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Through a Glass Darkly – How Four Good Ideas are Inhibiting Remediation of Orbital Debris

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“Through a Glass Darkly – How Four Good Ideas are Inhibiting Remediation of Orbital Debris”

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Abstract

Besides the legal, political and economic hurdles that are hindering timely remediation of orbital debris, four widely-held perspectives are inhibiting progress: “analysis paralysis”, national leadership, blaming others, and industry readiness concerns. Although grounded in fact and law, they are also fostering unintended consequences harmful to achieving results.

Introduction

Our ability to see the truth is often obscured by self-inflicted wounds.¹

Of all the man-made debris in space, Massive Derelicts² are the most dangerous. Clustered in a few circular orbits high above the International Space Station, intertwined within the most valuable but increasingly over-populated neighborhoods in LEO, and sharing physical characteristics, a few thousand discarded rocket bodies and defunct satellites hurtle around the globe. Collisions involving these huge objects are imminent and inevitable unless we take action to avoid them. Once begun, their dance of death will increase the cost and risk of space use and, if not checked, will lead eventually to an impenetrable shell of sand around Earth preventing further use of outer space for everyone for any purpose.

¹ “Through a Glass Darkly”, as used in the Bible (1 Corinthians 13:12, King James Version) and in literature, refers to the human condition where our capability to see absolute truth is clouded by our own imperfections.

² The phrase “Massive Derelicts” was coined by scientists to describe huge objects in Low Earth Orbit (LEO) that lack maneuverability. These used rocket bodies and dead satellites were left in space primarily during the last third of the twentieth century by China, the Russian Federation and the United States of America, and to a lesser extent by France, Japan, India and the European Space Agency. They will persist in space for centuries before naturally deorbiting.

Owned by a small handful of bitterly divided sovereign governments, the human existential problem we face from Massive Derelicts cannot be solved by one country acting alone. Cooperation will be necessary to meet this challenge, but despite the peril, no action has been taken to remediate these ticking time bombs.

A variety of legal, political and economic factors have been put forward to explain our current deadlock, including weaknesses of international space governance mechanisms, the economic nature of space as a global commons, limitations and bureaucratic tendencies of sovereign governments, international politics, and the huge costs involved.³ Besides these well-known causes, four other less obvious but still important influences are contributing to inaction.

“Analysis Paralysis”

Almost fifty years of space science, primarily mathematical statistics, an application of probability theory, from Donald Kessler to Darren McKnight, has clearly identified Massive Derelicts as the most dangerous debris in space because of their propensity to spawn thousands of smaller but still lethal fragments when they collide with themselves or other space objects.

These objects have been ranked by scientists to identify the most dangerous among them.⁴ Priority lists from 50 to 500 objects have been determined based on a variety of methodologies for risk measurement, including mass times collision probability, conjunctions (near misses), environmental capacity, and debris generating potential. But if the scientists are in agreement, why haven't we acted?

To be clear, the science is not the problem, but there are other reasons for inaction that flow from the numbers. The first is that the science is based on probabilities. Acting based on statistical risk is problematic⁵ – just ask the environmentalists.⁶ A second reason is that the sheer number of objects coupled with a variety of ranking methodologies means they can be rearranged like deck chairs on the Titanic to support almost any conceivable order of

³ See, e. g., C. Dickey, [“Three Country-Trusted Broker: An Effective Public-Private Model for Orbital Debris Remediation”](#), IAC-19.E7.4.12 (October 2019).

⁴ See C. Dickey, [“A Proposal for Active Debris Remediation – Selecting Objects”](#) (June 29, 2020) for a compendium of these objects and the scientific studies that identified and ranked them. Several more recent studies have confirmed the danger presented by Massive Derelicts. See, e. g., C. Tuttle, D. McKnight, T. Maclay, [“Refining Active Debris Removal Strategies”](#), AMOSTECH (September 2023).

⁵ Uncertainty regarding these objects is compounded by distance and speed, a variation on the Heisenberg Uncertainty Principle, making measurements of conjunctions among them imprecise. Reporting a “miss distance” of 23 meters, with an error margin of 51 meters, although unsettling, hardly inspires action.

⁶ Air pollution has been partially mitigated through the Precautionary Principle which recognizes that if we wait to act until we are certain about a future danger, it may be too late to defeat it.

remediation, fueling further debate.⁷ And that leads to a third reason for inaction – political decisionmakers generally lack the capacity or will to act in the face of uncertainty.⁸

For Massive Derelicts, picking objects in perfect order is not as important as getting started sooner. Regardless which Massive Derelicts top any list, the truth is that many more than 500 of these objects must be eliminated to significantly reduce risk. Moreover, assuming remediation takes place in groups of five or ten objects for reasons related to economic efficiency (e. g., shape, proximity, orbital inclination, altitude), as opposed to ownership under international law, each mission will invariably result in a reordering of the remaining objects. If we wait for certainty, it will never come, and we will be too late to stop the cascade.

