# **January/February Neg Case (Asteroid Mining)**

#### Because asteroid mining carried out by private entities is the only way to guarantee the survival of the human race, I negate the resolution, Resolved: The appropriation of outer space by private entities is unjust.

My value for today’s round is life.

My criterion is the reduction of the loss of life.

#### **Extinction outweighs, and even if not likely, a concern for extinction means taking actions that solve all other impacts and leads to justice.**

**Sandberg, PhD in computational neuroscience from Stockholm University, 2008.**

Anders Sandberg, PhD in computational neuroscience from Stockholm University, et al., “Bulletin of the Atomic Scientists, September 9, 2008. [How can we reduce the risk of human extinction, last accessed on December 8, 2021, Accessed at: <http://thebulletin.org/web-edition/features/how-can-we-reduce-the-risk-of-human-extinction>] MD

**There is a discontinuity between risks that threaten 10 percent or** even 99 percent of humanity and those that threaten **100 percent.** For disasters killing less than all humanity, there is a good chance that the species could recover. If we value future human generations, then **reducing extinction risks should dominate our considerations. Fortunately, most measures to reduce these risks also improve global security against a range of lesser catastrophes, and thus deserve support regardless of how much one worries about extinction.** These measures include: Removing nuclear weapons from hair-trigger alert and further reducing their numbers; Placing safeguards on gene synthesis equipment to prevent synthesis of select pathogens; Improving our ability to respond to infectious diseases, including rapid disease surveillance, diagnosis, and control, as well as accelerated drug development; Funding research on asteroid detection and deflection, "hot spot" eruptions, methane hydrate deposits, and other catastrophic natural hazards; Monitoring developments in key disruptive technologies, such as nanotechnology and computational neuroscience, and developing international policies to reduce the risk of catastrophic accidents. Other measures to reduce extinction risks may have less in common with strategies to improve global security, generally. Since a species' survivability is closely related to the extent of its range, perhaps the most effective means of reducing the risk of human extinction is to colonize space sooner, rather than later. Citing, in particular, the threat of new biological weapons, Stephen Hawking has said, "I don't think the human race will survive the next thousand years, unless we spread into space. There are too many accidents that can befall life on a single planet." Similarly, NASA Administrator Michael Griffin has noted, "The history of life on Earth is the history of extinction events, and human expansion into the Solar System is, in the end, fundamentally about the survival of the species."

**Contention 1: Inevitable extinction**

**There will be a rapid decline and eventual depletion of the resources we need on Earth, in as soon as 20 to 30 years.**

**Greenspon 16** (Andy Greenspon, Ph.D. candidate in Applied Physics at the Harvard John A. Paulson School of Engineering and Applied Sciences, 2016) https://sitn.hms.harvard.edu/flash/2016/precious-metals-peril-can-asteroid-mining-save-us/

Have you ever wondered how much gold remains to be mined on Earth? How about the lesser-known element indium, essential to computer and smartphone displays? **Known sources of some metals could be depleted in as little as** [**20 to 30 years**](https://www.acs.org/content/dam/acsorg/greenchemistry/industriainnovation/cs3-whitepaper2013.pdf)**, especially the rarest ones necessary to construct computers, smartphones, and other advanced technologies.** While some elements can be substituted for others, **many metals are effectively irreplaceable because of their unique properties.** While we may find new sources of these metals, it will likely be harder to extract them, leading to increased costs and a need for cheaper alternative sources. **If we can’t find them on Earth, we’ll have to begin searching the rest of our solar system, starting with asteroids.**

**Without intervening and a transition from fossil fuels, mass extinction up to 75% of all life, is likely by 2100. We have to transition from fossil fuels by 2050.**

