article, we can expect the cost of space activities to go steadily down. Step by step, these 6 orders of magnitude will slowly get munched away from both ends, until eventually asteroid mining becomes a viable operation. In other words: it will only become financially interesting once minerals become a thousand times more expensive and space activities a thousand times cheaper. As a point of reference, the introduction of reusable rockets by SpaceX, widely considered as one of the few truly disruptive changes in the aerospace sector in the last few decades, has "only" brought a cost reduction of 30%. While it's clearly amazing, we still need at least 220 innovations of the same calibre [3] before we can make it work (again: assuming the price of minerals simultaneously goes up by a factor of a thousand). It's therefore quite likely that space mining will not take place within our lifetime [4]. How can we accelerate the process? Firstly, we can only celebrate and support the numerous private initiatives which contribute to make that reality happen, either indirectly (e.g. launchers, space systems, etc.) or directly (e.g. in-space manufacturing, lunar exploration, etc.). Shout out to all the folks who manage to keep the flame of space exploration burning while generating profit for their investors. Secondly, space agencies and other institutional actors should continue to act as promoters of pioneering mission such as Hayabusa2, OSIRIS-REx, or DART. We can only regret that the Asteroid Redirect Mission from NASA and the Asteroid Impact Mission from ESA were not funded. From my perspective, these should actually be amongst the top priorities of our space exploration agenda. Not only are they instrumental to our understanding of the solar system, but they are also essential if we want to avoid the same fate as the dinosaurs. It's a question of survival. As a bonus, they also pave the way towards cost-efficient asteroid mining. In the meantime, we might want to consume existing resources a bit more efficiently.

#### Resource Shortages Exacerbate Conflict

Wingo 13 - Dennis Wingo, Former CTO of the Orbital Recovery Corporation, Founder & CEO of Skycorp Inc, and Greentrail Energy Inc., Co-Founder & CTO of Orbital Recovery Inc. Leader of NASA's the Lunar Orbiter Image Recovery Project (LOIRP), First in history to rescue and operate a spacecraft (ISEE-3) in interplanetary space, and University of Alabama in Huntsville Consortium for Materials Development in Space Researcher At University of Alabama in Huntsville Consortium for Materials Development in Space “Commentary | The Inevitability of Extraterrestrial Mining”, *Space News*, 7/29/2013, https://spacenews.com/36511the-inevitability-of-extraterrestrial-mining/

I am honored to provide the counterpoint to my esteemed colleague Ambassador Roger Harrison’s negative contention concerning the mining of extraterrestrial materials off of planet Earth. Let’s begin with his ending: “The conclusion is inescapable, though liable to be escaped, i.e., that raw materials will never be mined in space and sold profitably within the atmosphere or anywhere else. … Asteroids will continue unvexed in their obits, and the Moon too.” I bring a different quote, from the book “Empire Express,” the story of the intercontinental railroad, from U.S. Army Lt. Zebulon Pike, for whom Pike’s Peak is named: “In various places there were tracts of many leagues, where the wind had thrown up sand in all the fanciful forms of the ocean’s rolling wave, and on which not a spear of vegetable matter existed.” Pike’s visions of sand dunes, pathless wastes and sterile soils were reported, widely read and faithfully believed by geographers. The myth became innocently embellished by subsequent visitors, especially those in the party of Maj. Stephen H. Long, who traversed the whole area in 1820. It was reported to be “an unfit residence for any but a nomad population … forever to remain the unmolested haunt of the native hunter, the bison, and the jackal.” The delicious irony is that Mr. Harrison today lives in the shadow of Pike’s Peak, and the U.S. Air Force Academy where he teaches is in the middle of the confidently prophesied unmolested haunt. When Long’s report was written, the Erie Canal across New York was five years from completion and it was another 31 years before the first railroad was completed across the state. Mr. Harrison’s technical objections are for the most part valid today for his scenario, just as objections to a railroad across the North American continent were valid in the 1820s. However, technology is being developed today that will enable extraterrestrial mining, manufacturing and development just as technology was developed that would enable the creation of the national railroad. Mr. Harrison says it is an illusion that we are running out of resources. He is correct. That is not our claim. The claim is that extraction costs of economically viable terrestrial resources are rising dramatically and may soon exceed the cost of extraction from much more plentiful extraterrestrial sources. Today rapidly advancing costs and diminishing returns are rapidly redefining mining due to diminishing ore grades. This fact is developed in a 2012 distinguished lecture by Dan Wood before the Society of Environmental Geologists, “Crucial Challenges to Discovery and Mining — Tomorrow’s Deeper Ore Bodies.” This is a vitally important issue to solve as resource conflict has been the impetus for most wars in human history. We live in a global civilization of over 7 billion people, which will expand to over 9 billion before plateauing in mid-century. While American politicians are not paying attention to what this means, the rest of the world is noticing. Gross domestic product (GDP) growth and increasing global resource demand are addressed in “Iron Ore Outlook 2050,” a report commissioned for the Indian government. The GDP of the major powers (the United States, Europe, China, India and Japan) is forecast to rise from $48 trillion in 2010 to $149 trillion by 2050. The report’s substance is that with this massive increase in global GDP, an intensifying scramble for metal resources is inevitable. If the trend of resource consumption demand increase continues unabated, there are three likely potential outcomes. The first is collapse, forecast by the “Limits to Growth” school of thought. The second and more likely scenario is fierce national economic competition leading to wars over diminishing resources. The third, and most desirable, is to increase the global resource base by the economic and industrial development of the inner solar system. Mr. Harrison uses cost as the primary reason that extraterrestrial mining will never happen by focusing on a straw man argument related to mining asteroids in orbits far from Earth. Just as the U.S. railroad infrastructure began on shorter routes with lower capital requirements and shorter payback periods, asteroid mining can begin with our nearest neighbor, the Moon, where telepresence robotics, high-bandwidth communications and a short three-day trip for humans negate his premise. We know from the Apollo samples that plentiful metallic asteroidal materials exist in the lunar highlands. We also know from several missions that extensive water, titanium, thorium, uranium, aluminum and native iron all exist on the Moon, in easily separable oxide form. Improvements in remote sensing data from current missions and computer modelin

g continue to increase the amount of potential asteroidal material on the Moon, increasing confidence in the Moon first premise. The extensive resources of the Moon become the catalyst for an inner solar system-wide economy providing fuel, vehicles and the all-important experience in developing an industrial infrastructure off planet. The asteroids then become the force multiplier of inner solar system development with billions of tons of water, metals and free space energy from solar power. Mars figures in here as well as the second home of humanity, creating further demand for asteroidal resources, and providing something else that is becoming increasingly scarce on the Earth: hope for the future. The technical barriers that Mr. Harrison points to are being overcome just as those of the 19th century were. New technology developments in 3-D printing, additive manufacturing and advanced robotics are breaking down the final barriers to exploiting off-planet resources and indeed the industrial development of the inner solar system. It is not a question if, it is a question of when, and by whom. Just as the Pacific Railway Act of 1862 was a primary catalyst for a century of American economic growth, it should be the role of government to develop policies and concrete legislation to support this development for the continued health of the American economy and the future of all mankind.