



**NASA Mars Exploration Program**

# **Rough Lander Concept for Mars Exploration**

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# AGENDA

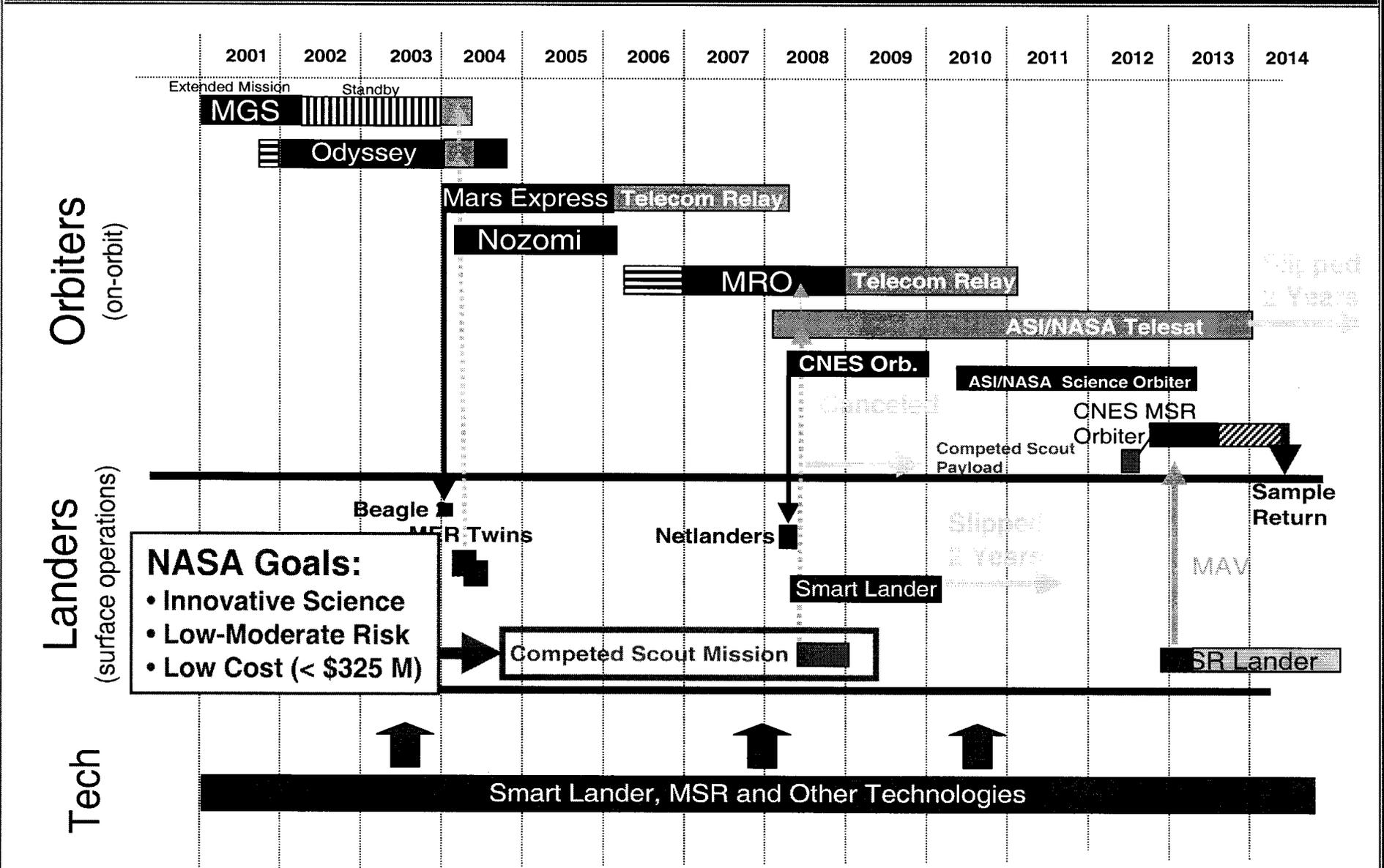


- **Mars Program Overview**
- **“Scout-Class” Landed Missions**
- **Rough Lander Concept**



# MARS PROGRAM OVERVIEW

## Program Schedule Summary (as of Sep. 2001)



**NASA Goals:**

- Innovative Science
- Low-Moderate Risk
- Low Cost (< \$325 M)



