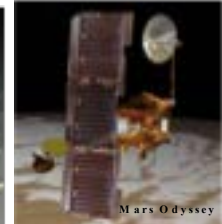




Mars Polar Lander



Stardust



Mars Odyssey

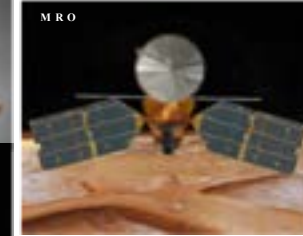


Genesis

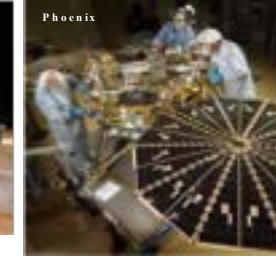


MER-A

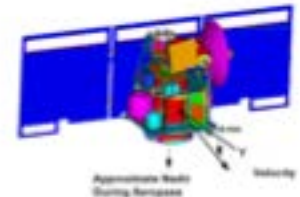
MER-B



MRO



Phoenix



Mars Climate Orbiter



Mars Global Surveyor



Mars Pathfinder Aeroshell



Magellan



MSL Aeroshell



Maven



OSIRIS-REx



InSight

*Bill Willcockson*

*37 Years of Aeroassisted Spacecraft*

*at*

*Martin Marietta*

*and*

*Lockheed Martin*

*IPPW-15, 6/14/2018*

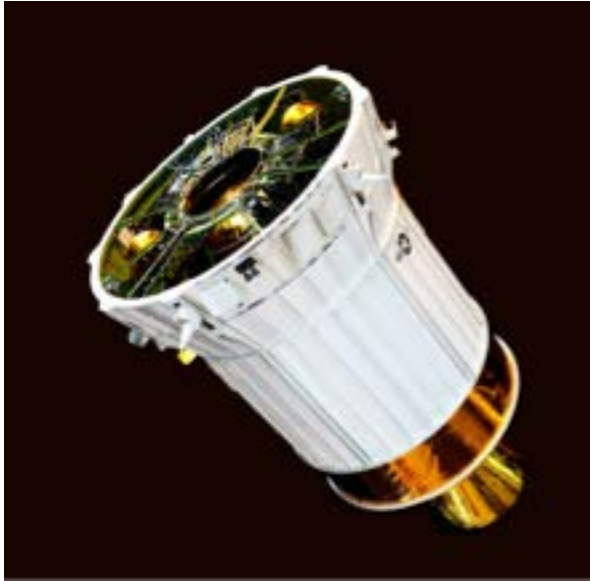
# *Wernher von Braun – Space Activist for the 1950's*



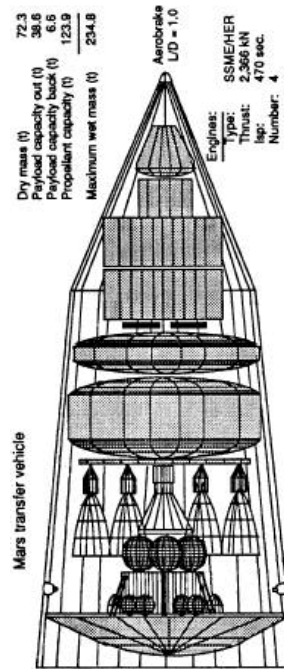
**Best Promoter of Space Exploration in the 1950's**  
**Magazine Articles (Colliers)**  
**Artwork with Chesley Bonestell**  
**TV Shows with Walt Disney**  
**Promoted the Possibilities of Coming Space Age**  
**The Fabulous Space 60's Owe Much to von Braun**



