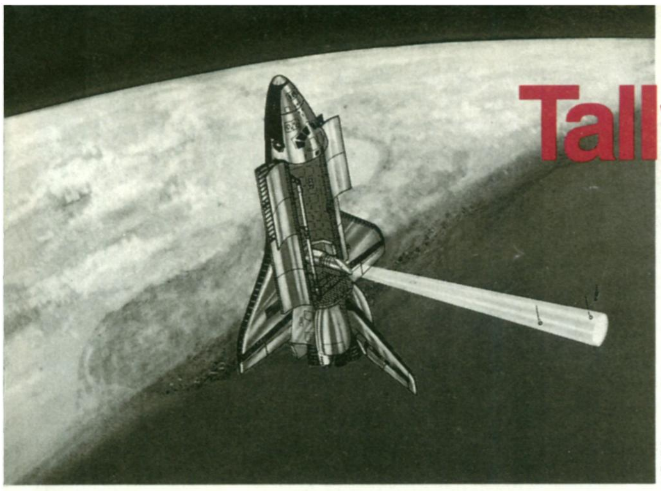
NASA

Tallying Orbital Trash

A debris-tracking telescope may ride the shuttle

By JONATHAN EBERHART

A veritable trash heap of manufactured materials encircles Earth. Made up of spent satellites, rocket stages and other space hardware, some broken into tiny pieces, the space junkyard now holds at least 7,000 objects with diameters ranging from several meters to about 10 centimeters, according to Air Force radar-tracking reports. Astronomers complain that the "light pollution" from sunlight glinting off the objects' surfaces interferes with celestial observations. Space engineers fret about the fragments' potential for damaging or destroying spacecraft, including the U.S. space station Freedom planned for human occupation in the late 1990s.

So in June, NASA called upon two Colorado companies – Ball Aerospace Systems Group in Boulder and Kaman Sciences Corp. in Colorado Springs – to study the feasibility of developing a large reflecting telescope that would take a detailed census of our planet's blanket of orbiting debris. Carried aloft by the space shuttle in the mid-1990s, the $30 million instrument would yield new data to help engineers assess the perils posed by space junk and the need for equipping the space station with protection systems, says the project's chief scientist, Faith Vilas of NASA's Johnson Space Center in Houston.

In the summer of 1961 – less than four years after the Soviet Sputnik 1 inaugurated the space age – the U.S. Air Force reported tracking about 60 objects in orbit around the Earth. The number rose abruptly on June 29 of that year when an orbiting U.S. rocket that had successfully launched a Navy navigation satellite exploded into 296 fragments, each measuring at least 10 cm across, says Donald J. Kessler of Johnson Space Center.

Five years later, as NASA was putting several craft into Earth-orbit in preparation for the Apollo moon flights, the Air Force reported about 1,300 orbiting objects of 10 cm or bigger, Kessler says. By 1970, with the manned Skylab space station in the works, the figure had grown to almost 1,850.

Last year, researchers made radar observations of limited portions of the sky with the Arecibo radiotelescope in Puerto Rico and the Goldstone dish antenna in southern California. This sampling indicated some 150,000 Earth-orbiting objects measuring at least 1 cm across, Kessler says. And the Goldstone data suggest that an additional 1 million 2-mm-sized objects now orbit the planet, he says, although that instrument could not detect objects smaller than about 2 millimeters. According to Kessler, this hints at the presence of five times that many 1-mm bits.

A million 1-mm particles would weigh only about 1 kilogram, he notes, adding that collisions in orbit "can create a lot of particles with a small amount of mass." Vilas sees the proposed telescope as having the capability to inventory most of these tiny but still potentially damaging fragments along with their heftier counterparts.

The debris-tallying telescope would have a circular mirror about 5 feet in diameter, Vilas says. The instrument would carry detectors sensitive to both visible light and thermal infrared emissions, which together can help reveal a particle's size and perhaps composition.

The project's primary goal, says Vilas, is to search for hardware particles, measuring the brightness of each in visible and infrared light and calculating its speed and direction of travel. This information should indicate each bit's reflectivity, diameter, distance and altitude.

In addition, astronauts aboard the shuttle carrying the telescope would eject into space what Vilas calls "toss-out stuff" – objects of known size, reflectivity and composition. Observations of these would help scientists interpret data on the unidentified debris found in orbit.

Most of the potentially hazardous objects orbit at relatively low altitudes, about 300 to 500 miles above Earth. However, Vilas hopes the device will also survey debris moving in geostationary orbits about 22,300 miles up. Because objects in such orbits make a complete revolution in the same time required for one rotation of Earth, they are always fixed over one spot on the planet's surface. Vilas says the telescope should spot particles as small as 6 cm in geostationary orbits.

At present, says Kessler, the smallest objects visible at that altitude are about 1 meter in diameter. Vilas notes that this part of space is crowded, since most of the working satellites there – almost all used for communications – remain fixed over the equator, though at different longitudes. This crowding raises the odds of damage from space debris.

Engineers are also studying several junk-hunting systems for installation on the space station. LIDAR (laser radar) or other "active" systems that both transmit and receive might complement "passive," purely receiving systems, perhaps resembling the proposed telescope, Kessler says. The technology already exists to detect a 1-cm particle at a distance of a few hundred kilometers, he adds, "but that's not good enough." Sharpening those capabilities will take more research.

And simply spotting incoming debris is only half the battle; the station and its occupants would also need some form of protection. "Whipple shields" (named for astronomer Fred Whipple, who suggested them) might offer one line of defense. The shields would consist of two or more layers of thin, lightweight material with gaps between them, breaking up about 80 percent of the small bits and deflecting the rest, Vilas says.

Whipple shields could not cover the space station's entire surface, however. If the crew spotted a piece of potentially destructive debris on its way toward the station, they might zap the intruder with a laser beam. Or, occupants could move to a secure enclosure – the space equivalent of hiding in the storm cellar, says Vilas. And if the "junk alert" came early enough, the crew might even reorient or relocate the whole station. □