RFC: Space Debris – Waste or Value?

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What does it cost to launch 8,000 tons into space?

- ~ 800 Ariane launches needed
- ~ 80 billion Euro launch costs
- 8,000 tons in space = 80 billion Euro
What are 8,000 tons of space debris made of?

ESA Space Debris Study: mass by object type

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Meaningful “hand-made” payloads…
...and valuable “mass-produced” rocket bodies
Upper stage value 1: many massive structures

Ariane ESC-A upper stage

4 tons Aluminium
64 of them in GTO or higher

Aluminium used as foil, structure, foam, powder

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Upper stage value 2: simple shapes & connectors
Upper stage value 3: useful storage capacity(?)

Storage Capacity

2,6t LH2

12t LO2
Upper stage value 4: their “paid” location in space

Delta-v to GTO (energy)
$9.5 + 2.5 = 12 \text{ km/sec} \sim 75\%$

Delta-v GTO to Moon:
$1.6 + 1.6 = 3.2 \text{ km/sec} \sim 25\%$

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The Moon station would benefit from these values

- 250 tons Aluminium or
- 850 tons storage capacity (5500MWh) available in form of ESC-A upper stages
What if a SSV could move upper stages to the moon?

- 1 Launch into GTO (>10 tons payload):
  - Up to 4 SSV (2t each)
  - Each SSV might move 1-2 upper stages
  - 16 - 32 tons to the Moon

- 8 Launches into lunar transfer (<7 tons):
  - Spaceship with propulsion and net payload < 4 tons
  - 16 - 32 tons on the moon

Savings of >6,000 Mio Euro

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A Gedankenexperiment: re-using rockets, but differently? (Is there only the SpaceX way to re-use rockets?)

- If max. payload weight is not used, could upper stages de-orbit themselves in direction Moon instead of Earth?
  - Additional propulsion, restartable engines,…
  - Could a small SSV (e-propulsion?) added as an additional payload?
    - Time for moon trajectory not important
- Could re-using upper stages be a “paid” offering?
  - Could material or tank value re-finance Ariane launches making them more competitive?
    - Could satellites be designed for their missions AND for their second life to refinance their mission costs partly?
Summary

• There are 8,000+ tons of space debris in orbit
  • Just waste? Or partly valuable?
    • E.g. 60+ Ariane upper stages (250 tons Aluminium / 850 tons storage capacity)

• SSVs: just for de-orbiting / servicing satellites?
  • Roughly same weight of upper stages in orbit
    • Additional companion research to ESA e.Deorbit / RemoveDebris needed

• The saving opportunity is ~ several billion Euros
  • Economic savings + reduced environmental pollution (launches)
    • ESA could leapfrog all space agencies & help the EU to reach climate goals

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Thank You!

Please share your thoughts & comments

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