Improving Science Missions with Better EDL Models

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Rationale: Every mission that touches an atmosphere relies on specialized expertise and tools for entry system design. This is a NASA-unique function and need that must be preserved and improved.

What is the Entry Systems Modeling Project?

Consistent support for experts to develop high-priority model improvements and validation testing, driven by mission needs, that can be delivered in 3-5 years to reduce mission risk and improve performance.

Jointly funded by STMD and SMD

OPAG Mission Applications: Dragonfly, CAESAR, Discovery-19, Uranus, Neptune, Enceladus Sample Return, Precision Landing…

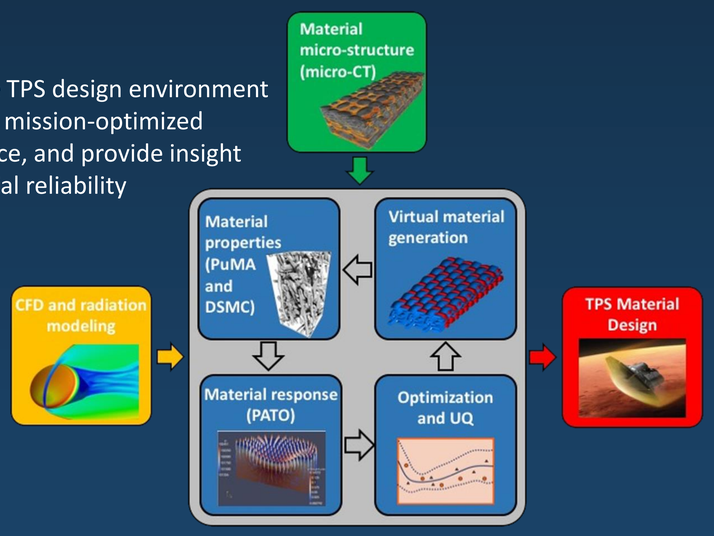
Focused research in four elements:

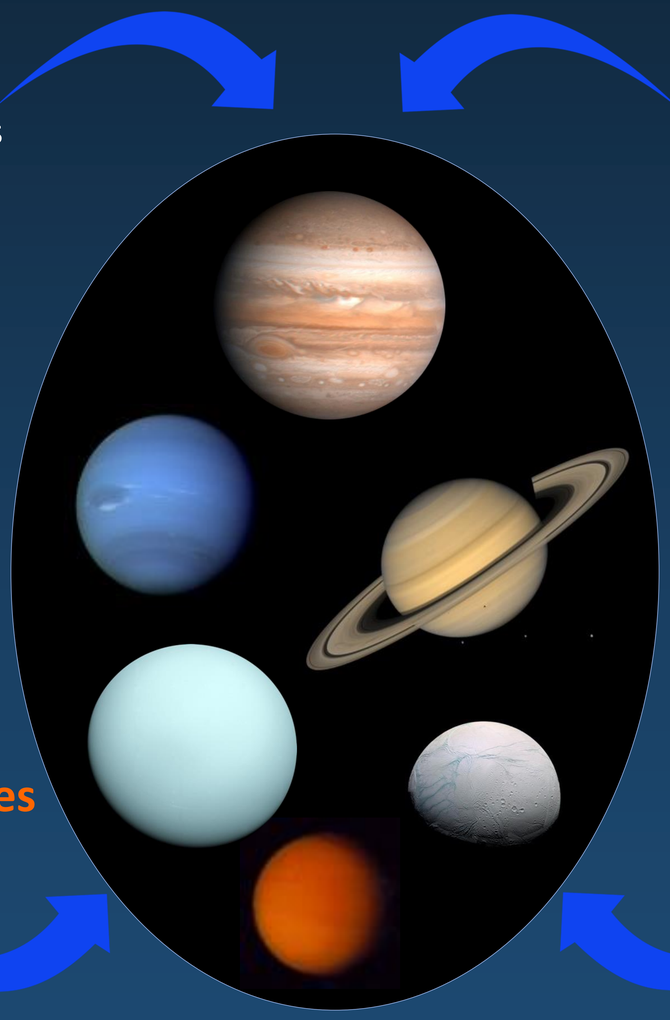
- Predictive Materials Modeling
- Shock Layer Kinetics and Radiation
- Computational and Experimental Aerosciences
- Guidance, Navigation and Control

Predictive Materials Modeling

- Advanced models of PICA and woven TPS
- Micro- to engineering-scale analysis tools
- TPS reliability: How flaws and features turn into failures
- Computational material design

