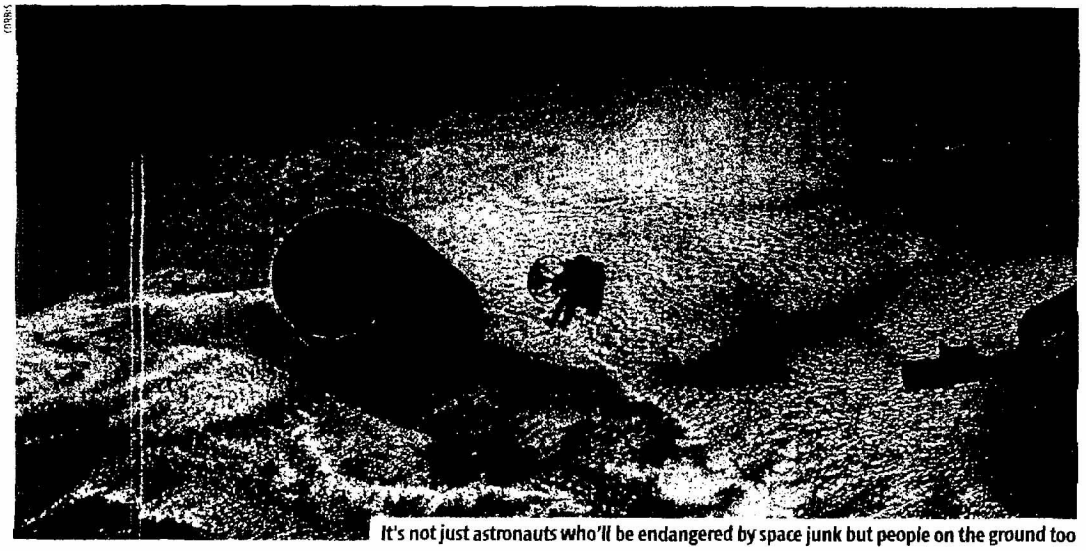


It's not just astronauts who'll be endangered by space junk but people on the ground too

Dead satellites haunt GPS

DUNCAN GRAHAM-ROWE

DEFUNCT global positioning satellites are being junked in graveyard orbits in which they risk colliding with their active sister satellites, according to research commissioned by the US Air Force. The errant spacecraft could pose a threat to the Global Positioning System in decades to come, as well as other satellites in low-Earth and geostationary orbits.

Engineers say the risk of a collision between dead and active GPS satellites is increasing all the time. And even without a collision, the service is in jeopardy as a dead satellite that drifts within a few hundred metres of an active satellite might obstruct its transmissions.

The problem, according to engineers at the Aerospace Corporation, in El Segundo, California, which carried out the research, is the long-term influence of the Sun and the Moon.

When fuel on one of the GPS satellites is about to run out it is tucked away in a "disposal" orbit 500 kilometres above the active GPS fleet of 24 craft, which orbit at an altitude of about 14,000 kilometres. "For a good period of time the [disposal] orbit can remain stable," says Anne Gick, one of the authors of the company's study. "But the Sun and the Moon's gravity perturbs the orbit in the long term." The result is that their orbits become increasingly elliptical (see Diagram).

There are currently 16 retired GPS satellites in disposal orbits, and each year there are two more. To make matters worse, the next generation need an extra launch vehicle stage, and these too will be dumped in the disposal orbits.

Gick, and colleagues Alan Jenkin and Chia-Chun Chao, have a way to reduce the threat from the next-generation craft, which will be much more manoeuvrable than the existing ones. They suggest using their engines to reduce any eccentricities in their disposal orbits from the outset, so it will take much longer – hundreds of years – to become unstable.

But this option isn't available for the majority of the satellites already in service: most are simply not capable of making the necessary manoeuvres. And a spokesman for the GPS Program Office, also in El Segundo, says the extra fuel used to make a disposal orbit more circular could lower its final disposal altitude.

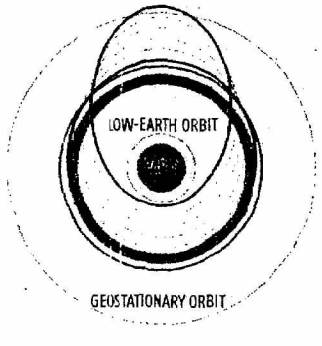
Those that have already been ditched are also beyond help. "There's nothing we can do about them," Gick says. That's because a satellite's fuel is dumped as soon as it is placed in a disposal orbit – to avoid an explosion in the event of a collision. After the fuel is dumped, there's no way the craft can be moved, the team reveal in the latest edition of the *Journal of Spacecraft and Rockets* (vol 39, p 532).

In theory, mission planners could have foreseen this problem 30 years ago when GPS was first launched. "But I'm not surprised they didn't know this," Gick says. "It's a very complicated problem." ●

GPS ORBITS

Retired satellites are on collision course

- GPS operating zone
- Degraded GPS disposal orbit after 20-40 years
- GPS disposal orbit
- Degraded GPS disposal orbit after 160-180 years



SOURCE: AEROSPACE CORPORATION

SOUNDBITES

"We do not accept that human society should be *constructed on the basis of* the savage principle of the survival of the fittest."

South African president **Thabo Mbeki** opening the World Summit in Johannesburg (26 August)

"The evidence shows that the Japanese troops used *bacteriological weapons*."

Judge Koji Iwata of the Tokyo District Court admits germ warfare killed many in China – but ruled that the survivors had no right to compensation (*Japan Today*, 27 August)

"It would be possible to carry your own child in the same womb, donated by [your] mother, as you developed in."

Mats Brännström of Gothenburg University, who has just carried out the first *womb transplant in mice and plans to try it* in humans (Society of Endocrinology press release, 21 August)

"I'd stake my life that there *won't be a living thylacine in* 10 years."

Janette Norman of Australia's Museum Victoria dismisses attempts by a team in Sydney to bring back the extinct Tasmanian tiger by cloning a preserved specimen (AFP news, 22 August)

"There does have to be some kind of a public message that stealing is stealing is stealing."

John Malcolm of the US Department of Justice warns that people who copy files *over the Internet may soon face* prosecution (Cnet.com, 20 August)

"This doesn't happen very often in Northallerton."

Siobhan Cowton, 14, on being struck on the foot by a meteorite outside her home in a North Yorkshire town (*The Daily Mail*, London, 27 August)