**Barnosky 15** (Professor at Department of Integrative Biology, University of California, Berkeley, 2015)

Anthony D. Barnosky, “MRS Energy & Sustainability,” September 15, 2015. [last accessed on December 20, 2021, Accessed at: https://www.cambridge.org/core/journals/mrs-energy-and-sustainability/article/abs/transforming-the-global-energy-system-is-required-to-avoid-the-sixth-mass-extinction/3B926E20A730AF666D6FCB75E366B703] MD

**Mass extinctions, which result in loss of at least an estimated 75% of known species** over a geologically short time period, **are very rare** in the 540 million year history of complex life on Earth. Only five have been recognized, the most recent of which occurred 66 million years ago, ending the reign of dinosaurs and opening the door for domination of the planet eventually by humans, who have now accelerated biodiversity loss to the extent that a Sixth Mass Extinction is plausible. Accelerated extinction rates up to now primarily have been due to human-caused habitat destruction and overexploitation of economically valuable species. **Climate change caused by** burning of **fossil fuels adds a** new and critically problematic **extinction driver because the pace and magnitude of change exceeds what many species have experienced in their evolutionary history,** and rapid climate change multiplies the already-existing threats. Particularly at risk are regions that contain most of the world's species, such as rainforest and coral reef ecosystems. **Avoiding severe losses that would commit many species to extinction by 2100 will require transforming global energy systems to carbon-neutral ones by 2050.** Currently, the transformation is occurring too slowly to avoid worst-case extinction scenarios.

**Allowing private entities to mine asteroids will set up a stable economy in space.**

**Greenspon 16** (Andy Greenspon, Ph.D. candidate in Applied Physics at the Harvard John A. Paulson School of Engineering and Applied Sciences, 2016) https://sitn.hms.harvard.edu/flash/2016/precious-metals-peril-can-asteroid-mining-save-us/

Given all the complexities and obstacles described above, asteroid mining is not currently technologically or economically feasible. **Asteroid mining will** only **become a reality if 1. mining for materials on asteroids becomes cheaper than mining them on Earth, or 2. mining and processing materials in space for use in space becomes cheaper than launching and sending spacecraft with those materials from Earth. Given humanity’s exponential increase in raw material consumption and** [**entrepreneurs’ desires**](https://www.wired.com/2016/09/elon-musk-colonize-mars/) **to push the** [**limits of spaceflight**](https://www.washingtonpost.com/news/the-switch/wp/2016/09/12/jeff-bezos-just-unveiled-his-new-rocket-and-its-a-monster/)**, this scenario could become a reality sooner than we think.**

**Currently there are two known companies with a long-term focus on asteroid mining**: Planetary Resources and Deep Space Industries (DSI), founded in 2010 and 2013, respectively. Planetary Resources raised $21 million this year to launch satellites with sensors to help manage natural resources on Earth. They plan to use this technology to eventually scan from afar near-Earth asteroids to identify desired materials. Within a decade, they and [**DSI**](http://spacenews.com/deep-space-industries-unveils-first-asteroid-prospecting-spacecraft/) hope to send survey probes to asteroids to map their surfaces and collect samples. **Both companies hope to determine the best asteroids for mining of not just metals but also water ice that can be “**[**converted into drinking water, breathable air, and rocket propellants**](http://www.geekwire.com/2016/planetary-resources-asteroid-mining-earth-observation-21-million-funding/)**” for use in a space economy.** The ultimate goal is to use fully automated robotic systems for mining, processing, and transporting products wherever they are desired, whether on Earth or in space.