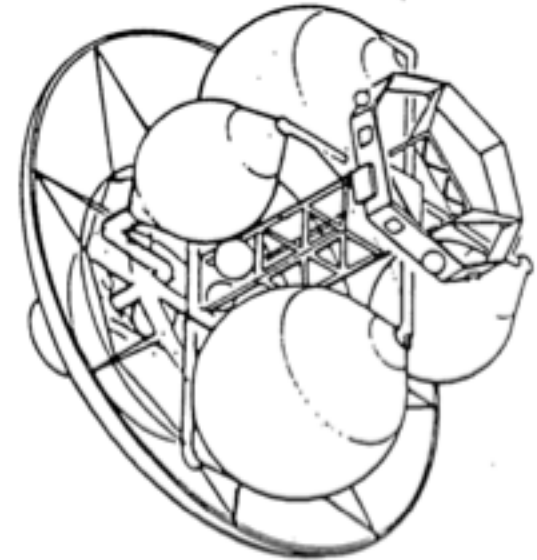
# Joining the Space Program – Martin Marietta 1980



*IUS (Inertial Upper Stage)  
Boeing*



*Manned Mars*



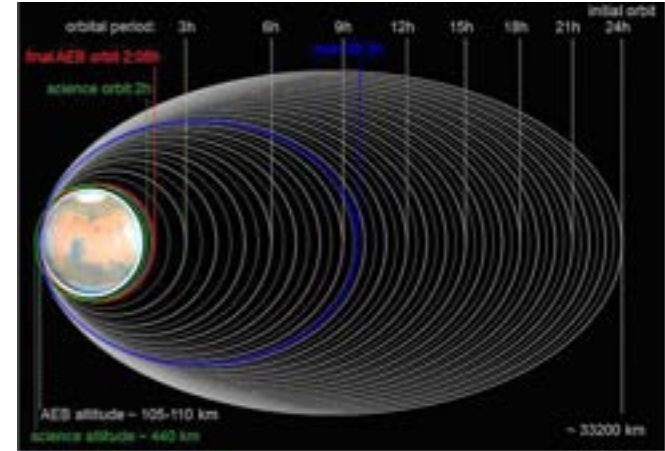
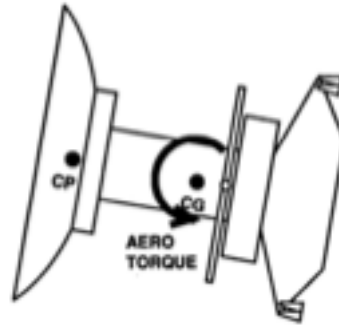
*OTV (Orbit Transfer Vehicle)*

**Titan/IUS Guidance V&V  
A Need For OTV Aero Support One Day....**

**Orbit Transfer Vehicle (OTV) Studies  
Manned Mars Studies (with Ben Clark)**



# Magellan – First Major Planetary Aerobraking (1993)



(ESA TGO Profile)

