Space Debris Mitigation (SDM) Technologies

Generic separation technologies to improve demise behaviour

DEFENCE AND SPACE

Martin Weihreter - Clean Space Industry Days 2023

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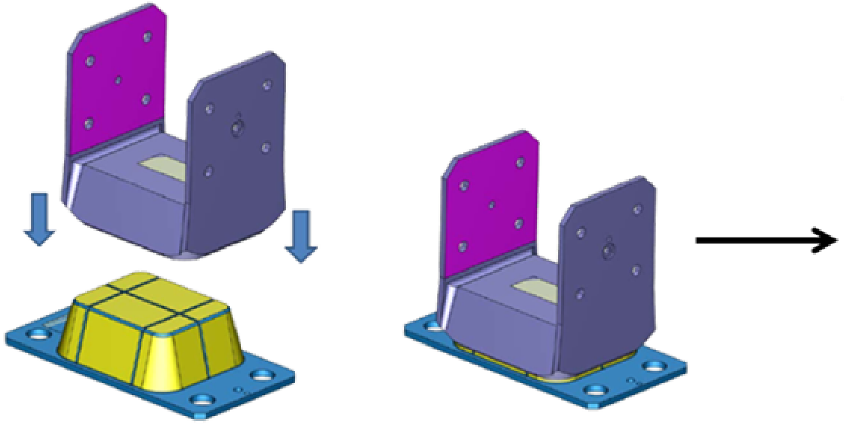
Introduction

- Past studies and projects show that early fragmentation of the satellite is an important method to improve demise behaviour

- Two objectives can be discerned:
  1. **Opening structural panels** to expose critical inner parts earlier.
     → Critical parts remain attached to the main fragment and benefit from its kinetic energy
  2. Completely **separating critical parts** from the main structure
     → maximized exposed surface area but less kinetic energy available for demise

- Airbus has developed generic separation inserts derived from the separation brackets that are flying on **Sentinel 1** C&D



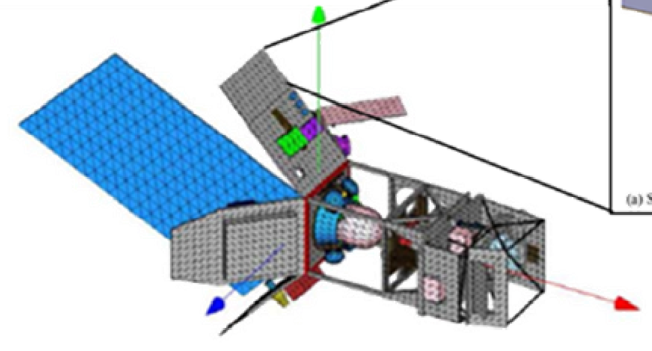
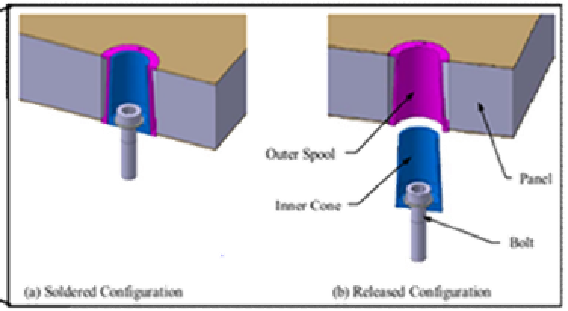
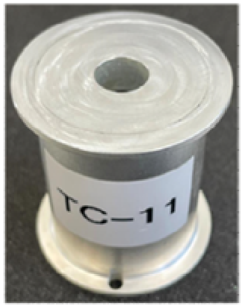


Illustration of side panels opening
(SCARAB model)

Two-part Soldered Demisable Insert



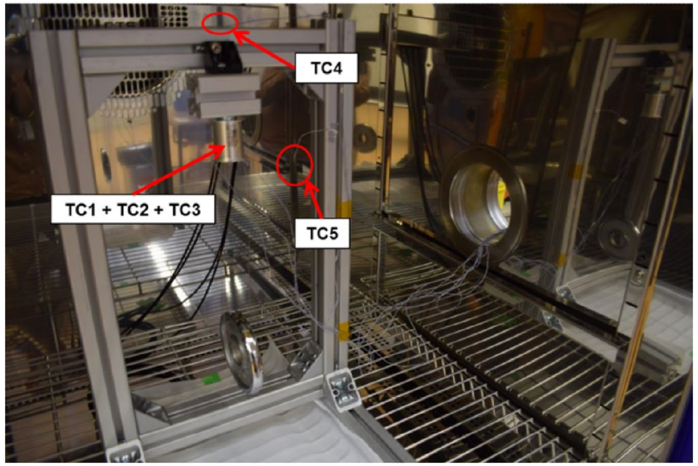


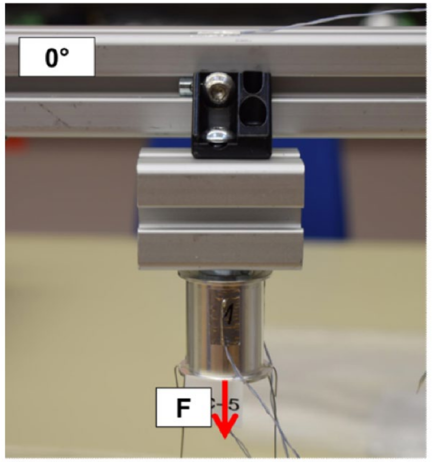
Selective and passive opening of platform panels by using Demisable Inserts