**Helium 3 found on the moon provides the answer and is the next step, but aff dooms the Earth as budget cuts and other priorities prevent national space agencies from mining.**

**Popular Mechanics, 2004.**

Popular Mechanics, December 7, 2004. [Mining the Moon, Last accessed on December 20, 2021, Accessed at: https://www.popularmechanics.com/space/moon-mars/a235/1283056/] MD

**It is not a lack of engineering skill that prevents us from using helium-3 to meet our energy needs, but a lack of the isotope itself**. Vast quantities of helium originate in the sun, a small part of which is **helium-3**, rather than the more common helium-4. Both types of helium are transformed as they travel toward Earth as part of the solar wind. The precious isotope **never arrives because Earth's magnetic field pushes it away. Fortunately, the conditions that make helium-3 rare on Earth are absent on the moon**, where it has accumulated on the surface and been mixed with the debris layer of dust and rock, or regolith, by constant meteor strikes. **And there it waits** for the taking. An aggressive program **to mine** helium-3 from the surface of the moon would not only represent an economically practical justification for permanent human settlements; it could yield enormous benefits back on Earth. **Budget cuts, a public bored with space and fear of losing a crew**--*Apollo 13* was still a vivid memory--**turned Apollo 17 into the last moon mission** of the 20th century. NASA decided to get the most scientific data possible from its last lunar excursion and made a crew change: Harrison H. Schmitt became the first and only fully trained geologist to explore the moon. Schmitt was a natural choice. With a doctorate from Harvard University, he was already on the staff of the U.S. Geological Survey's astrogeology branch in Flagstaff, Ariz. His job included training astronauts during simulated lunar field trips. There was only one hole in his résumé. Schmitt had never learned to fly. In 18 months he earned his wings, and became a jet plane and lunar landing module pilot. On Dec. 11, 1972, he and Eugene Cernan landed in the moon's Taurus-Littrow Valley. On the first of three moonwalks, Schmitt's scientific knowledge became evident. So did his enthusiasm. His periodic falls stopped hearts at Mission Control, which feared he would rip his spacesuit and die instantly. Four years after returning with 244 pounds of moon rocks, Schmitt was elected U.S. senator from New Mexico. Now chairman of Albuquerque-based Interlune-Intermars Initiative, he is a leading advocate for commercializing the moon.

**In the status quo, private companies will mine Helium-3. Aff forces national space agencies to take over all aspects of space exploration which delays space mining and the transition to Helium-3 dooming the Earth to extinction.**

**Sharma 21** (Editor-in-Chief of the Journal of Interdisciplinary Public Policy, 2021)

Maanas Sharma, “The Space Review,” September 7, 2021. [The privatized frontier: the ethical implications and role of private companies in space exploration, December 20, 2021, Accessed at:https://www.thespacereview.com/article/4238/1 ] MD

Another key matter to note is restricted capitalism in space “could also be our salvation.”[11] **Private space exploration could reap increased access to resources and other benefits that can be used to solve** the very **problems on Earth** that critics of capitalism identify. **Since governments offset some of their projects to private companies, government agencies can focus on altruistic projects that otherwise would not fit in the budget before** and do not have the immediate commercial use that private companies look for. Scott Hubbard, an adjunct professor of aeronautics and astronautics at StanfordUniversity, discusses how “this strategy allows the space agency to continue ‘exploring the fringe where there really is no business case’” but still has important impacts on people down on Earth.[12] Indeed, this idea is a particularly powerful one when considering the ideal future of private companies in space exploration. Though there is no one set way governments will interact with companies, the consensus is that they must radically reimagine their main purpose as the role of private space exploration continues to grow. **As governments utilize services from private space companies, “[i]nstead of being bogged down by the routine application of old research, NASA can prioritize their limited budget to work more on research of other unknowns and development of new** long-term space travel **technologies.**”[13] According to the Council on Foreign Relations,**such technologies have far-reaching benefits on Earth** as well. Past developments obviously include communications satellites, by themselves a massive benefit to society, but also “refinements in artificial hearts; improved mammograms; and laser eye surgery… thermoelectric coolers for microchips; high-temperature lubricants; and a means for mass-producing carbon nanotubes, a material with significant engineering potential; [and h]ousehold products.”[2] Agencies like NASA are the only actors able to pursue the next game-changing missions, “where the profit motive is not as evident and where the barriers to entry are still too high for the private sector to really make a compelling business case.”[8] **These technologies have revolutionized** millions, if not billions, of lives, **demonstrating the remarkable benefits of space exploration**. It follows then that it is net ethical to prioritize these benefits.