National Leadership

Recent calls for leadership among nations to address the problem of orbital debris are beginning to be heard.⁹ While these are certainly necessary and welcome, for Massive Derelicts national leadership becomes problematic.

This is because the objects and the totality of risk they present are owned by more than one government, so all must act, whether separately or together, if we are to effectively reduce overall risk in space. One nation, for example the United States of America, acting alone to remediate its own debris, will be ineffective to significantly reduce overall risk in space, and will possibly be counterproductive if it fails to spur action by the other primary stakeholders for Massive Derelicts, the Russian Federation and China.

Even if the United States of America decided to unilaterally remediate its own objects largely for its own commercial interests, there must be an equally compelling reason for China and the Russian Federation to act. Expecting them to clean up their own debris to make space safer and cheaper for a “competitor” is naive.

Calls for leadership can also be viewed as a thin veil for space dominance, since leaders imply followers. It would be ironic if the United States of America were to remove its own objects based on a public claim of space dominance, likely compelling China and the Russian Federation to do the same, only faster!¹⁰ More pointedly, remediation of Chinese or Russian Federation objects by the United States of America would violate international law and almost certainly lead to World War III.

⁷ Rankings can also be influenced by political considerations.

⁸ Despite its existential nature, the unseen risk of orbital debris can't compete for public attention with more “in your face” risks like war and famine.

⁹ C. Dickey, V. Uvarov, G. Wang, B. Weeden, “[Bridging National and International Efforts on Space Debris Remediation](#)”, IAC-22-A6/8-E9.1 (September 2022). *See also*, H. Hertzfeld, S. Plattard, “[Addressing Space Debris: A Simple Beginning to a Very Complex Problem](#)”, IAC-22-A6/8-E9.1 (September 2022).

¹⁰ The internationally competitive nature of space can be seen in recent debates about spectrum use. *See, e. g.*, “[U. S. bracing for tougher satellite radio wave negotiations](#)”, Space News (January 23, 2024).

Assuming independent and simultaneous action could be instigated, the economic cost of each stove-piped solution would be prohibitive – the huge cost of remediating Massive Derelicts must be managed through multiple object missions bridging national ownership borders.

The truth is, we need cooperation more than leadership. There are sufficient motives for China, the Russian Federation and the United States of America to cooperate in remediating Massive Derelicts, apart from supporting the United States of America's commercial space aims or pursuing a path of space dominance, but an alliance of purpose led by a champion is simply not possible today in our polarized world. The best we can hope for is an altruistic alignment of different purposes towards a common goal.¹¹

As an alternative to national leadership, the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) could provide cooperative guidance, but the United Nations charter and mandate for governance is weak. Leveraging UNCOUOS' connections with governments to encourage and facilitate cooperation through alternative means such as an International Non-Governmental Organization (INGO) is also possible.¹² Ultimately, no matter what mechanism is employed, governments have to decide to act, alone or together, based on their own interests.

Blaming Others

Just a handful of governments left Massive Derelicts in LEO predominantly during the last third of the twentieth century, as a common practice – arguably without fault. In fact, the practice continues today. If the United States of America, for example, were to remove its own objects, those remaining would still dominate risk probability scenarios. Moreover, the danger these objects pose has recently increased significantly simply because of the growing population of commercial space satellites in nearby neighborhoods.

Elaborating on Article 7 of the Outer Space Treaty, Article III of the Liability Convention states that “[i]n the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.”¹³ Whatever these words mean under either space law or the broader international law framework in which they rest, they suggest a fault-based premise for remediation is at least legally cognizable.

¹¹ All governments use space today for a variety of purposes in service of national interest, including crop management, weather forecasting, communication, transportation, exploration, navigation, international trade, and national defense. The shared goal of space sustainment is reflected in all of these.

¹² See threecountrytrustedbroker.com for a cooperative proposal led by an INGO. TCTB recently provided a [Technical Presentation](#) to UNCOUOS describing its “Track II” diplomacy proposal.

¹³ Convention on International Liability for Damage Caused by Space Objects, [United Nations General Assembly Resolution 2777 \(XXVI\)](#), 29 November 1971.

But demanding that a single government, for example the Russian Federation, voluntarily remediate its own Massive Derelicts at its own expense, through legal threats or by remedial example, is self-serving and myopic. Laying aside the tenuous legal nature of such arguments, consider that an accident is required first to posit responsibility or liability. The idea of therapeutic remediation to avoid the collision is lost in the argument. This is surely not the result we seek.

To fully grasp the futility of this legal argument, and with tongue in cheek solely to illustrate the point, consider liability from a broader perspective: While a few governments, whose populations are but a small fraction of humanity, dither over who should pay, all of humanity would be hurt by runaway debris. If liability and fault mean anything, taken to their intergenerational extreme, the governments who placed debris in space would be responsible for the rest of humanity's damages when the resulting sphere of sand prevents all of us from escaping our dying planet!¹⁴

Fault-based paradigms for debris remediation, while grounded in law, are flawed, and would harm remediation, not help it. **Sharing cost and risk based on future opportunity in space** that would be enabled by remediation (i.e., future cost avoided) is fairer, and would better motivate participants. In fact, this simple highlighted paradigm is the key to enabling efficient, effective and timely debris remediation.