# SCOUT-CLASS LANDED MISSIONS

## Goals and Considerations

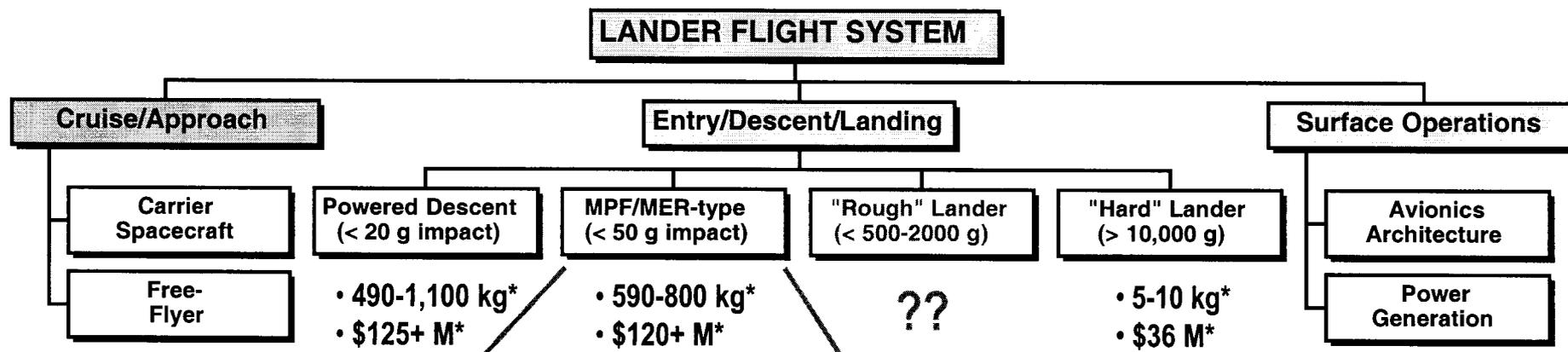


- **Multiple Landers**
  - Small Size
  - Low Cost
  - Low/Distributed Risk
- **Surface Access**
  - Landing Site Latitude
  - Landing Site Elevation
  - Rugged Terrain
- **Science Payload Accommodation**
  - Instrument Packaging
  - Mass and Power
  - High Data Transport Capability
  - Relatively Short Mission Duration



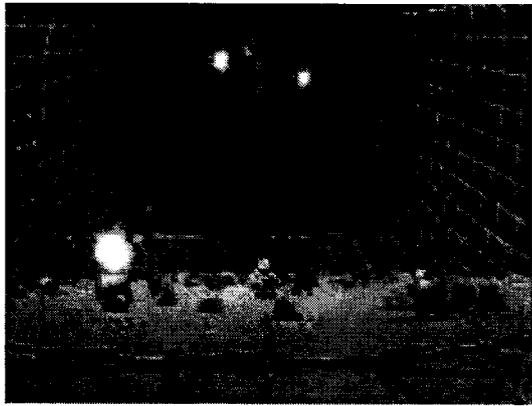
# SMALL SCOUT LANDER (cont'd)

## Flight System Trade Space



\*Entry mass range and low end of cost range for previous systems

**Airbag Subsystem Drop Test**  
NASA Plumbrook Station (1995)



**Design Characteristics**

- rugged and robust
- large mass fraction
- high mechanical complexity
- empirical design process
- high testing costs

