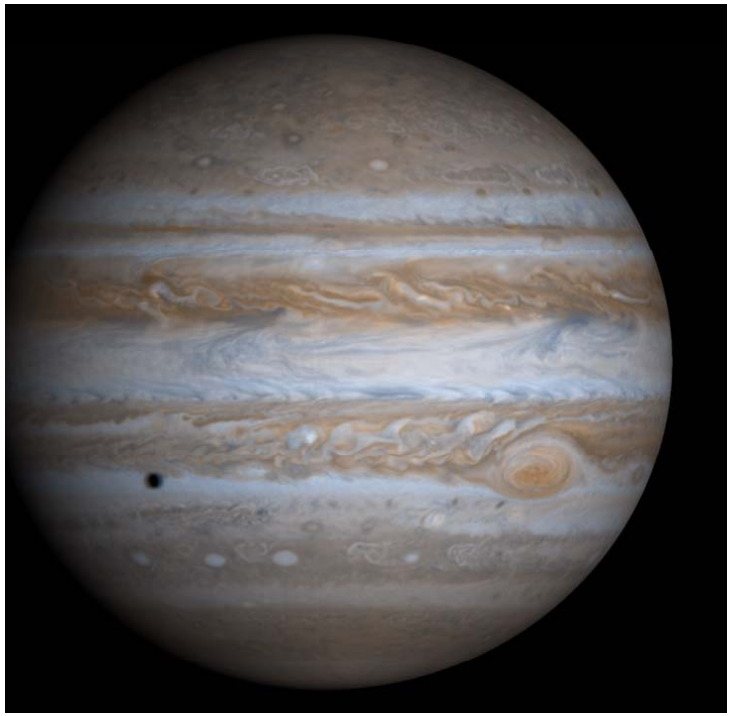
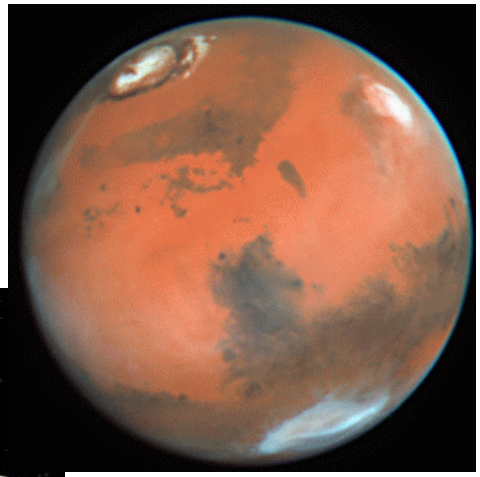
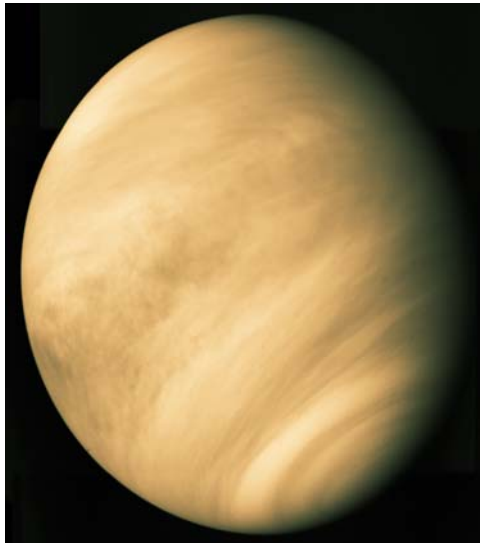
Advanced Entry Systems Concepts



