Lessons Learned from Space Failures

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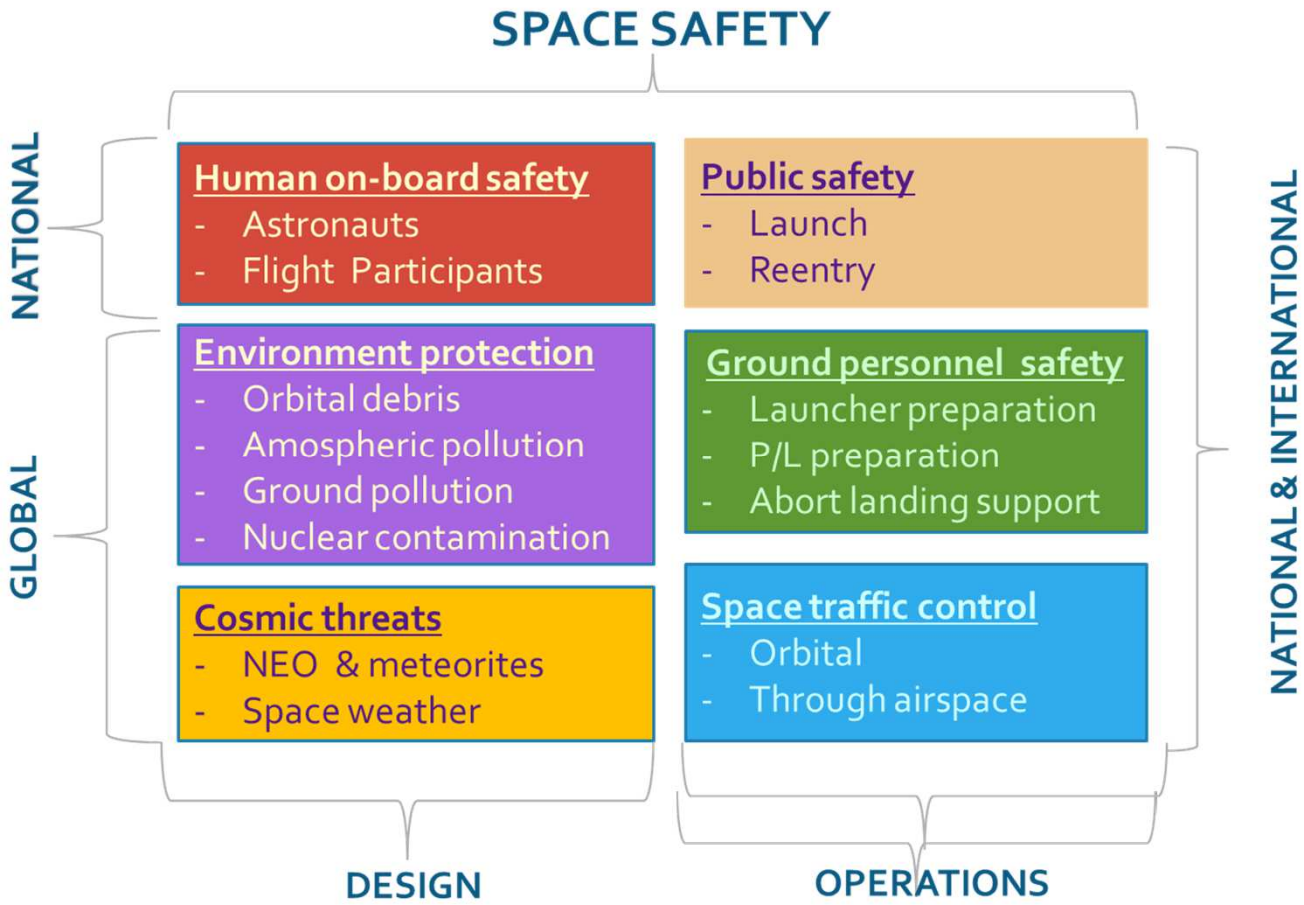
Space Safety: what is it?

People often think about ‘space safety’ essentially in terms of safety of human on-board. Space safety is wider than that and it is critical for the future of all space programs.

This presentation concentrates on space safety issues not directly related to the human on-board.

