Research Report

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Forum: *Environment Commission*
Issue: *The question of space debris*

Position: *Deputy Chair*

Introduction

More than 500,000 pieces of debris are tracked as they orbit the Earth. They all travel at speeds of up to 17,500 mph, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft. As space exploration expands, the protection of outer space has become increasingly important. The gradual rise in space debris increases the potential danger to space vehicles such as the International Space Station and other spacecraft with humans on board.

Collision risks are divided into three categories depending upon size of threat:

- 10 cm and larger: Conjunction assessments and collision avoidance maneuvers are effective in countering objects which can be tracked by the U.S. Space Surveillance Network. Collisions of this type are potentially catastrophic.
- 1-10 cm: Objects in this category are usually too small to track and too large to shield against. Collisions of this type can disable or disrupt a mission.
- < 1 cm: Debris shields can be effective in withstanding impacts of particles in this category. Unshielded portions of satellite subject can lead to mission degradation or loss.

Definition of Key Terms

Space debris (orbital debris, space junk, space waste)
The collection of manmade defunct objects in orbit around Earth. This includes spent rocket stages, old satellites and fragments from disintegration, erosion and collisions.

LEO (low Earth orbit)
A low Earth orbit is an orbit around Earth with an altitude between 160 kilometres and 2,000 kilometres. All human spaceflights and the majority of satellites have taken place in LEO. A low Earth orbit is simplest and cheapest for satellite placement, causing it to become congested with space debris.

Collision
An accident in which a vehicle that is moving crashes into something.

Satellite (vs. spacecraft)
An object that is sent into space to travel round the Earth in order to receive and/or send information.

Spacecraft (vs. satellite)
A vehicle that can travel in space.

General Overview

Space debris encompasses both meteoroid and man-made particles. Meteoroids are in orbit about the sun, while most artificial debris is in orbit about the Earth.

There are more than 20,000 pieces of debris larger than a softball orbiting the Earth. There are 500,000 pieces of debris the size of a marble or larger. Whereas there are many millions of pieces of debris that are so small they are extremely difficult to track. "The greatest risk to space missions comes from non-trackable debris," said Nicholas Johnson, NASA chief scientist for orbital debris.
The National Research Council's scientists in the United States have warned NASA that the amount of space debris orbiting the Earth is at this tipping point. The junk is generated at a much faster rate than it is removed by natural forces.

Collisions would not only endanger space vehicles, but it can also be a risk to the territory and life on earth itself. A Soviet nuclear-powered satellite fell from its orbit, re-entered the earth's atmosphere, and broke up over Canada in 1978. It put the Canadian population at serious risk as it resulted in scattered radioactive debris across the Northwest Territories.

Another problem arises with the advancements in technology of satellites. The demand for high-speed data communications have caused the skies to become congested with older satellites which are no longer in use. The new-comers have to devote huge amounts of money and time to fit their satellites into the overpopulated space. This way, the Recommendations of the International Telecommunication Union (ITU) are violated. These regulations prohibit disturbances and interference in radiofrequencies by satellites which are in an inoperative state, and oblige States from causing harmful interference with their stations to activities carried out by other States.

Additionally, The Outer Space Treaty of 1967 states that all activities must be carried on for the 'benefit and interest of all countries', and that outer space shall never be subject to national appropriation. From this it can be argued that the very existence of space debris is illegal internationally, because the treaty has arguably become customary international space law.

The long-lived problem of growth in space debris forces the international community, and consequently the Environment Commission, to take a strong long-term stance to safeguard the space environment for future generations.

Major Parties Involved

The Space Surveillance Network of the United States
The main source of information on space debris is the Space Surveillance Network, which tracks, correlates and catalogues approximately 17,000 objects larger than 5 to 10 cm in Earth orbit since September 2012.

China
China remains the absolute space junk leader claiming an estimated 40 percent of manmade objects in space. Beijing took over leadership in the space junk stakes in a single event on January 11 2007, when the People's Liberation Army tested an anti-satellite missile.

Russia and the United States
With their extensive space exploration programs, Russia and the US are regarded among the world leaders cluttering up near-Earth orbits being responsible for 25.5 and 27.5 percent of space junk respectively. In 2009, a US Iridium satellite collided with an outdated Russian military communication satellite, creating about 600 new hazardous fragments.