International Planetary Probe Workshop – 8
Portsmouth VA
June 4-10, 2011

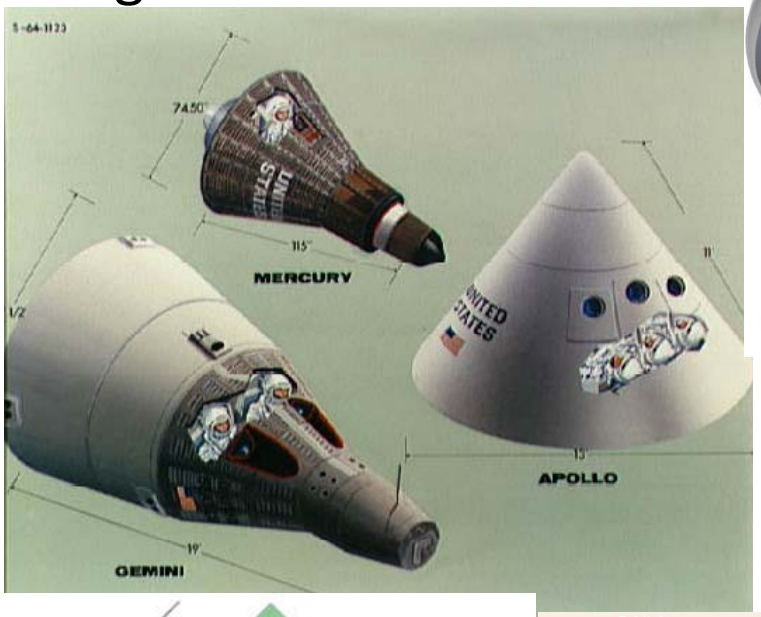
Charles.H.Campbell@nasa.gov
NASA-JSC Applied Aeroscience and CFD Branch/EG3

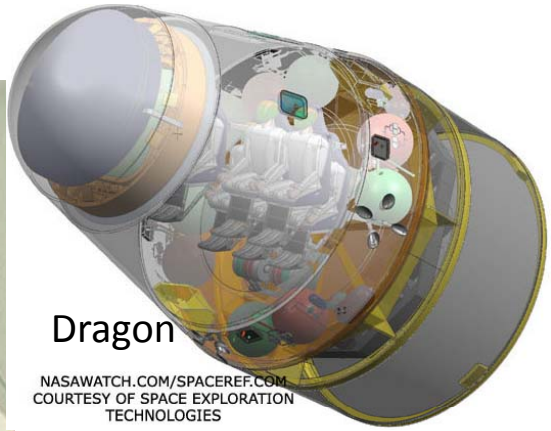




Blunt Entry Vehicles

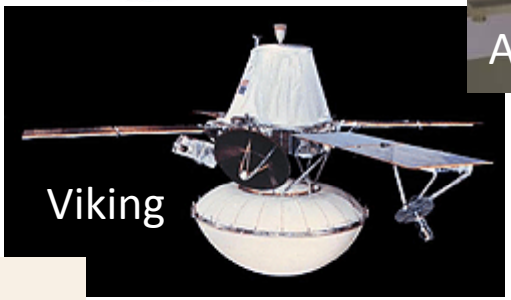
Majority of entry spacecraft are blunt vehicles flown with low lift-drag at trim conditions





