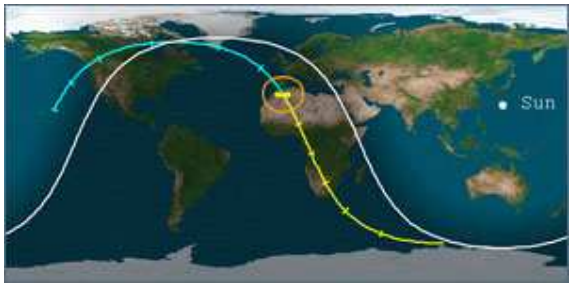
When the sky threatens to fall on one's head: Dealing with space junk

by Eugene Avenant

At the CSIR Satellite Applications Centre, we are in the business of helping put satellites in space, but from time to time, we encounter space hardware (also known as space junk or space debris) coming back to earth.

This was the case in 2000 when Willem Botha, former CSIR Fellow, was asked to identify an object almost as big as a VW beetle that fell from space. After some investigation, he found it to be the remnants of a Delta II rocket that fell in the Western Cape. This can still be seen in the museum at the South African Astronomical Observatory (SAAO).

Imagine the excitement when I was contacted in November 2008 by Ina le Roux of Tshwane, asking if I would be interested in a piece of debris found on the farm of her uncle, Mr Van Rensburg of the farm Zandvliet, in the western Free State near Herzogville. When the debris finally arrived at the CSIR's Hartebeesthoek site, staff immediately set out to identify it.



Prediction ground track

Solving the mystery: what is it and where did it come from?

Our assessment was that the debris resembled half of a fuel tank from a rocket upper stage. It is approximately 400 mm in diameter and for it to have survived re-entry, it is probably made of titanium. In terms of rocket construction, this material is used to withstand the pressure required inside the tank and remain as light as possible. The tank most likely ruptured because the heat of re-entry caused the residual fuel in the tank to raise the internal pressure.

Since the last time the CSIR had to deal with an intriguing event like this, the web has made solving these mysterious occurrences considerably easier. The site www.reentrynews.com lists all recent and upcoming re-entry events. Scanning through the list of potential candidates, and taking into account the re-entry orbits and the time window in which the likely impact took place, we were left with two possible candidates: A Russian Proton-K auxiliary motor or a second stage from a Japanese H2A rocket. Both have spherical hydrogen fuel tanks of the approximate dimensions of the object we had before us.

To help determine the most likely option, more information was needed. The H2A rocket re-entered from a westerly direction and the Proton-K from the North. By establishing the direction of impact, we would be able to decide which one of the two it had been. I phoned Mr Van Rensburg to determine the exact location of the discovery and to find out if there were any physical clues regarding direction of impact. He confirmed that this was not possible due to farming operations underway at the time. The object was found when harvesting the sunflower fields and the earth had been disturbed before the discovery was made, thus obliterating any obvious physical clues.

However, his comment about the timing of the discovery provided the next vital clue to the identity of the object. The clincher was that the maize was planted later in the year, meaning that re-entry must have been during the earlier of the two growing seasons. Thus by pinpointing re-entry 'after the sunflowers and before the maize', meant that it had to be the Proton-K auxiliary motor. Re-entry was on 26 June 2008.

Space junk: How dangerous is it?

Why was only this one piece found? Looking at the re-entry trajectory, it must be realised that the debris was spread over many 1 000s of kms across Africa and the ocean to the South. It is likely that very little else was left to be found.

This brings us to the point of the likelihood of being struck by debris. The odds of getting struck by a piece of space junk are one in a trillion - compare this to one in 1.4 million of being struck by lightning. The reason for the low odds is that not much debris reaches the Earth; in addition, two-thirds of the Earth is covered by water and another 50% is not inhabited. This suggests that there is a greater likelihood of debris hitting the ground undetected and thereby fortuitously 'missing' a human target.

Consider the odds from another perspective: The worldwide population density on Earth is 43 people per km² - if we were spread evenly across the earth, your closest neighbour would be 155 m from you. The same argument goes for orbital debris still left 'up there'. Event though there are 70 000 pieces of orbital debris of 2 cm or larger catalogued in orbits between 850-1 000 km, there is also a lot of uninhabited Earth for it to hit.

Although the danger of collision is not that high, the odds are, however, not zero. For satellites in general and astronauts in the International Space Station (ISS) specifically, this is a problem. Debris in the lower orbits (between 200 and 400 km) presents a serious threat to the ISS, due to the extremely large relative velocities between the ISS and the debris. Even if the debris is very small with low weight (designated by m), the energy it brings to a collision is calculated by the equation: ½ m*v2. With high velocity (v), comes high energy and greater damage.

For this reason, the United Nation Office of Outer Space Affairs (UNOOSA) sub-committee called COPUOS (Committee for the Peaceful Use of Outer Space) is now trying to regulate what is left in the low orbits. Satellite operators and launchers are encouraged to plan for the safe de-orbiting of non-used space equipment, such as upper stages of rockets and larger low earth orbit (LEO) satellites with spent on-board fuel. Satellites with too little fuel that are left to operate, become debris and will eventually re-enter uncontrolled. Anything that does not burn up on re-entry, poses a threat (albeit small) to people on Earth.

For those visiting Hartebeesthoek, this piece of 'space junk' will go on permanent exhibition in our foyer with the kind permission of Mr Van Rensburg.

Some facts on the debris:
Object description:
Type: Proton-K Auxiliary Motor
Int'l Designation: 2004 053G
Launched: 26 DEC 2004 @ 13:53 UTC
Site: Baikonur Cosmodrome LC200
Mission: Cosmos 2411/2412/2413

Reentry prediction:

Predicted re-entry time: 26 JUN 2008 @ 02:56 UTC ± 30 minutes

Prediction epoch: 26 JUN 2008 @ 00:51:41.096 UTC

Enquiries: CSIR Communication