**Contention 2: Asteroid Mining by Private Entities Solves**

**Asteroid mining provides a solution for this by storing an abundance of rare metals we need on Earth.**

**MIT, Mission 2016: The Future of Strategic Natural Resources, Asteroid Mining 2012** *Asteroid Mining*, https://web.mit.edu/12.000/www/m2016/finalwebsite/solutions/asteroids.html.

Asteroids are a class of small rocky and metallic bodies orbiting the sun. These bodies represent the remains of failed planetesimals, or proto-planets (Asphaug, 2003) & (Binzel & Barucci, 1991). **Asteroid composition varies widely, from volatile-rich bodies to metallic bodies with high concentrations of rare metals such as gold, silver, and platinum in addition to more common elements such as iron and nickel. Platinum-rich asteroids may contain grades of up to 100 grams per ton, 10-20 times higher than** open pit **platinum mines in South Africa** (Sonter, 2006). **These ore grades mean that one** 500-meter-wide **platinum-rich asteroid could contain nearly 175 times the annual global platinum output**, or 1.5 times the known world reserves of platinum group metals ("Asteroid composition", 2012). Asteroid mining is a proposed approach to mining critical elements from these small bodies. Because of the difficult nature inherent to mining asteroids, few companies or governments are currently considering asteroid mining. At present, only one company, Planetary Resources, is conducting research into the technologies and strategies necessary to make asteroid mining economical. Our current understanding of asteroid composition confirms they are a likely source of many critical elements, such as the platinum group elements. However, asteroid mining is currently only viable as a long-term solution; currently, the infrastructure and techniques needed to mine and refine asteroid resources is under development, making short term returns unlikely for mining companies.

**As Earth is running out of critical resources, governments find themselves struggling to safely invest in the mining of asteroids. This is why we need private entities.**

**SAME SOURCE**

(MIT, Mission 2016: The Future of Strategic Natural Resources, Asteroid Mining 2021)

**The** KISS **study claims that it will be feasible to "identify, capture, and return" an asteroid** seven meters in diameter and 500,000 kg in weight **using technology that could be developed in the next decade** (48). This study states that asteroid mining is feasible as long as three major advances are in place- development of an efficient solar/electric propulsion system, development of a campaign to discover and target potential asteroids, and the establishment of a human presence in lunar orbit ("Is Asteroid Mining Possible?", 2012).

Although asteroid mining is capable of producing significant amounts of critical elements, Mission 2016 recommends that funding for asteroid mining come from the private sector. **At present, the high start-up costs, high risk, and long timescales on investment returns make it difficult for governments to safely invest in asteroid mining. Since some resources are projected to become critically low very soon,** Mission 2016 suggests that governments focus on more easily available resources and technologies.

**NASA has mined an asteroid in the past, showing that it is more than possible.**

**NASA 2020** “NASA’s OSIRIS-REx Successfully Stows Sample of Asteroid Bennu” Potter, Sean.

Potter, Sean. “NASA's OSIRIS-Rex Successfully Stows Sample of Asteroid Bennu.” NASA, NASA, 29 Oct. 2020, https://www.nasa.gov/press-release/nasa-s-osiris-rex-successfully-stows-sample-of-asteroid-bennu.

**NASA’s** Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (**OSIRIS-REx**) **mission has successfully stowed** the spacecraft’s Sample Return Capsule (SRC) and **its abundant sample of asteroid Bennu.** On Wednesday, Oct. 28, the mission team sent commands to the spacecraft, instructing it to close the capsule – marking the end of one of the most challenging phases of the mission.