**First Major Planetary Aerobraking Mission  
Aerodynamics & Aeroheating Predicts**

**Operational Corridor Concept**

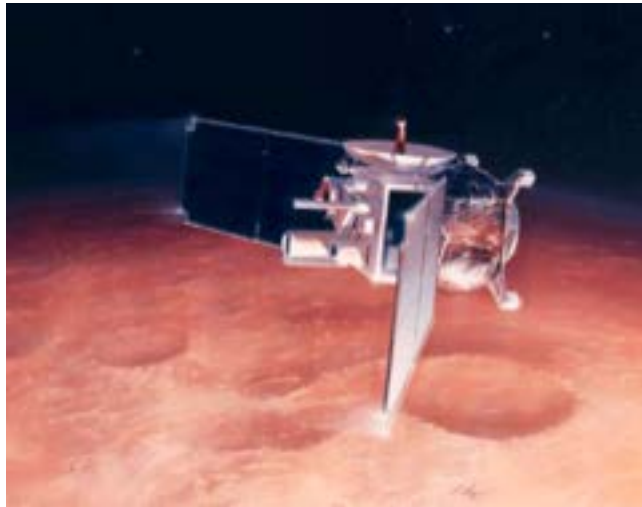
**Sliding Sequencer for S/C events**

**Apoapsis: 8470 km to 542 km in 2 months**

**1.7mps per pass, 730 passes, 1221 mps total**

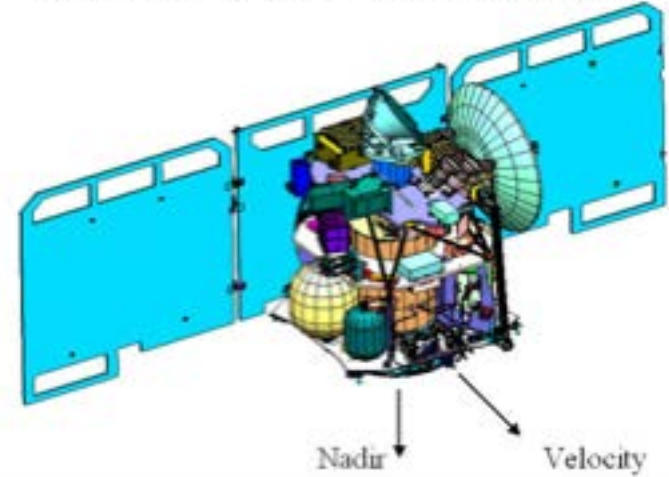


# *Follow-On Missions Utilizing Aerobraking*

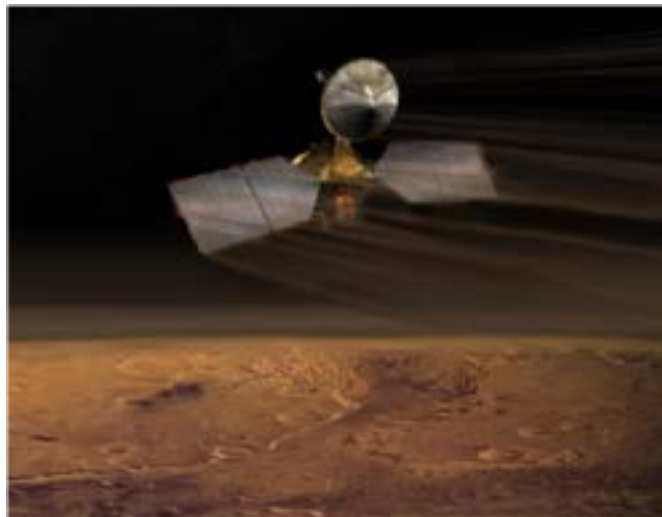