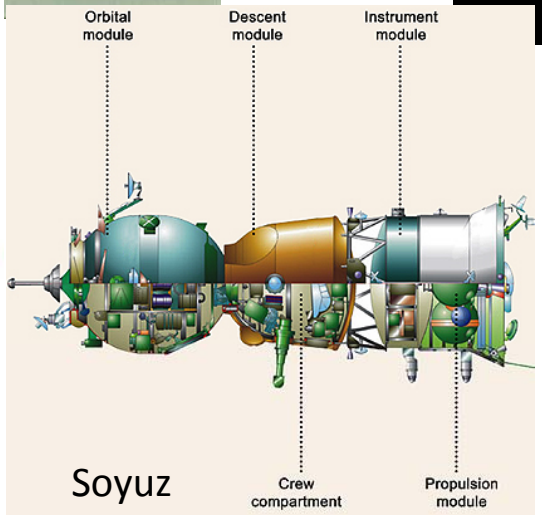
Dragon

ARD



Viking

Shenzou

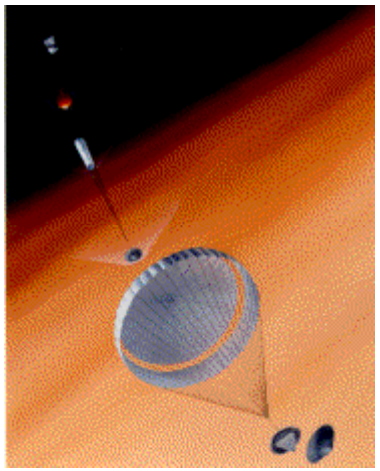


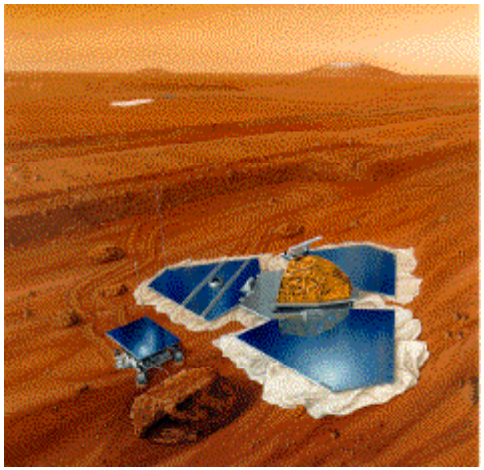
Soyuz

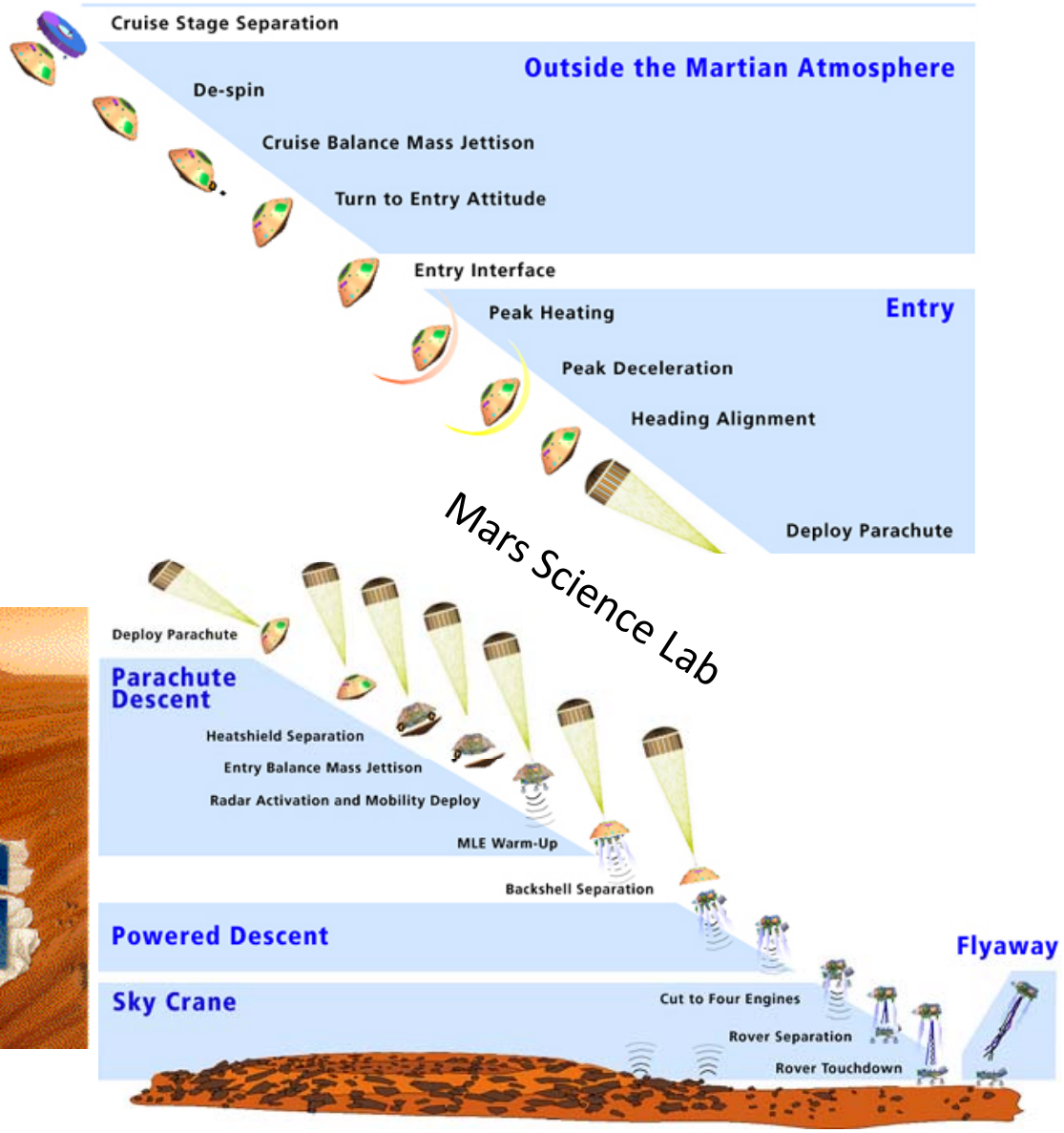
Galileo

Blunt Vehicle Landing Systems

Pathfinder/Sojourner

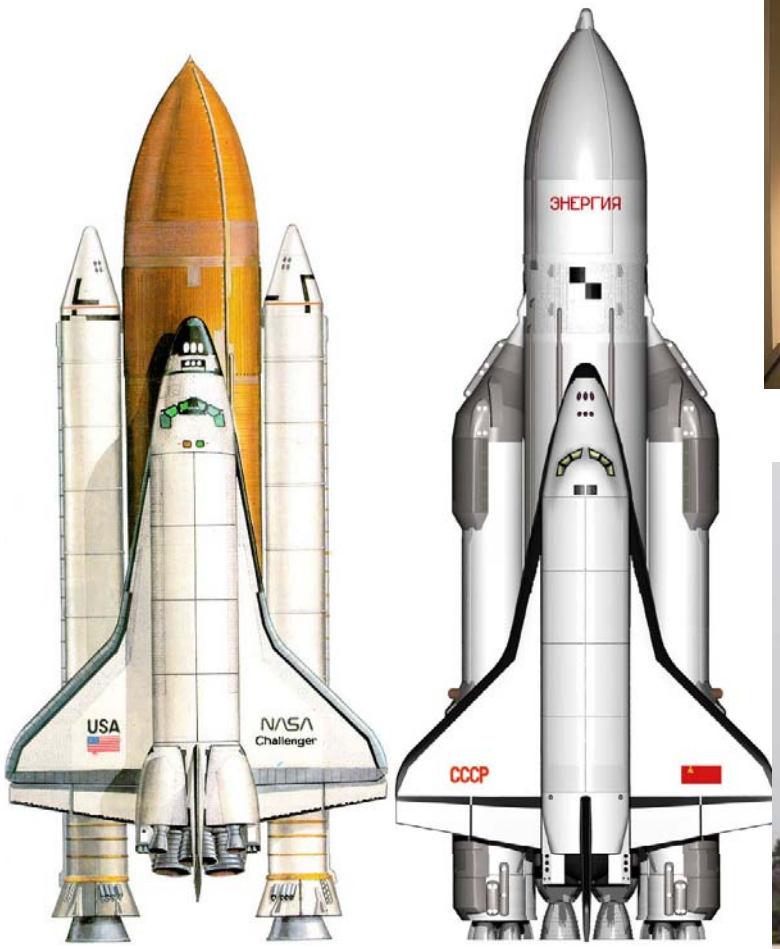


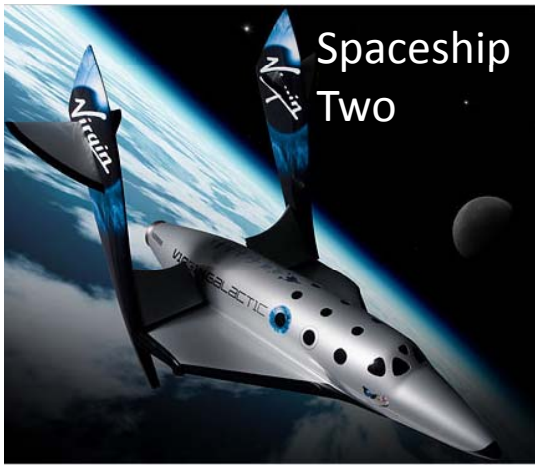