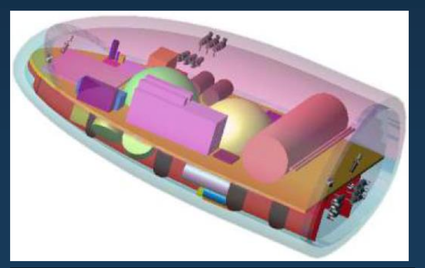
Multi-scale TPS design environment can enable mission-optimized performance, and provide insight into material reliability

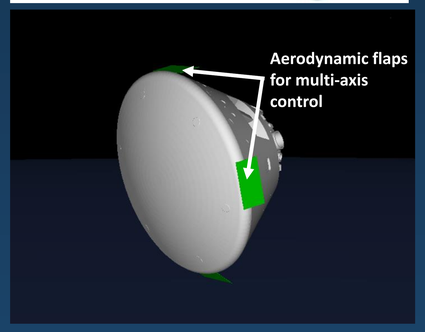


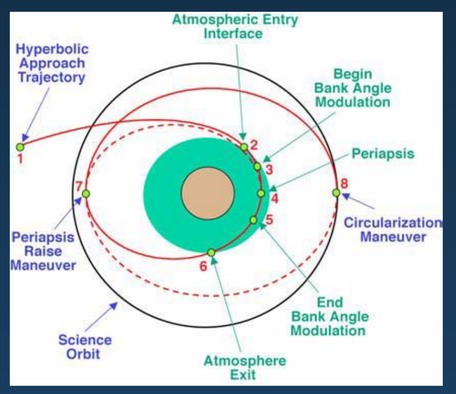


Guidance, Navigation, and Control

Aerocapture at Neptune with heritage aeroshell configurations can be enabled with new multi-axis control and guidance schemes





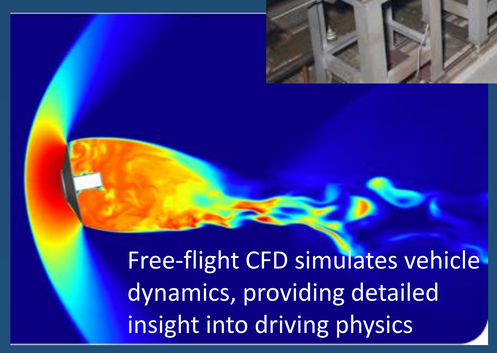


(Above image from Lockwood, 2004) Past studies relied on ellipsled (top left) configurations and bank angle maneuvers. Multi-axis control can open trade space to include heritage blunt aeroshells.

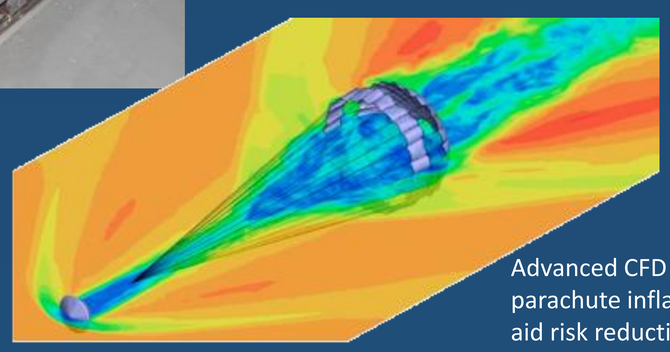
Computational and Experimental Aerosciences

- **Parachute Dynamics**
- **Free-flight CFD**
- **Fully coupled CFD & radiation toolset**
- **Magnetic Suspension Wind Tunnel**

Magnetic suspension tunnel generates low-cost data for vehicle dynamics models and CFD validation



Free-flight CFD simulates vehicle dynamics, providing detailed insight into driving physics

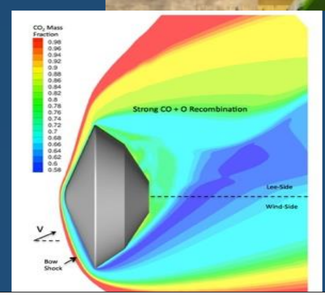


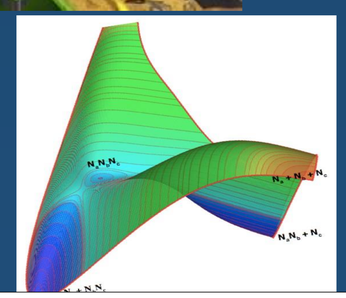
Advanced CFD tools simulate parachute inflation and dynamics to aid risk reduction and qualification

SMD has a unique interest in non-Earth environments and bringing things home at high velocity with high reliability.

Shock Layer Kinetics and Radiation

- Shock layer radiation databases and models for all destinations of interest
- Reduce implied risk for multiple NF targets





Integrated program of experiments, theoretical analysis, and applied modeling has reduced shock layer radiation modeling uncertainty 100x for Earth – Outer Planets destinations are in work.