*MGS (1996)*

AEROBRAKING CONFIG - NORMAL



*Mars Odyssey (2001)*

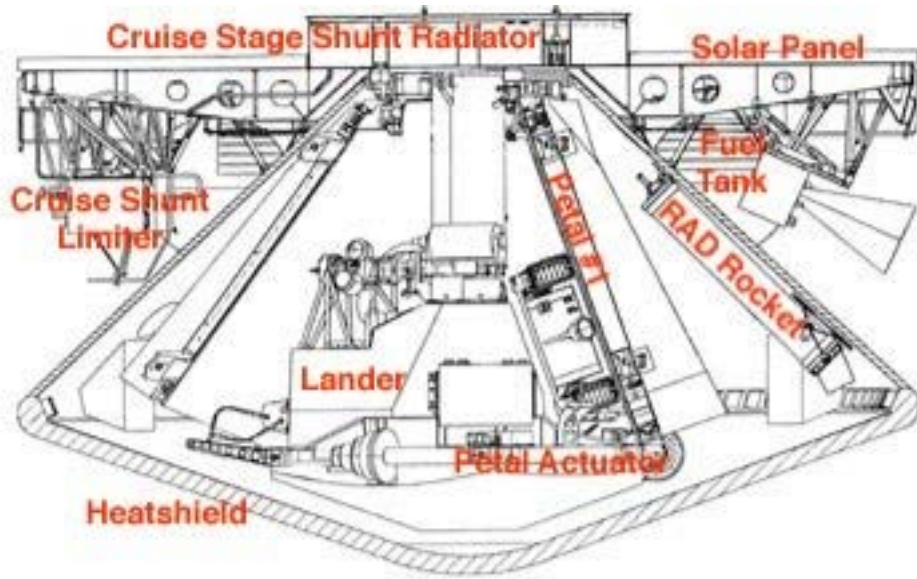


*MRO (2005)*



*Maven (2013)*

# *Mars Pathfinder 1996 – First Mars Lander After Viking*



**First Mars Lander Since Viking 1976**  
**Heatshield+Backshell Built in Denv**  
**Viking SLA-561V Ablator + Composite Structure**  
**Mars Direct Entry and Retrograde**  
**Highest Entry Speed of any Mars Lander**



