A New Space Age… For Space Debris?

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There are many major junctures currently facing the space community. Geopolitics of the "Cold War kind" are seemingly reincarnating and projecting themselves into the space domain, as they did half a century before. Commercial activity has skyrocketed. While adventure tourism in space will long remain the domain of the few, it is looking as though it may soon be more available to the super-elite (rather than just the super-super-super elites such as Dennis Tito and Mark Shuttleworth in the early 2000s).

Thus, we find ourselves asking: Are we at the dawn of a New Space Age? We are not—although not because we aren't seeing major change. All of the processes that we have seen are, in some way, a continuation of the past. We are seeing evolution, rather than revolution. This is not to say that we should not recognize the significance of these changes and consider the policy, ethical, legal, and technological implications of where we go from here. Still, it is worth keeping these changes in historical context to best understand—and prepare for—the future. Despite the urgent need for action, it is important to find reasons for optimism and the motivation to pursue solutions.

Environmental Awareness Feedback Loops

It was an unexpected gift of our forays into space that we gained so much emotional and scientific understanding of our own Earth environment: The stunning visual images of Earth had an impact on the wider public, whilst Earth observation data had a major impact on our understanding of climate change. In searching the universe, we looked back and discovered ourselves.

The increased awareness of the impact that we have on our own environment has affected our awareness of the space environment itself, and space debris. Anecdotally, there is increased awareness when interacting with the lay public about space debris issues, driven in part by events such as anti-satellite tests (ASATs). This has synergised with a focus in global politics towards environmental awareness. There is also a strong interest in the topic amongst younger space experts, such as the Space Generation Advisory Council. This is culturally consistent with the younger generations' concerns with sustainability. Space activity has increased awareness of our own Earth environment, and that awareness has fed back to greater awareness of the space environment.

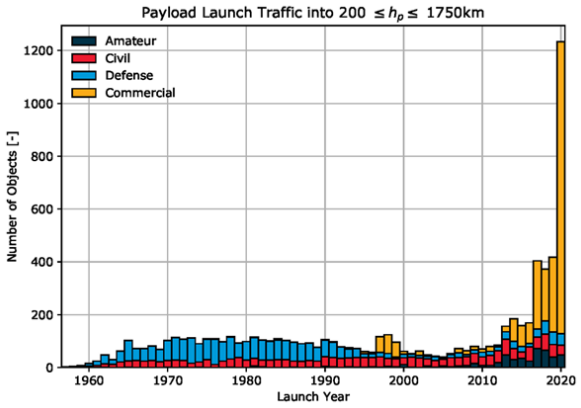
Space Debris: Then and Now

Space debris itself is hardly new; indeed, the oldest piece of known orbiting space junk is a U.S. satellite launched in 1958. In the early stages of the First Space Age, mitigation concerns were lost in the fog of Cold War competition and the excitement of the opening of a new domain. However, there is some good news: It is notable that from these earliest days that North American Aerospace Defense Command (NORAD) tracked debris. Since that time, our ability (and motivation) to track debris has consistently improved, as has the technology to de-orbit defunct objects in space.

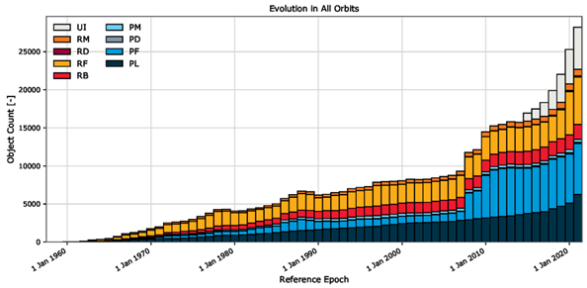
Two things mark the current period as

particularly unique: the sheer (1) volume of objects being launched into space and (2) the debris created over the past 15 years by ASAT events.