Space safety: what is it? (cont'd)



Space safety: ground operations safety risk

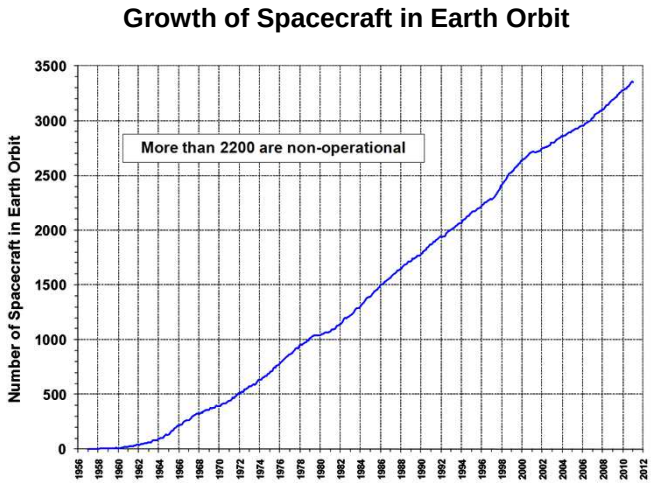
Spaceports worldwide involved in commercial operations could sometimes operate below common bests practices.

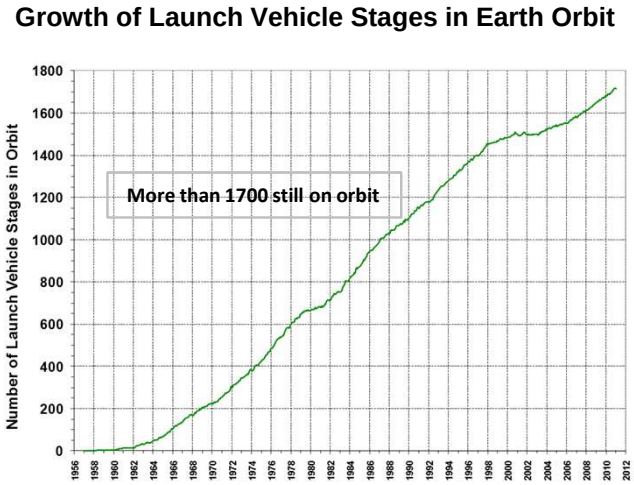
Foreign teams involved in launch preparation may be exposed to unwanted levels of risk.

Space safety: launch failures

There is no international organization to monitor and control the cumulative risk imparted annually to overflown populations by launch and re-entry operations.

Space safety: space debris

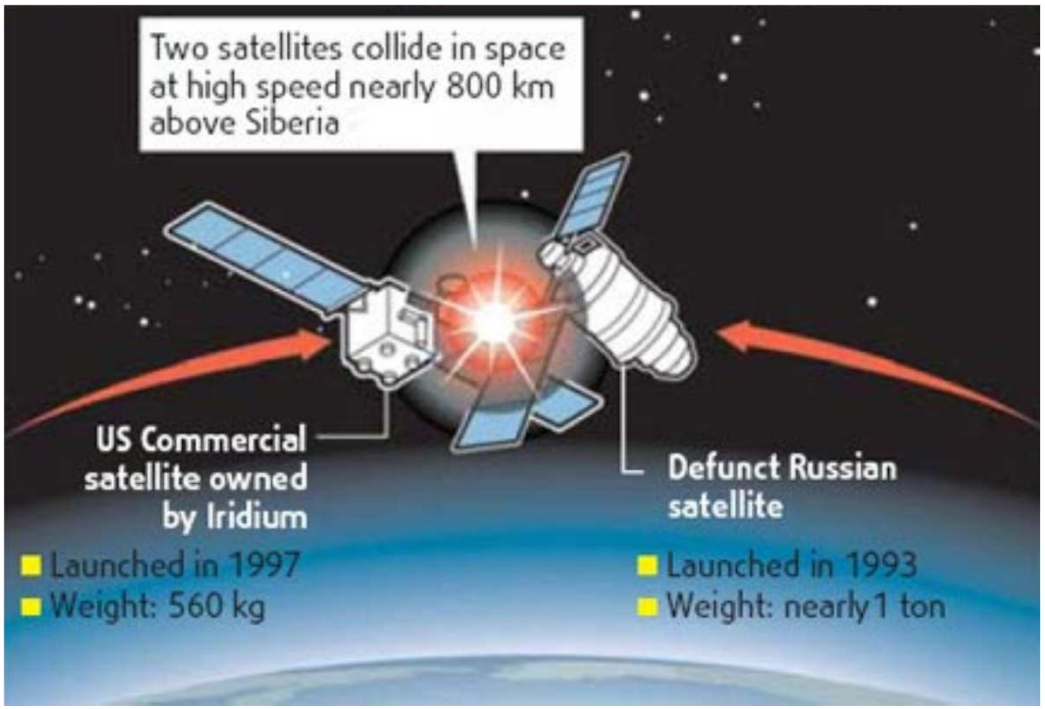




- **More than 6800 spacecraft** have been placed into Earth orbit since Sputnik 1 in 1957. Currently, more than 3200 spacecraft remain in Earth orbit. **2200** of them are orbital debris.
- More than **5400 launch vehicle stages** have been placed into Earth orbit since 1957. Currently, more than **1700** launch vehicle stages remain in Earth orbit. Sizes range from <100 kg to 8 tons.
- **We have to consider carefully future debris population evolution in the low Earth orbit. If the instability of future debris population is confirmed, costly remediation measures could be needed**

Space safety: on-orbit collision risk

The first catastrophic **hypervelocity collision** between two intact artificial satellites in Earth orbit occurred at 16:56 UTC on February 10, 2009 when Iridium 33 and Kosmos-2251 collided at a speed of **42,120 km/h**.