# *Follow-on NASA Aeroshell Missions*



*MER – Spirit/Opportunity (2003)*



*Phoenix (2007)*



*MSL – Curiosity (2011)*

**MER Aeroshell (2)**

**Phoenix**

**MSL Aeroshell**

**Stardust SRC**

**Genesis SRC**

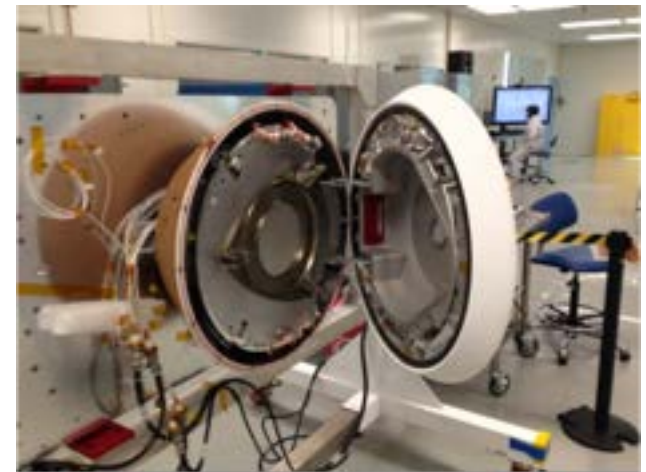
**OSIRIS-Rex SRC**

**InSight**

**Mars-2020 Aeroshell**

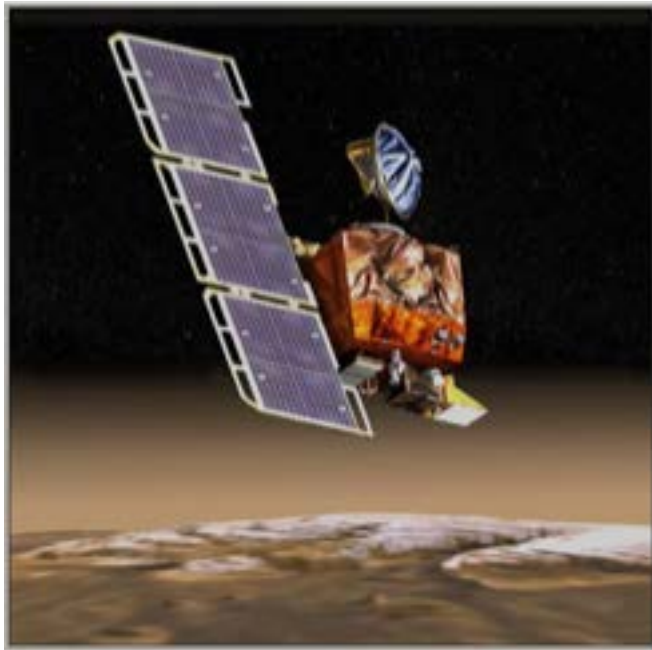


*Stardust (1999)*

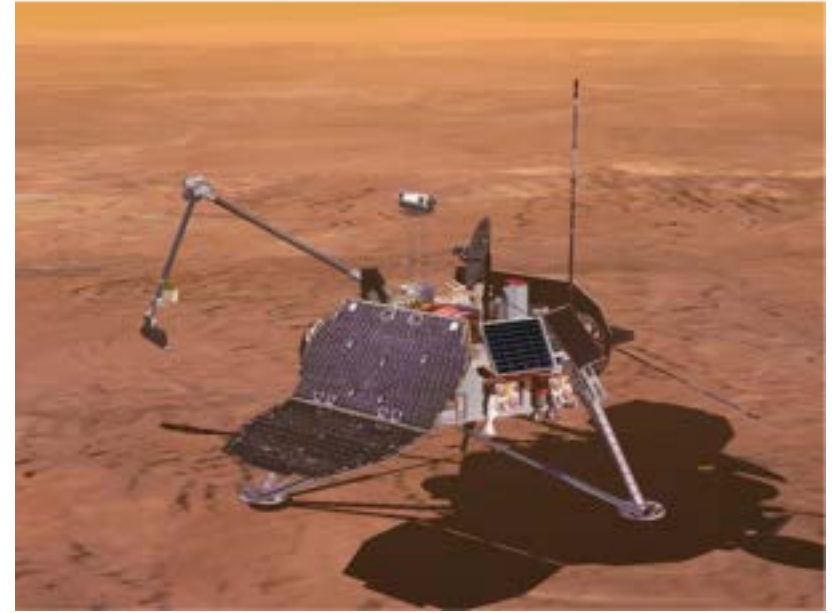


*OSIRIS-Rex (2016)*

# *The Failed Mars-98 Missions*



*Mars Climate Orbiter*



*Mars Polar Lander*

## **Mars-98 Missions**

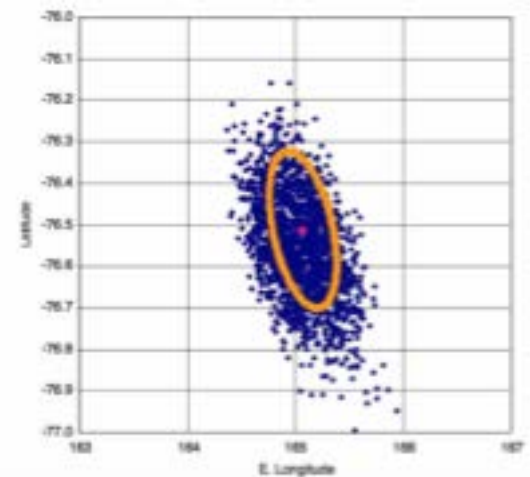
**Lost in 1999 despite a lot of very hard work**

