Fighting Space Junk with Nature:

Warriors of Biomimicry

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Imagine an astronaut repairing a satellite in the silence of space and suddenly struck by a piece of metal traveling ten times faster than a bullet. This isn't a scene from a sci-fi thriller like Star Trek. What Hencsh (2022) once called 'the final frontier' is now the terrifying reality of space junk because it is no longer unexplored territory. Millions of pieces of space junk are orbiting Earth at incredible speeds, threatening everything from communication satellites to future missions to the Moon and Mars (NASA, n.d.). This is not science fiction—this is a real problem. According to NASA (n.d.), low Earth Orbit (LEO), which once seemed like a huge empty space, has become a junkyard filled with debris from old satellites, rocket parts, and even tiny flecks of paint that crash into each other and break apart in an endless cycle. Right now, there are an estimated 500,000 to 900,000 pieces of space junk larger than a centimeter, and over 100 million tiny fragments all floating around like ticking time bombs (McKnight et al., 2023).

Space junk history started in 1957 with the Soviet Union's launch of Sputnik 1, the first artificial satellite (Garber & Rand, 2022). That moment kicked off the space age and began the problem of space junk. Currently, the danger is growing, collisions between space debris are happening more often, and the risk of a chain reaction called the Kessler Syndrome is becoming more real (Carter,2022). This scenario warns that if the junk keeps building up, it could surround Earth and make it too dangerous to launch spacecraft (O'Callaghan, n.d.). If not acted soon, space might become too dangerous to use, causing problems like communication breakdowns, military issues, and even disruptions to weather forecasting (Sipiera, 2024).

Nature, often regarded as the ultimate problem solver, offers powerful solutions to complex problems and space junk is no exception. Although some may doubt the feasibility of applying biomimicry to address space junk, its proven success in solving challenges on Earth highlights its potential. By studying natural designs, like the gecko's ability to stick to surfaces, the Venus flytrap's method for capturing debris, and the remora fish's sticky qualities, biomimicry could show us how these strategies might be used as emerging technologies to solve the growing issue of space debris.

The Gecko Kit Cannon, inspired by the natural adhesive abilities of geckos, provides an innovative solution for removing space debris. In nature, it is impressive to see how their feet stick to surfaces so easily. Geckos have tiny, microscopic hairs on their feet that help them cling to surfaces with a lot of strength. Geckos selectively engage and disengage their feet, allowing them to maintain grip while moving forward. Scientists have studied this natural ability and used it to create a system that helps robotic arms grab and move space debris. The Gecko Kit Cannon uses a special, gentle adhesive that can stick to space debris, allowing robotic arms to remove it safely (Vedantu, 2025). Even though the tough conditions in space might wear down the adhesive over time, this approach shows how nature can help solve big problems. It’s a great example of how looking at the natural world can lead to new ideas and solutions for challenges like cleaning up space debris.

Another idea comes from the Venus flytrap plant. Nature’s silent predator’s ability to capture prey through movement-triggered action can inspire a simple yet effective solution for removing space debris. Similarly, this principle can be adapted to debris removal, as it has already been implemented in small-scale robots, demonstrating the potential of this mechanism for technical applications. Imagine a spacecraft that similarly captures debris. A Venus flytrap-inspired spacecraft would move toward debris, and as it gets closer, the debris would trigger a mechanism that 'snaps' shut, capturing it without the need for complex targeting (Banken et al., 2023). This method operates efficiently, using energy only when necessary. It provides a simple, effective, and economical solution for capturing and safely removing medium-sized debris. While the system is limited to small debris, it remains a promising option for researchers by offering a more cost-effective and efficient solution to this problem.

One of the most promising solutions comes from nature's Remora fish, known for hitching rides on larger animals with a unique suction method, which inspires an innovative solution for the controlled removal of space debris. Remora fish attach to larger animals like sharks using a unique suction method that allows them to travel with minimal effort. As researcher Rayalla (2023) stated, a groundbreaking device called "Remora" has been developed, offering a novel solution for the controlled and efficient deorbiting of satellites at the end of their operational lifespan. It's lightweight, efficient, and just like nature intended—minimal energy for maximum impact (Rayalla, 2023). Just like the Remora fish uses suction to hitch a ride, this device would use the same idea to safely remove space junk and fits perfectly with global efforts to make space safe and sustainable. Although it hasn't been tested in space, the prototype tests are promising for the future of fighting this issue.

These bio-inspired designs, Gecko Kit Cannons, Venus flytrap mechanisms, and the Remora Device, are more than just ideas. They are real solutions that could help clean up space debris and make space safer for everyone. The space junk crisis may seem overwhelming, but with nature's help, following a path that blends innovation with sustainability ensures a feasible way out. With solutions inspired by the Gecko Kit Cannon, the Venus flytrap, and the Remora device, nature has the answers. Space junk is like a "ticking clock" if it does not stop the mess from worsening, space could become off-limits for future exploration (Hensch, 2022). Acting is all that's required. The future of space is in the hands of humanity, and by learning from nature's warriors, the space junk nightmare can be turned into a win.

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