**“This achievement by OSIRIS-REx on behalf of NASA and the world has lifted our vision to the higher things we can achieve together,** as teams and nations,” said NASA Administrator Jim Bridenstine. “Together a team comprising industry, academia and international partners, and a talented and diverse team of NASA employees with all types of expertise, has put us on course to vastly increase our collection on Earth of samples from space. **Samples like this are going to transform what we know about our universe and ourselves, which is at the base of all NASA’s endeavors.”**

The mission team spent two days working around the clock to carry out the stowage procedure, with preparations for the stowage event beginning Oct. 24. The process to stow the sample is unique compared to other spacecraft operations and required the team’s continuous oversight and input over the two-day period. For the spacecraft to proceed with each step in the stowage sequence, the team had to assess images and telemetry from the previous step to confirm the operation was successful and the spacecraft was ready to continue. Given that OSIRIS-REx is currently more than 205 million miles (330 million km) from Earth, this required the team to also work with a greater than 18.5-minute time delay for signals traveling in each direction.

Throughout the process, the OSIRIS-REx team continually assessed the Touch-And-Go Sample Acquisition Mechanism’s (TAGSAM) wrist alignment to ensure the collector head was being placed properly into the SRC. Additionally, the team inspected images to observe any material escaping from the collector head to confirm that no particles would hinder the stowage process. StowCam images of the stowage sequence show that a few particles escaped during the stowage procedure, but the team is confident that a plentiful amount of material remains inside of the head.

“Given the complexity of the process to place the sample collector head onto the capture ring, we expected that it would take a few attempts to get it in the perfect position,” said Rich Burns, OSIRIS-REx project manager at NASA's Goddard Space Flight Center in Greenbelt, Maryland. “Fortunately, the head was captured on the first try, which allowed us to expeditiously execute the stow procedure.”

By the evening of Oct. 27, the spacecraft’s TAGSAM arm had placed the collector head into the SRC. The following morning, the OSIRIS-REx team verified that the collector head was thoroughly fastened into the capsule by performing a “backout check.” This sequence commanded the TAGSAM arm to attempt to back out of the capsule – which tugged on the collector head and ensured the latches are well secured.

“I want to thank the OSIRIS-REx team from the University of Arizona, NASA Goddard, Lockheed Martin, and their partners, and also especially the SCaN and Deep Space Network people at NASA and JPL, who worked tirelessly to get us the bandwidth we needed to achieve this milestone, early and while still hundreds of millions of miles away,” said Thomas Zurbuchen, NASA’s associate administrator for science at the agency’s headquarters in Washington. “What we have done is a real first for NASA, and we will benefit for decades by what we have been able to achieve at Bennu.”

On the afternoon of Oct. 28, following the backout check, the mission team sent commands to disconnect the two mechanical parts on the TAGSAM arm that connect the sampler head to the arm. The spacecraft first cut the tube that carried the nitrogen gas that stirred up the sample through the TAGSAM head during sample collection, and then separated the collector head from the TAGSAM arm itself.

That evening, the spacecraft completed the final step of the sample stowage process –closing the SRC. To secure the capsule, the spacecraft closed the lid and then fastened two internal latches. **As of late Oct. 28, the sample of Bennu is safely stored** and ready for its journey to Earth.

**On Case**

**Turn- Space debris technology developed by countries risks a space arms race as it is dual use. Private companies are the best option.**

**David, owner of SDR&I, and reporter for Space.com, 2021.**

Leonard David, “Scientific American,” April 14, 2021. [Space Junk removal is not going smoothly, last accessed on December 25, 2021, Accessed at: https://www.scientificamerican.com/article/space-junk-removal-is-not-going-smoothly/] MD