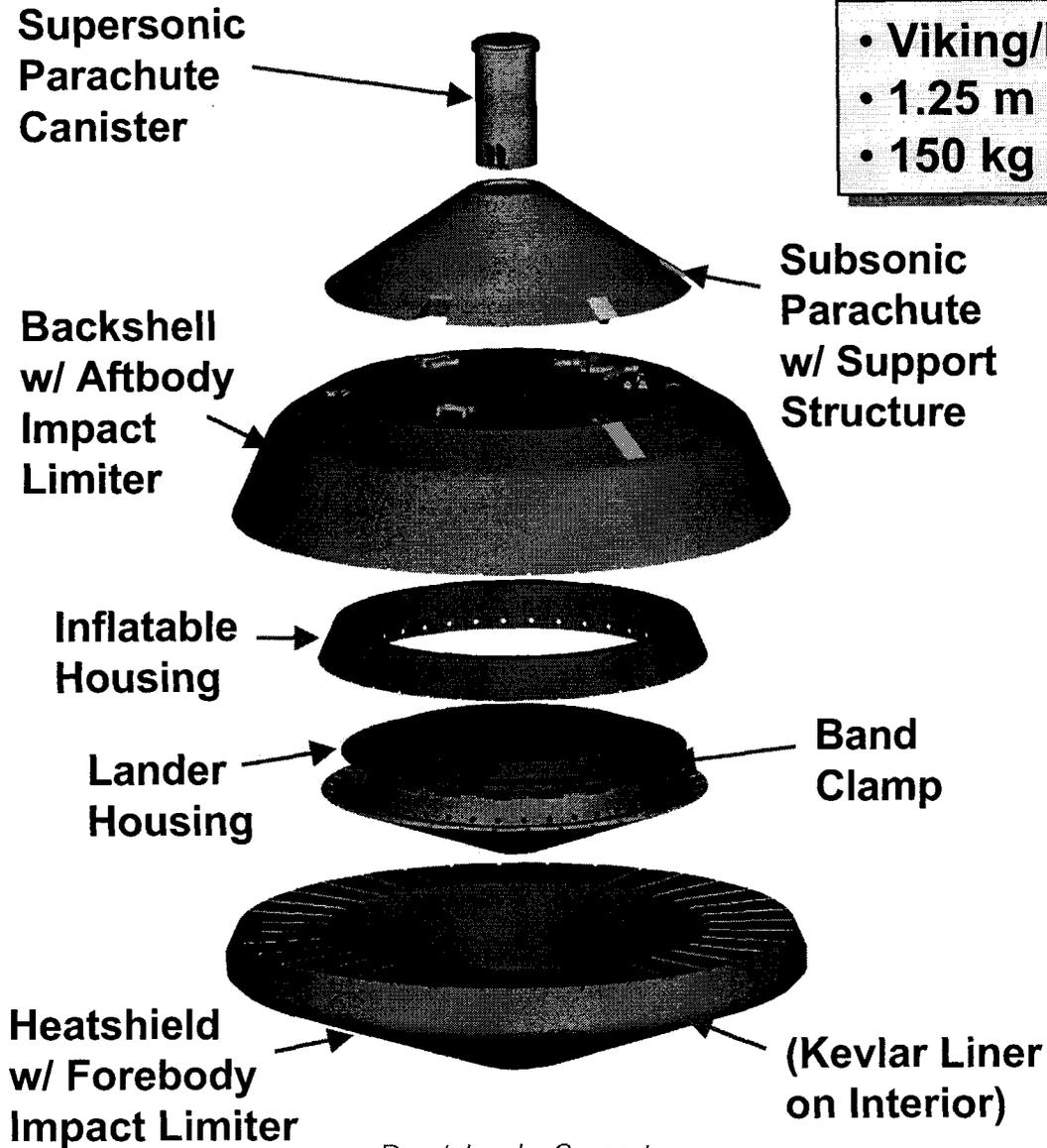
**Key:**

- Major Cost Driver(s) Identified
- No Significant Cost Leverage



# ROUGH LANDING CONCEPT

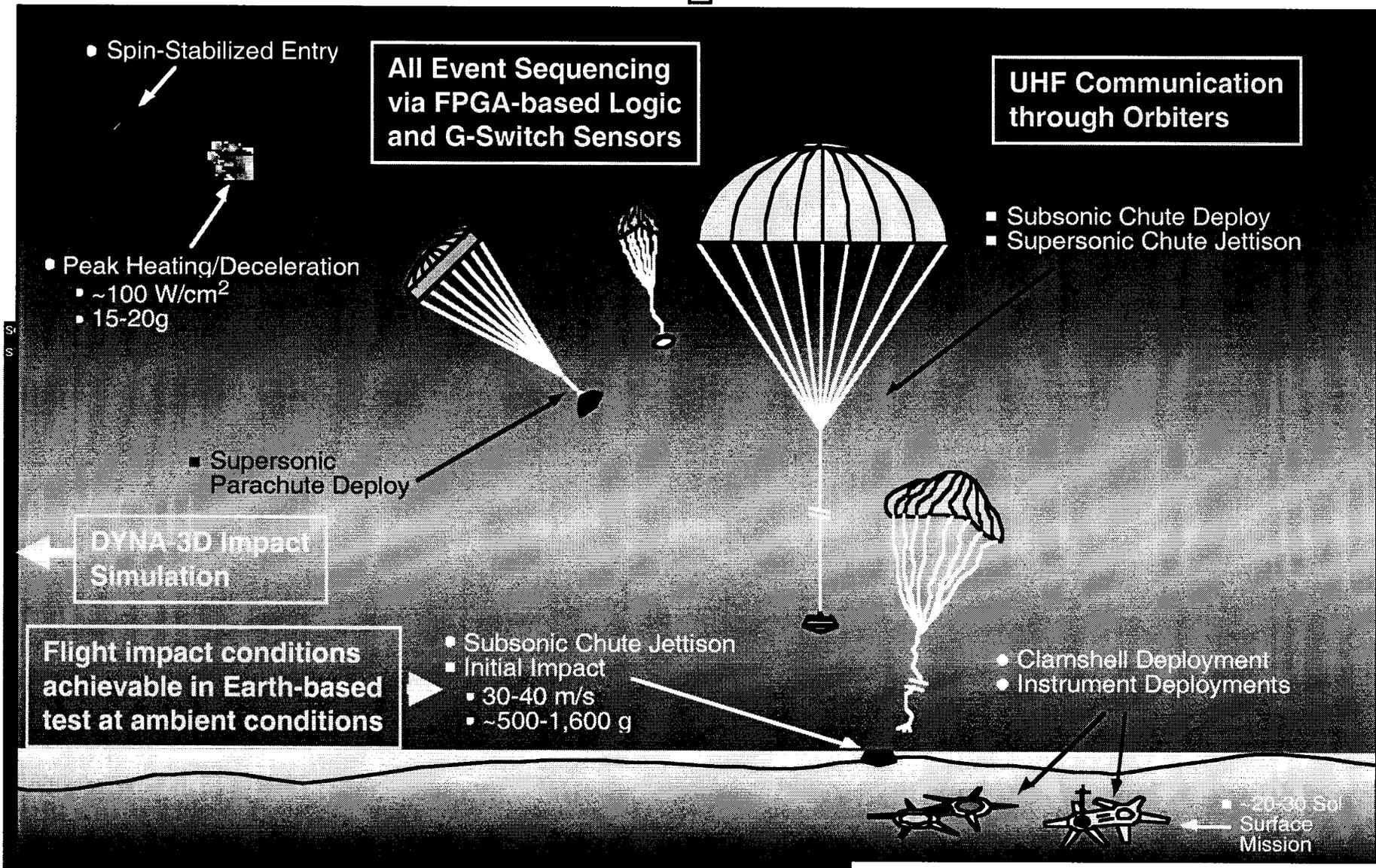
## Flight System Configuration





# ROUGH LANDING CONCEPT (cont'd)

## Entry/Descent/Landing Sequence



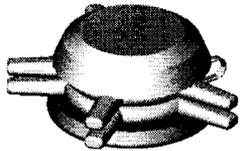


# ROUGH LANDING CONCEPT (cont'd)

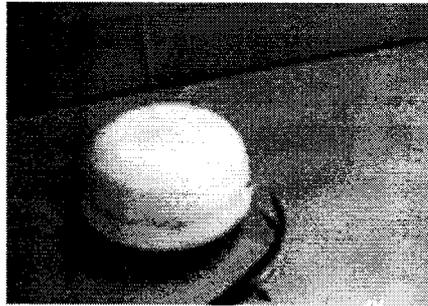
## Inflatable Self-Righting System



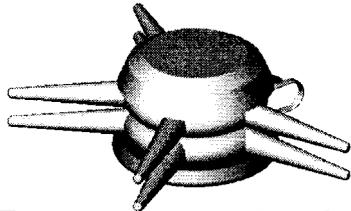
1. Lander after TD.



2. Torus and arms begin to inflate.

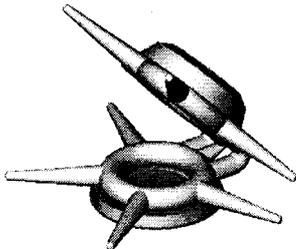


**Proof-of-concept inflatable self-righting system built and successfully tested for Mars Smart Lander in 2001.**

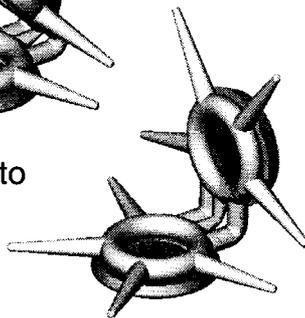


3. Torus and arms inflated.

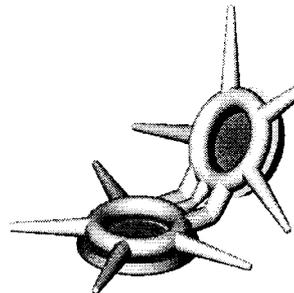
**Gas generator-inflated vectran bladder system provides tip-over stability and self righting force required to automatically open and upright the backshell and forebody.**