**The Limits of Faster/Cheaper/Better**

**Daughter Spacecraft Succeeded**

**Mars Odyssey Orbiter (2001)**

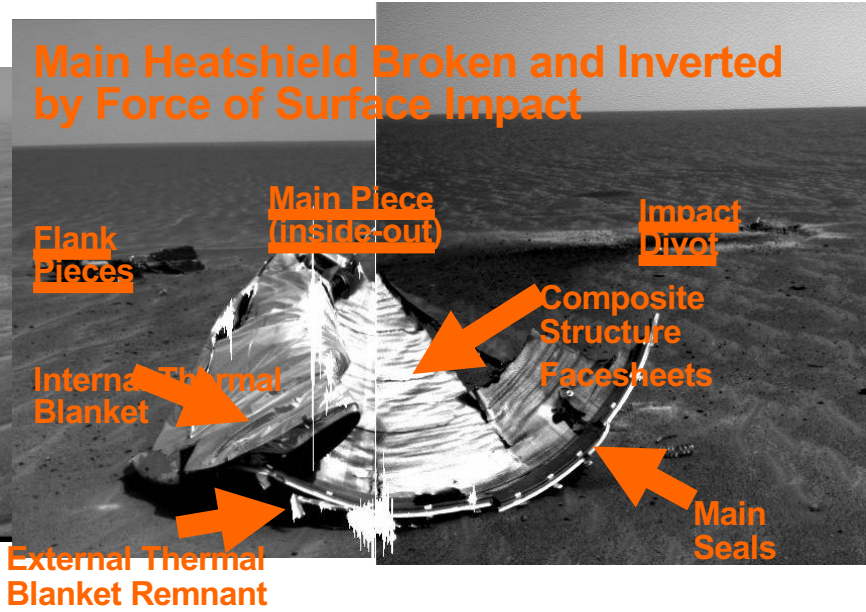
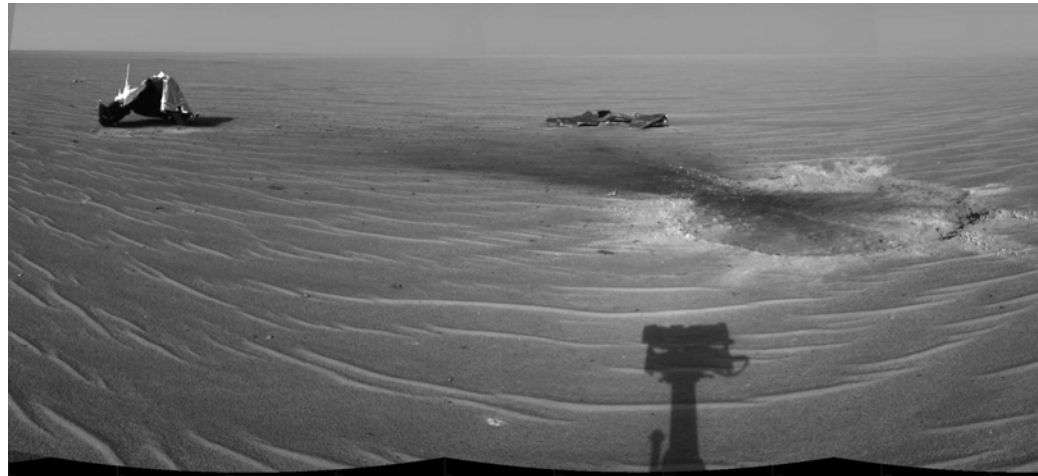
**Phoenix Lander (2007)**



*MPL Search Ellipse*



# MER/Opportunity Rover Heatshield Inspection (2004)



**First In-Situ Exam of Expended Mars Heatshield  
Opportunity Rover Drove to Debris Site**

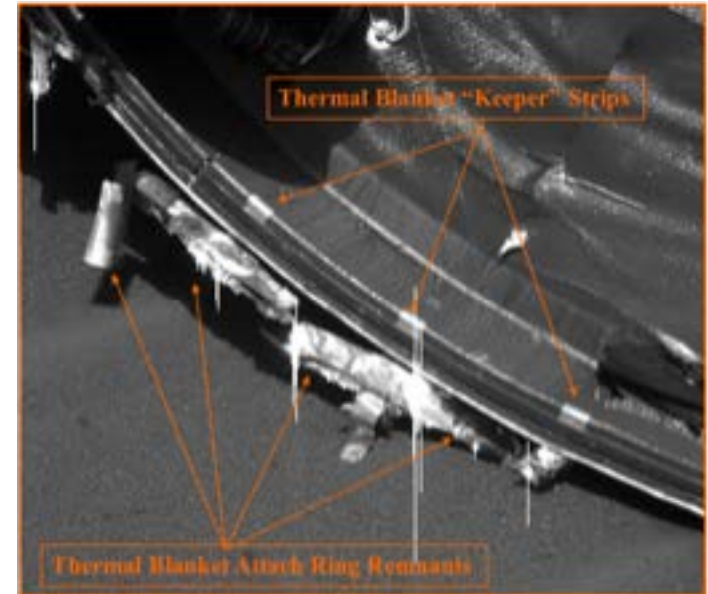
**Inspection Showed Nominal TPS Performance**

**Assessed via Remaining Virgin Ablator Layer  
No Thermal Distress of Structure or Seals**

**Also Showed Source of Entry Oscillations**

**GFE Thermal Blanket Strip**

*Mars Exploration Rover Heatshield Observation Campaign – Szalai, et al  
Anomalous Disturbance Torques During the Entry of MER – Tolson, et al*



*All in All*

**An Amazing String of Spacecraft Built in Colorado**

**Talented & Dedicated Team-Members, Supportive Management**

**The Importance of Private Industry**

**Don't be Shy to Answer that Knock on the Door**