As the below European Space Agency (ESA) graph shows (ESA 2021), the number of launches (and particularly commercial space launches) has jumped significantly in recent years:

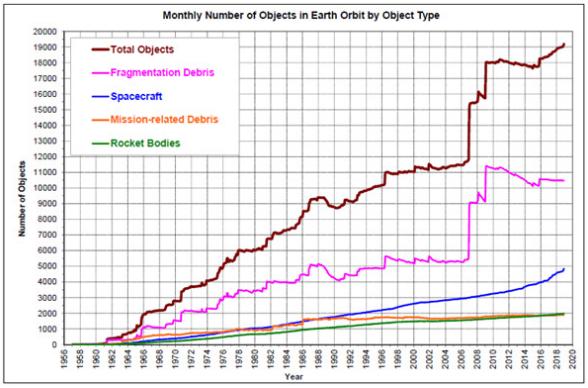


However, the amount of debris attributed to space craft has increased at a steadier, linear rate. The significant recent jumps in debris can be attributed to ASAT events or accidental collisions such as Cosmos 2421 (chart from ESA 2021):



Where PL = Payload (the "cargo": usually one or many satellites that a rocket launches to space); PF = Payload Fragmentation Debris; PD = Payload Debris; PM = Payload Mission Related Object; RB = Rocket Body; RF = Rocket Fragmentation Debris; RD = Rocket Debris; RM = Rocket Mission Related Object; UI = Unidentified.

Alternatively, represented in this NASA Orbital Debris Program Office (ODPO) graph :



Although the problem is far from new, the sheer volume of that debris, and the dangers that it poses, has increased in urgency.

Mitigation: Still a Tragedy of the Commons Scenario

Improved technology means that we can limit debris through most end-of-life procedures for new spacecraft sent into orbit. And new methods are being tested and have the potential for removing defunct space junk already in place. A major barrier is the economic and regulatory structure currently in place, which continues to tie the international community back to a tragedy of the commons scenario. The economic implications of debris mitigation are poorly reflected in mission costs—although insurance premiums do go some way to internalizing financial penalties in the case of collision. In general, however, debris disadvantages users collectively to the point where there is limited incentive for individuals to control it.

One challenging solution to this is greater regulation and incentivization at both the domestic and international levels

(incorporating commercial entities). A "carrot and stick" approach would reward good practice, such as with reduced insurance premiums or government incentives to entities seeking to develop debris removal technology. And "sticks" would take the form of governance structures (such as agreements, voluntary good practice opportunities, and even regulation such as through the International Telecommunication Union) to guide or even constrain actor behavior when it comes to activity that could create debris.

Needless to say, wrangling the diverse range of space-engaged actors (including a wide range of countries but also different types of actors such as commercial entities) into such an institutional framework is not trivial. However, there is reason for optimism, as many countries have developed their own debris mitigation procedures, and organizations such as United Nations Committee on the Peaceful Uses of Outer Space proactively engage with the issue. Individual agreements and policy victories are in themselves noteworthy, but it is the collective reinforcement of norms of behavior that we can hope will constrain rogue behavior (or at least result in an international outcry when such norms are violated) and encourage coordinated, if not cooperative, activity on the issue of space debris.

Conclusion

The current space debris situation is a result of issue evolution, rather than a major revolution. We are facing major changes in the geopolitics, technology, and commercial landscape of space activity as of 2022. The issue of debris is becoming more urgent, as we rely more on space infrastructure, place more and more objects in space, and as the sheer volume of debris increases. However, the roots of this situation were seeded in 1957, and thus we have a good system of debris monitoring, a pre-existing normative and legal infrastructure for governance, and emerging technological capabilities to proactively tackle the problem. That is not to say that the solutions will be simple or even feasible—particularly in the face of recent ASAT testing and the potential of a Kessler event—but there is reason to press forward with potential solutions. Perhaps most important of all is an increased awareness and passion amongst the public and particularly younger generations of space professionals, in the environment and sustainability—both on and off the planet.