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Master Thesis Announcement

Design Analysis of Deployable Elements for the Return of Orbital Rocket Bodies

With the significant rise in the number of orbital rocket launches by annually about 15% or more within the next decades (not including space tourism), the risk of collisions with uncontrolled space objects in certain orbits increases. Possible solutions include removing existing objects and modifying future missions. Concepts for space debris disposal involve destructive re-entry, but this approach may not be sustainable as it prevents reuse or recycling and can cause environmentally and climatically harmful effects, such as damage to the ozone layer. However, sustainability and ecological impact are becoming important issues in the space industry. Also, large space structures like upper rocket stages, which make up half of debris-generating objects, burn incompletely in 5-40 % of cases when performing uncontrolled re-entry, which can end up either in disposal over the sea or as a serious hazard on the ground.

A shift to non-destructive, controlled re-entry of spacecraft systems after use ("Design not to Demise") by using appropriate entry, descent and landing systems (EDL) represents a solution to the aforementioned problem. In addition, this would be a decisive step towards at least partial reusability. One approach for such a non-destructive system is a rigid deployable entry system, that uses deployable surfaces to generate aerodynamic drag for controlled entry and to provide thermal shielding. A major benefit of this technology is that it provides high flexibility for integration into existing transport system. Within this master's thesis, a deployable decelerator system shall be designed which can be efficiently stowed during launch and, after deployment, is capable of safely and stably decelerating an orbital stage (e.g. Ariane 6 Upper Liquid Propulsion Module) during atmospheric re-entry. To do so, a respective re-entry trajectory is given as a reference. The task comprises literature research on comparable concepts and re-entry technology in general, the development of a suitable design in Siemens NX as well as thermal and mechanical load analysis using the finite element method (FEM). The design process includes the selection of a deployment mechanism/actuator concept, materials for the deployable structure taking into account the maximum thermal loads and a (simplified) consideration of possible interfaces with the orbital stage.

Task description of the Master thesis work:

- Literature research on atmospheric re-entry and deployable elements in context of re-entry technology
- Familiarization with suitable FEM tools (e.g. Ansys)
- Mechanical design of the overall system in Siemens NX (Deployment actuator, materials, interfaces, …)
- Evaluation of the design with respect to a given reference trajectory
- Perform FEM computation on the design (based on trajectory data) and respective design iterations
- Documentation

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Starting date: Immediately/ by arrangement

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