There is no doubt that active orbital debris removal is technically challenging, Gorman says. “However, the big issue is that any successful technology that can remove an existing piece of debris can also be used as an antisatellite weapon,” she says. “This is a whole other can of worms that requires diplomacy and negotiation and, most importantly, trust at the international level.” Indeed, the ability to cozy up to spacecraft in orbit and perform servicing or sabotage has spurred considerable interest from military planners in recent years, says Mariel Borowitz, an associate professor at the Georgia Institute of Technology’s Sam Nunn School of International Affairs. “These rapidly advancing technologies have the potential to be used for peaceful space activities or for warfare in space,” she says. “Given the dual-use nature of their capabilities, it’s impossible to know for sure in advance how they’ll be used on any given day.” For now, according to Moriba Jah, an orbital debris expert at the University of Texas at Austin, the business case for space debris removal is not monetizable and is more a “PowerPoint talk” than a real marketplace“I think people are hoping that government basically comes to some common sense to help create and establish a marketplace for industries to engage in these sorts of activities,” Jah says. In order for that to happen, he believes that spacefaring nations have to agree that near-Earth space is an ecosystem like land, air and the ocean. “It’s not infinite, so we need environmental protection,” he says.

**No solvency- Nations have shown no will to address space debris, and can’t remove satellites owned by private corporations. Only private companies solve.**

**Giordano is a second-year student at Columbia Law School and a Staff member of the Columbia Journal of Transnational Law, 2021.**

Giordano, Columbia Journal of Transnational Law, October 31, 2021. [Giordano is a second-year student at Columbia Law School and a Staff member of the Columbia Journal of Transnational Law, last accessed on December 21, 2021, Accessed at: https://www.jtl.columbia.edu/bulletin-blog/space-debris-another-frontier-in-the-commercialization-of-space] MD

The nation best positioned to notify space actors of collision risks is the United States, and the burden of that task currently falls on the [Department of Defense](https://www.govexec.com/media/d1-mission-space.pdf). However, the Trump administration issued a [directive in 2018](https://www.cnbc.com/2018/06/18/national-space-council-trump-signs-space-debris-directive.html), shifting the responsibility from the DoD to the Department of Commerce, and the [transition has yet to materialize](https://www.govexec.com/media/d1-mission-space.pdf), leaving DoD struggling to keep pace [with increasing commercial activity](https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/look-out-below-what-will-happen-to-the-space-debris-in-orbit). In the face of public paralysis, addressing the problem through industry looks more and more attractive. This has led some to call for a new legal order that still leaves room for government, but reframes who the rules exist to serve. Rather than our current, rudimentary treaty regime designed to [prevent international conflict](https://www.theverge.com/2017/1/27/14398492/outer-space-treaty-50-anniversary-exploration-guidelines), [commentators](https://space.nss.org/wp-content/uploads/NSS-Position-Paper-Space-Debris-Removal-2019.pdf) have called for an additional regime resembling [maritime law](https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/) that preserves the interests of a more diverse set of stakeholders, including those in the future that can bring technology and interests to space that may not yet exist. These commentators shun the common conception that space regulation should resemble air-traffic control, which is suited to a narrower set of uses (transport). Under such a “maritime” regime, the light touch of central regulatory bodies, and perhaps their non-existence, is preferred, just as it has been on the seas. This way, individual nations have a degree of flexibility in instituting controls they see fit while leaving room for industry to address problems and introduce new uses for space. Furthermore, governments seem ready and willing to construct the legal and incentive framework in concert with such private action.  [In a joint statement this summer](https://www.gov.uk/government/news/g7-nations-commit-to-the-safe-and-sustainable-use-of-space), G7 members expressed openness to resolving the technical aspects of the debris problem with private institutions, and there is some promising progress. Apple co-founder [Steve Wozniak](https://www.space.com/apple-cofounder-steve-wozniak-space-junk-company) signaled his plans to address the problem through a new company with a telling name: Privateer Space. Astroscale, a UK-based company, successfully launched a pair of satellites in the Spring of 2021 [that will remove certain space debris from orbit](https://astroscale.com/astroscale-celebrates-successful-launch-of-elsa-d/). Astroscale also [stated their desire](https://astroscale.com/space-sustainability/) to work with governments and international governing bodies to craft policy with private efforts to control the problem top of mind. In light of public policy’s silence on space debris, the initiative of actors like Astroscale involving themselves in policy may be advised, as it could [promote further private investment](https://docs.google.com/document/d/1NCO5Vvjf-kgoZLNfgaOn4bDj_CAfyD1Qhz2oW3TrcHc/edit) in technology for space debris removal. A popular [policy recommendation](https://reason.org/policy-brief/u-s-space-traffic-management-and-orbital-debris-policy/) among experts is the establishment of public-private partnerships, and Astroscale has entered several such agreements including with [Japan](https://www.satellitetoday.com/in-space-services/2021/07/27/space-clean-up-company-astroscale-signs-partnerships-with-mhi-and-japanese-government/) and the [European Space Agency](https://spacenews.com/astroscale-clearspace-aim-to-make-a-bundle-removing-debris/). Other actors include [ClearSpace](https://www.space.com/esa-startup-clearspace-debris-removal-2025), [OneWeb](https://www.hou.usra.edu/meetings/orbitaldebris2019/orbital2019paper/pdf/6077.pdf), and [D-Orbit](https://www.satellitetoday.com/in-space-services/2021/09/10/esa-awards-d-orbit-uk-contract-for-debris-removal-demonstration/). Some may want to push back against further private involvement. The congestion of space is, in part, industry’s fault, and if we conceptualize orbital space as a common resource, it might be right to fear the effects of the [Tragedy of the Commons](https://www.britannica.com/science/tragedy-of-the-commons). Critics may seek to bolster international treaties, give legal teeth to the guidelines occasionally issued by the UN, and preserve the public posture of the heavens. These may be welcome adjustments, but unlike a pond that industry overfishes or a well that industry dries up, here industry is working to add more fish and water. Moreover, governments stand to benefit from this private decluttering, as well, as [they are expected](https://astroscale.com/wp-content/uploads/2020/02/Reg-V-Development-of-Global-Policy-for-Active-Debris-Removal-Services-v2.0.pdf) to be major customers of some of these private actors. As for the public posture, space has long been a commercial place. Telecommunications companies and government contractors historically depend on space. As the number of commercial satellites set to launch skyrockets, it seems natural to craft policies that are responsive to their interests and provide incentives to remedy issues created in the course of spacefaring, such as space debris. In light of the long silence of international law on such issues and the demonstrated motivation by private actors, space debris represents the latest frontier in the abdication of space from the public concern to the private.