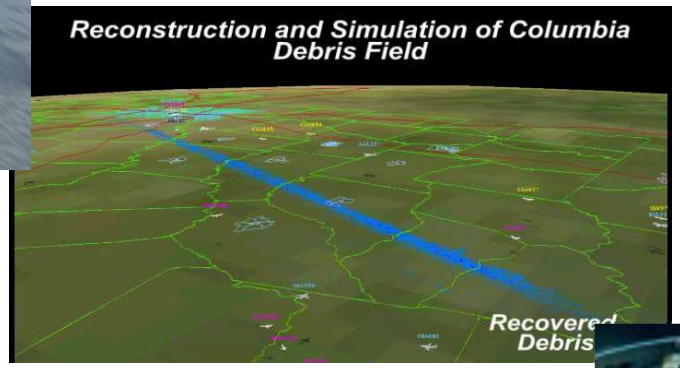
International coordination to prevent collisions is making good progress.

Space safety: re-entry risk

Every year **100 tons of space debris and meteorites** enter the atmosphere and fall to ground. There is on average **one re-entry of a major space system** (spacecraft or rocket upper stage) **per week**.

The IAASS is leading an international benchmarking exercise of tools currently used for breakup and demise risk analysis.

Space safety: aircraft vulnerable to (small) space debris



A **300 grams** debris can be catastrophic for an aircraft in flight.

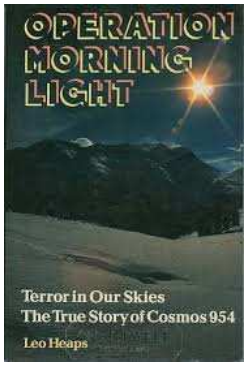
In the 40 minutes that the 250,000 debris from Shuttle Columbia disintegration took to fall to ground, nine airliners flew through them. Although luckily no damage was reported, the probability of being struck was as high as 0.1 (1 in 10) to 0.003 (3 in 1,000).

The IAASS is developing ADMIRE (Aircraft Space Debris and Meteorites Integrated Risk Evaluation) tool.

Space safety: ground & atmospheric pollution

Credit Tsenki TV

On July 2, 2013 a Proton-M plunged to ground 2.5 km from Baikonur launch pad spreading 600 tons of highly toxic UDMH and Dinitrogen Tetroxide.



Cosmos 954 - Canada 1978

30 kg of uranium-235 from Cosmos 954 were spread over 124,000 km^2. Only 1% of fuel was recovered in 12 pieces. They emitted radioactivity of up to 1.1 Sieverts/hour. (Usually a nuclear emergency is declared at 500 micro-Sieverts/hour).

There is no international organization to monitor and control the environmental consequences of space operations on Earth

Lessons learned

1) Space operations entail risks for human life, environment and systems that are international in nature.

2) Acceptable risk thresholds and hazard control measures need to be agreed internationally, and then implemented in national regulations (as French Space Operation Act).

3) We need to continually assess and control space hazards at national and international level including space debris threat . Safety analyses must be carried out in accordance to internationally recognized standards and recommended practices.

4) We need to provide means to confidently show to the international community of stakeholders that space missions hazards are effectively controlled.

5) We operate complex and highly hazardous hardware and processes, in a challenging environment. We need free exchange of data and know-how in safety matters.

IAASS Manifesto

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MANIFESTO
FOR
A SAFE AND SUSTAINABLE SPACE

I. *Ensure that citizens of all nations are equally protected from the risks posed by over-flying space systems and objects during launch and re-entry/return operations*

II. *Ensure that space systems are developed, built and operated according to common minimum ground and flight safety rules*

III. *Seek to prevent collisions or interference with other aerospace systems during launch, on-orbit operation, and re-entry*

IV. *Ensure the protection of the ground, air and on-orbit environments from chemical, radioactive and debris contamination related to space operations*

V. *Ensure that mutual aid provisions for space mission safety emergencies are progressively agreed, developed and made accessible without restriction anywhere on the Earth and in Outer Space*