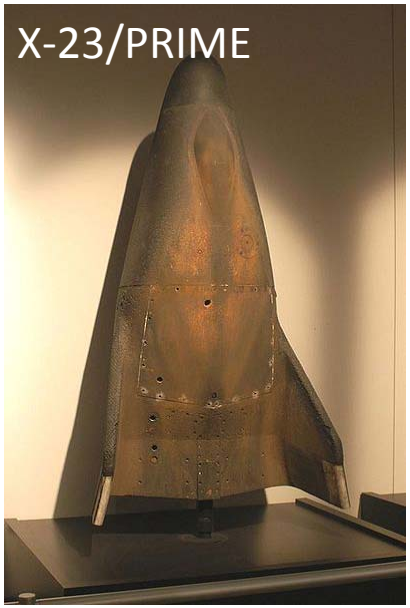


Lifting Entry Vehicles

Entry Vehicles that generate at least moderate lift-drag ratios are much less common. On Earth, they enable runway landing…..





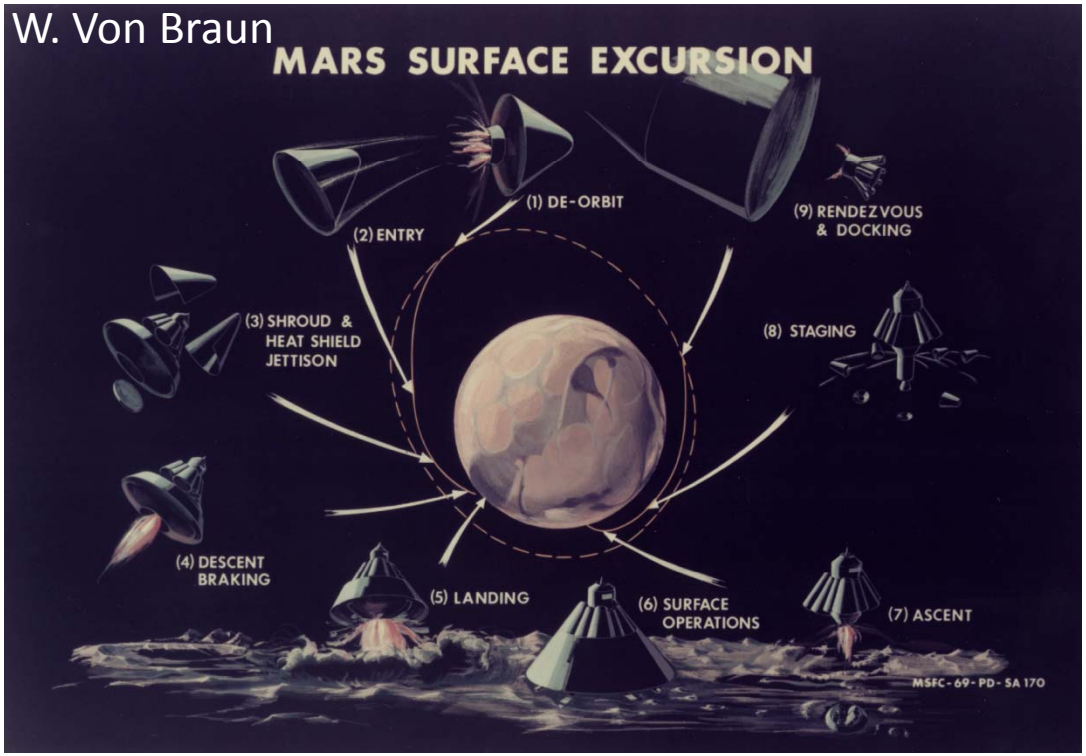


Flight Test Vehicles

Testing of new technologies is critical to developing knowledge and experience necessary to utilize new approaches

Ideas from the Past can Inform Us

W. Von Braun



Entry Vehicle Concepts

Exploration Systems MD
- Constellation
- ETDD

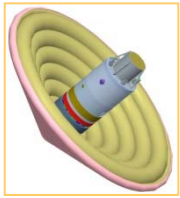
Space Operations MD
- ISS Utilization
- CCDeV
- COTS

Office of Chief Tech.
- Early Stage Innovation
- Game Changing Tech.
- Cross Cutting Tech.