Industry Readiness Concerns

The alleged technical immaturity of industry for remediation – the same industry that gave us exquisite space technology in the service of national defense, and employing the very same technologies but for a different purpose – has been cited by politicians and scientists as a reason for waiting. Even so, several government-funded technology demonstration projects have been completed or are underway across the globe, primarily seeking to enhance domestic commercial capability.

Never underestimate industry to find ways to solve problems. Technologies for remediation already exist in the form of accomplished national defense projects, including in-space propulsion, refueling and grappling, and rendezvous and proximity operations.¹⁵ Moreover, governments can hardly conclude that technology is immature without actually asking industry to develop and submit priced (estimated cost) technical proposals. Claims of technical immaturity are lost within a complex mix of political factors including funding limitations and domestic priorities.

But suppose an international “Request for Proposals” was issued by a neutral procurement agency to receive competitive proposals from world-wide industry for remediation of one or more of the most dangerous Massive Derelicts. Suppose further that several governments agreed to fund or support selected proposals and help mitigate mission

¹⁴ Of course, whoever held the final debt would die with the debtor in the same fiery end. Subsequent collection efforts might be problematic!

¹⁵ See, e. g., Secure World Foundation, [Global Counterspace Capabilities Report for 2023](#) (website accessed January 2, 2024).

risk through indemnity or insurance.¹⁶ It's not the technology that is missing in action, it's political will.¹⁷

In July 2024, the remediation technology industry and others will gather in Tokyo, Japan, to discuss industry readiness, and to explore avenues for bridging government funding with capable remediators.¹⁸ Besides building a connection among governments for cooperative remediation, a bridge between industry and government is necessary before action can begin.

Conclusion

We live in a world of sovereign nations, but under the present governance framework for outer space, our shared resource, cooperation will be necessary to insure sustainability.

Cooperative remediation of Massive Derelicts is needed now!

TCTB, an acronym for "Three Country – Trusted Broker" which describes its remediation model in a few words, is an INGO formed for the purpose of facilitating planning among participating governments for cooperative remediation of Massive Derelicts before they begin to collide. TCTB's Track II diplomacy path, working through and with the assistance of UNCOPUOS, can help solve shared problems where traditional diplomacy is challenged and time is of the essence.¹⁹

TCTB is an example of cooperation in action to save lives, not only in outer space where more and more people work and will live, but also on Earth where people depend on space services for a myriad of purposes. Much like the Soyuz-Apollo joint rescue effort in 1975, which began through the friendship of Thomas Stafford and Alexei Leonov, TCTB is an

¹⁶ See C. Dickey, "[Three Country-Trusted Broker: An Effective Public-Private Model for Orbital Debris Remediation – Part Two: Country Contracting Phases](#)", IAA-UT-STM-02-04 (February 2020), for a description of a neutral, transparent, international procurement process that could engage industry across the world in a best-value competition to tackle Massive Derelicts. Providing a vehicle for sharing cost, risk and information among participating governments, and avoiding domestic preferences that would otherwise stymie cooperation, an INGO could also provide a "firewall" to protect national security, export-controlled and proprietary information used in each mission from improper disclosure. The public perception that taxpayers of one country are paying to remediate another country's debris could be overcome by demonstrating mutual benefit.

¹⁷ For a recent summary of technology and industry readiness for remediation as well as for other in space activities, prepared by a panel of leading members of the International Academy of Astronautics from across the world, see R. Opromolla, "[Future in-orbit servicing operations in the space traffic management context](#)", Acta Astronautica 220, p. 469-477 (2024).

¹⁸ [6th Summit for Space Sustainability](#), Secure World Foundation (July 2024, Tokyo).

¹⁹ TCTB acts in furtherance of the Guidelines for the Long-term Sustainability of Outer Space Activities ([UNCOPUOS A/AC.105/2018/CRP.20](#)), in particular Guideline C.4.

international project formed through the cooperation and friendship of experts from several countries.²⁰

TCTB has recently issued invitations to diplomats from China, the Russian Federation and the United States of America to be briefed on our planning process for cooperative remediation of Massive Derelicts. Identifying technical experts from each jurisdiction to participate in such briefings could provide a starting point for discussions. Proceeding under separate but equivalent planning contracts, engaging in TCTB's "international mediation" process will help governments determine whether cooperative remediation of Massive Derelicts is possible. To read more about TCTB and our detailed planning process, visit our website at threecountrytrustedbroker.com or contact the authors of this paper.

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²⁰ See <https://kiozk.ru/article/ekspert/novyj-souz-apollon-iz-kosmiceskogo-musora>.