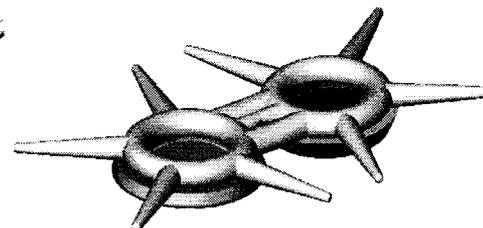
4. Elbows begin to overturn lander.



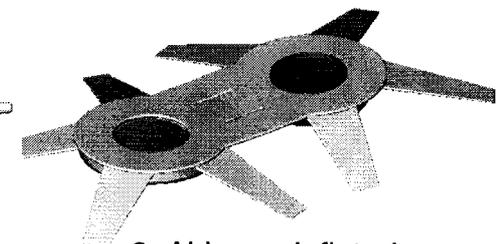
5. Lander overturning.



6. Lander overturning (cont'd).



7. Lander opened and righted.

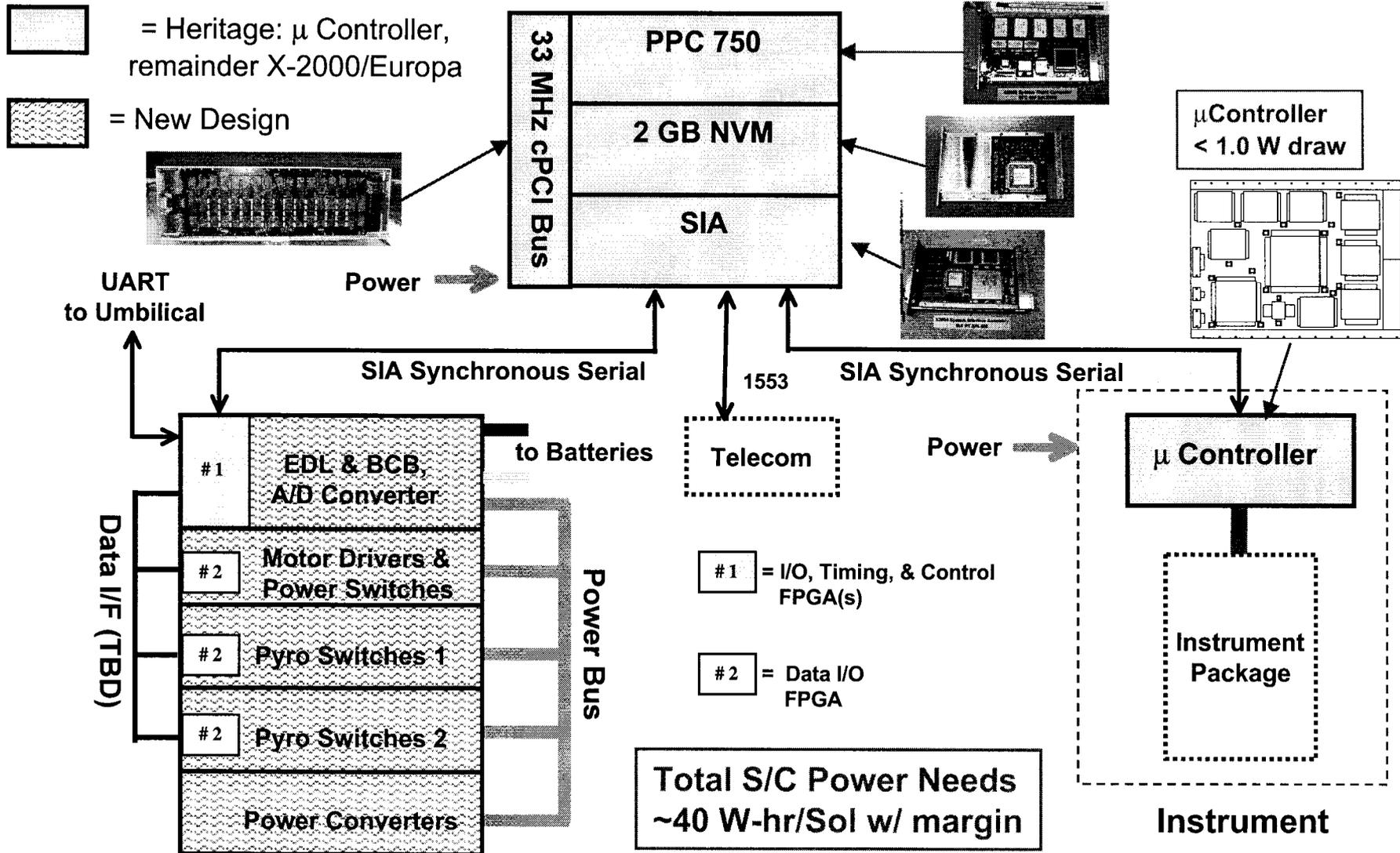


8. Airbags deflated, EDL complete.



# LANDER FLIGHT SYSTEM (cont'd)

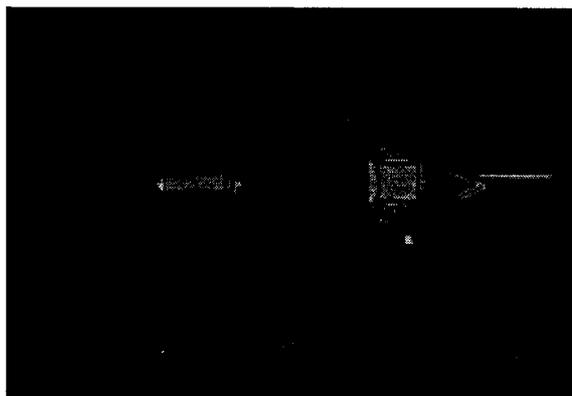