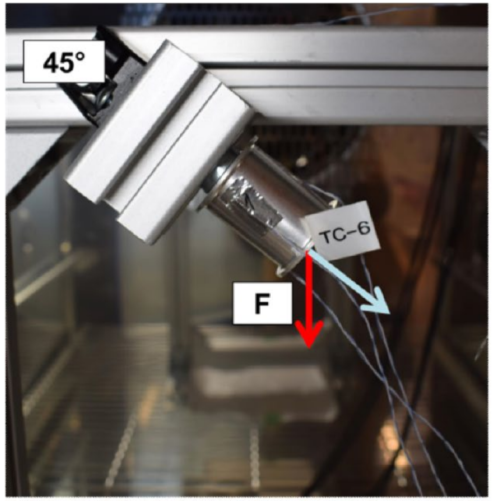
Separation Inserts design description

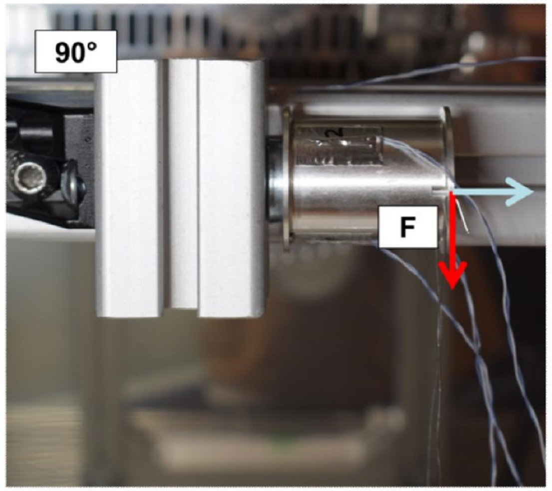
- Two parts soldered insert made of AA 6082 T6
- Mass: 50-75 gr
- Current focus on M8 bolt size (scalable to all sizes)
- Threaded and through inserts under development
- Diameter (bonding surface): 35-42 mm
- Insert allowable exceed ECSS requirements with large margin
- Release temperature range: 140°C ± 5°C (target, could be tailored in the future using different material compositions)
- Reliable separation at desired temperature
- Minimal separation force
- Reliable separation at variable load directions (interlocking observed at 90° but relevance of such a load scenario TBD)
- Stable production quality (void content and parts relative positioning, NDA included in manufacturing flow)
- Two different designs under investigation

→ Design and scalability makes this technology applicable to the majority of mechanical links inside a spacecraft (structure/structure, structure/unit, unit/unit)









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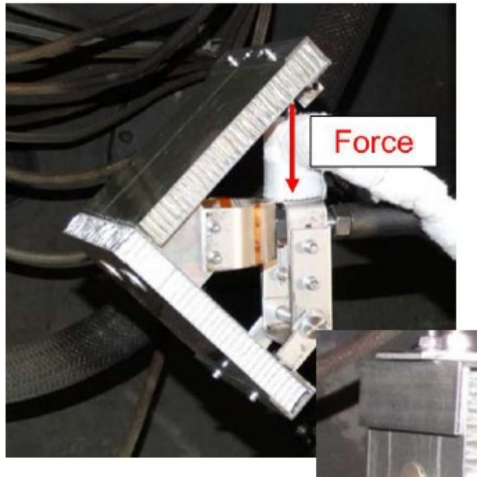
Current status and next steps

- Current TRL for both through and threaded inserts for both design variants is 4
- We are currently working on TRL 6 for the through hole insert of the preferred design variant (threaded inserts will follow).
- Achievement of TRL 6 is planned for spring 2024.

- TRL 5/6 will include:
  – Load carrying tests at panel level → potted inserts shall sustain IP and OOP load according to ECSS
  – Thermal cycling and thermal vacuum → no degradation of mechanical and release performance
  – Fatigue testing at insert level → demonstrate ability of the solder to sustain launch environment
  – Separation functionality at assembly level → at desired temperature, minimal separation force at variable configuration /load directions



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Applicability of technology

Advantages:

- Low system impact: 1:1 direct replacement of normal potted inserts.
- High development flexibility: Can be implemented in the structure design very late during AIT. D4D/D4C strategy can be adapted with virtually no system level impact as the project matures.
- Low cost.
- Low lead time.
- Very consistent results (at hardware level, <0,5°C release temperature variation).
- Fully passive, high reliability, no lifetime limitation.
- Fully compatible with other sustainability criteria.
- Compatible and complementary with most if not all other D4D methods.

Limitations:

- The end to end predictability of the improvement is driven by the re-entry modelling at satellite level.
- No fully validated modelling approach available yet (implementing temperature separation triggers works in DRAMA and SCARAB).
- Compatibility with a D4C approach obviously has to be critically assessed.
- Early separation does not always improve the ground casualty risk. Low ballistic coefficient items might benefit from remaining attached to the main fragment (but early exposure, i.e. removing panels is always good for the exposed object).

Thank you, Questions?

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