Other Govm't Agencies
- DARPA
- AFRL
- AFOSR
- DOE

On-Orbit Capabilities

Ground Based Construction



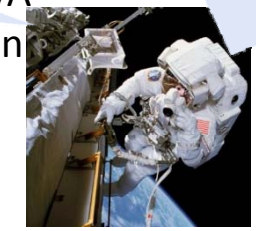
On-Orbit Deployment

Risk
Reliability
Technology Maturity
Commercial Space
International Partnering
Non-recurring Cost
Recurring Cost
Etc.

On-Orbit Assembly

On-Orbit Robotic Construction

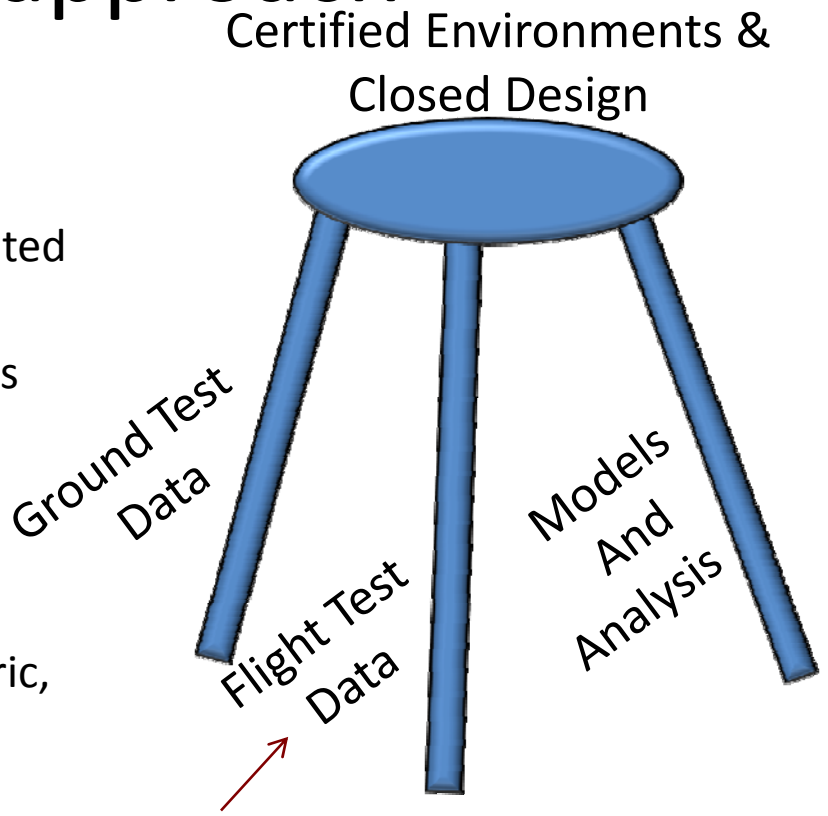
On-Orbit EVA Construction



NASA OCT Grand Challenges can identify framework, and OCT/NRC Roadmapping can define goals.

Modeling / Ground /Flight Testing Three pronged approach

- Integrity of Flight Environments modeling *requires* 3-legged stool approach
- Demonstration of vehicle design margin requires application of flight relevant models validated/calibrated with ground and flight data
- Closing a design and certifying a flight vehicle requires an integrated modeling framework which captures all relevant phenomena
- Current SOA for integrated EDL analyses utilizes 6-DOF monte carlo with *simplified response models* using material, aero, aerothermodynamic, atmospheric, etc. databases
- Enhanced integrated entry analyses should leverage high fidelity response surface modeling and inclusion of detailed physical models where possible



Integrated Simulation is a surrogate for flight test data.

An integrated analyses framework is required for DDT&E, and should be performed with the highest practical fidelity using comprehensive SOA.

Ideas that May Enable Future Capabilities

- Flexible Thermal Protection Systems
- Combined aero/propulsive capabilities
- Inflatable/Deployable approaches that are scalable across large range of masses
- On-orbit construction of large vehicle systems
- Supersonic Retro-Propulsion
- Auto-rotation landers
- More capable supersonic parachutes

- Ultimately, the entry vehicle aerodynamics and controllability must provide for sufficient altitude to support deployment terminal guidance and touchdown systems
  - Is supersonic reconfiguration possible?
  - Is sufficient lift/drag provided to stage for terminal approach?
  - Are vehicle touchdown systems appropriate to the task of landing in a variety of gravitational and planetary surface characteristics?