## Avionics Subsystem Block Diagram



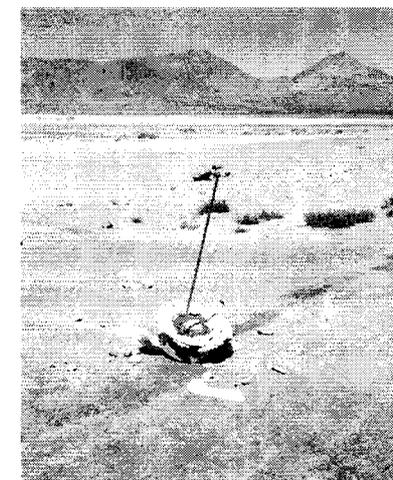
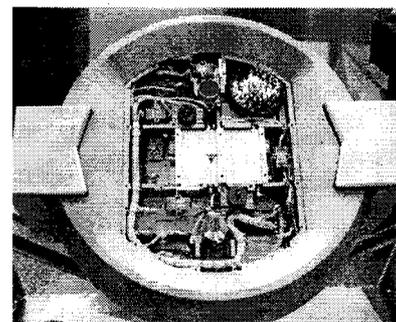
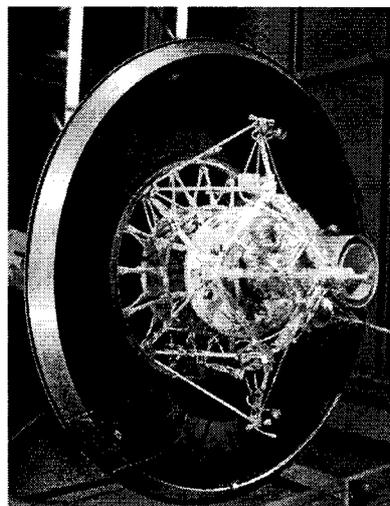
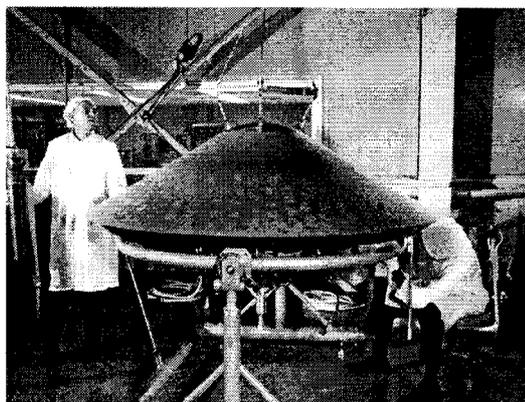


# HISTORICAL COMPARISON

## Capsule System Advanced Development, 1967-68



### CSAD Rough Lander Mission Concept



### Feasibility Model Development and Testing