**If we were to take a step to remove space debris, we would need private corporations to create the tech and perform the removal.**

**The National Academies Press, 1995**

**Two main approaches could theoretically be employed to reduce the long-term creation of debris from collisions. These are (1) to decrease the number of collisions by employing collision avoidance techniques or (2) to remove objects capable of causing collisions away from crowded orbital regions.** (Limiting the *number* of objects in orbit without reducing mass is not sufficient to reduce the long-term potential for collisions, because such reductions do not affect the total kinetic energy in orbit available to cause collisions.) **The problem with the first approach is that**, as discussed in [Chapter 6](https://www.nap.edu/read/4765/chapter/119.html#p200063399970119001), **current collision warning systems are ineffective**, and the development of effective systems would be both technically challenging and costly. **Even if an effective collision warning system were implemented, it would probably not be of use in preventing breakups of either nonfunctional spacecraft or other debris (because such objects are incapable of maneuvering to avoid a collision)**. Consequently, removing debris from crowded orbits may be the only practical alternative.

**There are four techniques that can move debris** from heavily trafficked orbits: (1) **deorbiting** (the deliberate, forced reentry of a space object into the Earth's atmosphere by application of a retarding force, usually via a propulsion system) at EOL; (2) **orbital lifetime reduction** (accelerating the natural decay of spacecraft and other space objects to reduce the time that they remain in orbit) at EOL; (3) **moving objects into less populated "disposal" orbits** at the end of their functional lifetime; and (4) **active removal of debris from orbit.**