Timeline of Events

1959	The Committee on the Peaceful Uses of Outer Space (COPUOS) is set up by the General Assembly to promote international cooperation in the peaceful uses of outer space and develops legal frameworks to address problems arising from the exploration and use of outer space. Since its inception, COPUOS has concluded five major international treaties and five sets of legal principles governing outer space activities.
1978	NASA scientist Donald J. Kessler showed that if the density of space debris in low Earth orbit is high enough, each collision generating space debris would increase the likelihood of further collisions.
1996	A French satellite was hit and damaged by debris from a French rocket that had exploded a decade earlier.

2008	Countries at the UN adopted space debris mitigation guidelines to curb the pollution of outer space and promote international consensus on acceptable spacecraft operations so that outer space may be used in a sustainable way.
2009	a defunct Russian satellite collided with and destroyed a functioning U.S. Iridium commercial satellite. The collision added more than 2,000 pieces of trackable debris to the inventory of space junk.

Previous Attempts to solve the issue

NASA takes the threat of collisions with space debris seriously and has a long-standing set of guidelines on how to deal with each potential collision threat. These guidelines, part of a larger body of decision-making aids known as flight rules, specify when the expected proximity of a piece of debris increases the probability of a collision enough that evasive action or other precautions to ensure the safety of the crew are needed.

The Department of Defense maintains a highly accurate satellite catalog on objects in Earth orbit that are larger than a softball.

The International Law Association was compelled to frame the "International Instrument on the Protection of the Environment from Damage Caused by Space Debris" in order to highlight the growing threat of space debris. These guidelines have also been acknowledged by the Scientific and Technical Sub-Committee of UNCOPUOS. UNCOPUOS prescribes precautions against the creation of space debris, measures for debris mitigation, and strictures for assigning liability to the generators of such debris.

Possible Solutions

The Outer Space Treaty describes that States shall bear international responsibility for all their national activities carried out in outer space. When a national action involves the creation of space debris, the State should be identified as the appropriate administrant to bear responsibility for junk created by a space collision. The object causing the problem should be monitored and tracked; the technology for doing this is very expensive and therefore commonly ignored. Assigning liability for space debris

pollution is thus extremely difficult.

Debris-prevention includes the reduction of the production of mission-related debris and the avoidance of break-ups. Improvement in designing and launching stages and minimization of debris-creation are essential in combatting the problem of space junk.

A decommissioned spacecraft can be removed from the orbital regions populated by working spacecraft. They can be transferred to a disposal orbit above LEO and retrieved. Another option is to manoeuver the spacecraft or satellite to a lower orbit. Objects below approximately 160 kilometres will experience very rapid orbital decay and altitude loss. However, objects may crash on Earth if they do not burn up completely in the atmosphere. In January 1978, a satellite crashed in Canada causing radioactive material from the spacecraft's nuclear power generator to scatter over plenty of square miles. Much damage had been done to the environment and only 0.1% of the dangerous debris was ever recovered. Therefore, this solution does not come without any drawbacks.

Actions can also be taken before taking off. Space systems should be designed in a way that they do not release debris during operations or, if this is unavoidable, the effects on the outer space environment should be minimized. When the spacecraft returns to Earth, spacecraft operators must ensure that debris from the LEO that survives to reach the surface of the Earth does not pose an excessive risk to people nor property, such as through environmental pollution caused by precarious substances.

'Catcher' spacecraft have also been proposed. Mobile spacecraft equipped with a catching device could be launched from Earth to intercept and catch debris. The catcher spacecraft should be able to precisely match the speed and direction of the debris, making it an tricky solution. Any physical contact between the debris and the spacecraft can result in multiplying the debris.

Appendix/Appendices

- http://www.uklsa.co.uk/wp-content/uploads/2014/06/UKLSR-Volume-2-Issue-1-Article-6.pdf
- http://m.esa.int/Our_Activities/Operations/Space_Debris/FAQ_Frequently_asked_questions
- http://images.spaceref.com/news/2009/ODMediaBriefing28Apr09-1.pdf
- http://www.fas.org/ota/reports/9033.pdf
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